

DESCRIPTION**"Floating unit for drilling operations"**FIELD OF APPLICATION

[0001]. The present invention relates to a floating unit
5 for drilling operations

[0002]. The floating unit according to the invention may consist of a drillship intended, in particular, for operating in deep (over 450m) and ultra-deep (over 1,500m) waters, for localising, exploring and exploiting deposits
10 of hydrocarbons or other energy and mineral resources.

[0003]. Alternatively, the floating unit according to the invention may consist of a drilling platform, in particular of the semi-submersible type.

STATE OF THE ART

15 [0004]. As is known, in the current floating units for offshore drilling, whether ships or platforms, in almost all cases the drilling rigs comprise - at least one drilling tower (known in jargon as derrick) consisting of a structural trestle-work characterised by a structure of
20 crossed rods bolted to each other.

[0005]. Almost all the drilling equipment, including the hook for hoisting the drill strings, is enclosed within the trestle-work structure.

[0006]. From a structural point of view, as shown in
25 Figure 1, the trestle-work structure A rests on the so-

called drill floor B. In turn, the drill floor B is supported by a scaffolding C, known in the jargon as "substructure", which in turn is placed on the main deck D of the ship. Generally speaking, the substructure C
5 comprises four support columns C1 which support the drill floor B and are placed at the support points of the trestle-work structure on the drill floor and continue vertically to interlock deep down in the hull structure under the main deck. The vertical forces are discharged
10 along the four corners of the base which rest on the drill deck. This solution has been widely experimented in over twenty years of use on various offshore floating vessels. The entire structure described above extends upwards of a central well E (in the jargon "moon pool") which extends
15 from the main deck as far as the bottom and through which there is direct access to the water.

[0007]. Over recent years, in order to resolve a number of technical and industrial issues related to trestle-work drilling tower, structural alternatives have been proposed
20 which replace the trestle-work with one or two towers having a box-like structure. The hoisting hook is placed outside the tower and overhangs in relation to the axis of said tower.

[0008]. This alternative solution permits a more
25 industrial, modern approach to the construction of the

tower, which may be built by welding instead of bolting, and other operating advantages directly related to the drilling operations. Considered as a free-standing system and compared to the trestle-work structure of the traditional derrick, the main advantage of the box-like structure tower lies in its simplicity and its industrialised construction. The further advantages are of an operational nature.

[0009]. The integration of a box-type tower on a floating unit for drilling operations entails however the adoption of a series of structural modifications to the substructure of the tower above the main deck. In particular, the drill floor needs to be adequately strengthened to enable it to withstand the weight of the box-like structure tower, taking into consideration the asymmetric distribution of the weights and strains generated by the fact that in a box-like structure tower, unlike a trestle-work derrick, the drilling devices are placed externally to said tower.

PRESENTATION OF THE INVENTION

[0010]. Consequently, the purpose of the present invention is to eliminate the drawbacks of the prior art mentioned above, by making available a floating unit for drilling operations, and in particular a drill ship, which does not require a structurally oversized drill floor in

terms of load capacity, despite being fitted with one or more drilling towers having a box-like structure with drilling devices external to said tower.

[0011]. A further purpose of the present invention is to make available a floating unit for drilling operations, and in particular a drill ship, fitted with one or more drilling towers having a box-like structure, which permits adequate operativity of the drilling devices through the relative moon pools.

10 BRIEF DESCRIPTION OF THE DRAWINGS

[0012]. The technical characteristics of the invention, according to the aforesaid purposes, can be seen clearly from the contents of the following claims and the advantages of the same will be more clearly comprehensible from the detailed description below, made with reference to the attached drawings, showing one or more embodiments by way of non-limiting examples, wherein:

[0013]. - Figure 1 shows a schematic isometric view of a trestle-work tower of the traditional type and of the relative support structure of the drill floor on the main deck;

[0014]. - Figure 2 shows a perspective view in cross-section of a floating unit according to the present invention, consisting of a drill ship;

25 **[0015].** - Figure 3 shows an enlarged detail of Figure 2,

relative to the engagement zone of the drilling towers in the ship body;

[0016]. - Figure 4 shows an isometric view of the cross-section in figure 2, according to the arrow IV indicated
5 therein;

[0017]. - Figure 5 shows figure 4 with the movement of the positioning of the drill strings by means of the drilling tower represented;

[0018]. -Figure 6 shows a simplified view of a portion
10 of the ship in figure 2, according to a cross-section taken along a longitudinal centreline plane passing through the moon pools.

[0019]. - Figure 7 shows a perspective view of an alternative solution to that shown in Figure 3, relative
15 to the engagement zone of the drilling towers in the ship body;

[0020]. - Figures 8 and 9 shows two isometric views, from the front and side respectively, of a floating unit according to the present invention, consisting of a
20 drilling platform;

[0021]. - Figures 9 and 10 shows two isometric views, from the front and side respectively, of an exploded detail of the structural interface between the floating unit and drilling tower according to the invention.

[0022]. The floating unit according to the invention may consist of a drillship or alternatively of a drilling platform, in particular of the semi-submersible type.

[0023]. With reference to the appended drawings,
5 reference numeral 1 globally denotes a floating unit for offshore drilling according to the invention consisting of a ship and with reference numeral 100 a floating unit for drilling operations according to the invention consisting of a platform.

10 **[0024].** Here and henceforth in the description and the claims, reference will be made to the floating unit for drilling operations, whether a ship 1 or platform 100 in conditions of use. References to an upper or lower position or horizontal or vertical direction should
15 therefore be understood in this sense.

[0025]. According to a general embodiment of the invention, the floating unit for offshore drilling operations 1, 100 comprises a floating structure 2 which defines a main deck 3, above which a drill floor 4 is
20 positioned, and at least one drilling tower 5 which extends above the drill floor 4 next to at least one moon pool 6.

[0026]. In particular, as shown in Figure 7, the floating structure 2 may define one or more secondary
25 decks 7 positioned below the main deck 3.

[0027]. In the case in which the floating unit consists of a ship the aforesaid floating structure is defined by the hull 2 of the ship 1, which extends along a longitudinal axis Z between a bow 21 and a stern 22.

5 **[0028].** In the case in which the floating unit consists of a semi-submersible platform, the aforesaid floating structure comprises: at least one deck 101, which in conditions of use is above water; - a hull 102, which is positioned under the deck, and is fitted internally with
10 first watertight compartments acting as ballast and in conditions of use is under water; and - a plurality of columns 103 which structurally connect the hull 102 to the deck 101.

[0029]. As may be observed, for example in Figures 2 and
15 5, or in Figures 8 and 9 the moon pool 5 vertically crosses the floating structure at the drill floor 4 as far as the bottom 8 of said floating structure.

[0030]. Advantageously, as shown in Figures 2 to 7, the floating unit, in particular if consisting of a ship 1,
20 may be fitted with two or more drilling towers 5. Such two or more towers may each operate on its own moon pool, independently of the others, or alternatively may operate on a single communal moon pool.

[0031]. Preferably, as shown in the appended drawings,
25 each of the aforesaid one or more drilling towers 5 serves

a single drill line. In other words, preferably such two or more towers operate independently of each other.

[0032]. Advantageously, even in the case in which the floating unit has a single drilling tower, such tower may
5 be structured to serve a single drill line.

[0033]. Preferably, in the case in which the floating unit is a ship, the single moon pool or independent moon pools where provided for are made on the longitudinal centreline axis Z of the ship.

10 **[0034].** The aforesaid at least one drilling tower 5 has a box-like structure, of a column shape with a base of any shape (generally circular) and is fitted with a hoisting hook 50 of the drill strings placed outside the tower and projecting in relation to the vertical extension axis Y of
15 said tower.

[0035]. This type of tower supports a compression load only, both the external, overhanging load suspended from the hoisting hook 50 and the pull coming from the hoisting winch cables 51 on the opposite side to the tower being
20 perfectly aligned, vertical and symmetrical. As shown for example in Figures 5 and 8, the hoisting cables of the hook go to a pair of pulleys 52 and 53, positioned on the top 5' of the tower 5 and directly running to the winch 51 symmetrically to the hoisting hook 50. Such geometry
25 guarantees a perfect vertical and symmetrical alignment of

the hoisting cables and thus a static load on the tower solely of compression.

[0036]. According to the invention, the aforesaid at least one drilling tower 5 is directly supported by a support structure 10 structurally integrated with the floating structure 2 of the floating unit. The support structure 10 and/or the tower 5 crosses the drill floor 4.

[0037]. The drill floor 4 is structurally supported by the support structure 10 of the tower 5, by the tower itself or by both the support structure and the tower.

[0038]. The technical solution, which the present invention is based on, has conceptually overturned the traditional approach.

[0039]. As already mentioned above, traditionally the drill floor or drill deck, which the feet of the base of the traditional trestle-work tower (derrick) rest on, is directly supported by a scaffolding provided with vertical legs (substructure), which engage on the main deck of the ship and then directly on the internal structures of the unit.

[0040]. According to the invention, it is the drill floor (or drill deck) instead which is supported by the drilling tower or support structure which the tower rests directly on. This means that the drilling tower does not rest on the drill deck, but crosses it and engages

directly in the floating structure 2 by means of the aforesaid support structure 10.

[0041]. The drilling tower is thus made entirely independent of the drill deck. Considering that the drill
5 deck is essential for operating purposes and must be positioned higher than the main deck, it proves advantageous to make use of the presence of the tower and relative support structure to rest thereon the drill deck also.

10 **[0042].** This structural solution has a number of advantages among which a significant reduction in weight, other features being equal. The drill deck does not in fact have to be sized to support the weight of the tower.

[0043]. Advantageously, the drill floor 4 (or drill
15 deck) - as well as the tower 5 and/or support structure 10 of the tower - may also be conveniently supported by dedicated pillars or other vertical structures present in the perimeter of its extension.

[0044]. Preferably, as shown in the appended drawings,
20 the support structure 10 of the tower 5 extends vertically inside the floating structure 2. The support structure 10 may extend inside the floating structure 2 to a depth varying case by case and depending on the different opportunities and requirements to be considered separately
25 for each project.

[0045]. According to the embodiment illustrated in Figures 2 to 6, the support structure 10 of the tower extends vertically inside the floating structure 2 as far as the main deck 3 and is structurally integrated with the
5 main deck 3 resting thereon.

[0046]. According to the embodiment illustrated in Figure 7, the support structure 10 of the tower extends vertically inside the floating structure 2 as far as the bottom 8 thereof and is structurally integrated with the
10 bottom 8 resting thereon.

[0047]. According to an alternative embodiment, not shown in the appended drawings, in the case in which the floating structure 2 defines one or more secondary decks 7 positioned below the main deck 3, the support structure 10
15 of the tower may extend vertically inside the floating structure 2 as far as one of said secondary decks 7 and is structurally integrated with one of said secondary decks resting thereon.

[0048]. Preferably, the support structure 10 of the
20 tower 5 is a column structure.

[0049]. In particular, the support structure 10 of the tower is a tubular or box-like structure.

[0050]. Preferably, the support structure 10 comprises a main portion 11 which extends along a main vertical
25 extension axis X, laterally to the aforesaid at least one

moon pool 6 which the drilling tower 5 operates on supported by the support structure 10.

[0051]. Advantageously, the support structure 10 of the tower 5 comprises a portion 12 of interface and connection with the base 5' of the tower 5.

[0052]. The particular geometry of the box-like tower with hoisting hook positioned externally to the tower does not permit the tower to be positioned in line with the moon pool 6, but requires an installation lateral to said moon pool

[0053]. Preferably, as shown in the appended drawings and in particular in Figure 4, the aforesaid interface and connection portion 12 is offset in relation to the main vertical extension axis X of the support structure 10 and at least partially overlaps the moonpool 6. This way, the support structure 10 can support the box-like drilling tower 5 at least partially to overhang above the moonpool 6, so as to position the hoisting hook 50 above the moonpool 6.

[0054]. Preferably, the interface portion 12 extends in the moonpool so that the hoisting hook 50 is aligned with the main vertical extension axis Y of said moon pool.

[0055]. Alternatively, the drilling tower may be placed fully in line with the vertical extension axis of the support structure, avoiding the construction of cantilever

structures. However, to ensure adequate manoeuvring space for the drill strings, avoiding interference with the edges of the moon pool, the pulleys 51, 52 positioned on the top of the towers must be adequately enlarged to ensure a sufficient distance between the movement axis of the strings and the edges of the moon pool. The increase in dimensions of the pulleys increases the distance between the movement axis of the strings and the vertical extension axis of the tower. This determines an increase in the already large dynamic loads weighing on the tower which must therefore be adjusted from a structural point of view.

[0056]. The partial cantilever arrangement of the tower over the moonpool makes it possible to position the hoisting hook perfectly in line with the vertical extension axis of the moon pool using pulleys of smaller dimensions, thereby avoiding the need for oversizing of the tower. This translates into the possibility of installing a tower, which is lighter and occupies less space.

[0057]. Preferably, the drilling tower 5 is aligned perpendicular to the interface portion 12 of the support structure 10.

[0058]. In the preferred case in which the interface portion 12 is positioned so as to partially overhang the

moon pool, the support structure 10 of the tower 5 comprises a fitting portion 13 between the main portion 11 and the interface portion 12. Such fitting portion 13 extends from the main portion 11 towards the moonpool 6
5 deviating from the main vertical extension axis X of the support structure 10 of the tower 5.

[0059]. Preferably, as shown in Figures 10 and 11, the base 5' of the tower 5 and the interface portion 12 of the support structure 10 penetrate each other. In particular,
10 the base 5' of the tower 5 engages inside a seat 14 made in the interface portion 12.

[0060]. Advantageously, the base 5' of the tower 5 is attached to the interface portion 12 by means of a flanged coupling. However different types of coupling to a flanged
15 coupling may be provided for.

[0061]. Preferably, the floating unit consists of a ship. The floating structure is defined by the hull 2 of the ship 1, which extends along a longitudinal axis Z between a bow 21 and a stern 22.

20 **[0062].** According to the embodiment illustrated in Figures 2 to 7, the aforesaid at least one drilling tower 5 is positioned asymmetrically in relation to the longitudinal centreline axis Z of the ship, the tower 5 being shifted towards a first side 23 of the ship.

25 **[0063].** According to an embodiment not illustrated in

the appended Figures, the aforesaid at least one drilling tower 5 may be positioned symmetrically in relation to the longitudinal centreline axis Z of the ship, i.e. the drilling tower 5 is positioned on the longitudinal
5 centreline axis Z of the ship,

[0064]. Advantageously, in the case of asymmetric positioning of the tower, the drill floor 4 (or drill deck) - as well as by the tower 5 and/or by the support structure 10 of the tower - may be supported by at least
10 one structural support element 30 which extends vertically from the main deck 3 next to the second side 24 of the ship, opposite the drilling tower 5 in relation to the longitudinal centreline extension axis Z of the ship.

[0065]. Preferably, as shown for example in Figures 3 and 4, the aforesaid structural support element 30 is
15 composed of a wall which delimits the storage and assembly area of the drill strings next to the drilling tower 5. In particular, such wall 30 extends vertically beyond the drill floor 4 (or drill deck).

[0066]. The storage and assembly area of the drill strings is called the "setback" in the jargon. This area, integrated or in any case next to the drill floor is used
20 to store the drill strings previously prepared in groups of three strings screwed one to the other to form a single
25 string of approx. 41 m. This makes it possible to reduce

the times for lowering and raising the total string, often several kilometres long and to have the right diameter and type of string for the specific drilling operation planned.

5 **[0067]**. Operatively, the drill strings thus pre-assembled using the main lift hooks are vertically stored between one drilling campaign and another in the setback in special racks called fingerboards which block the strings vertically in two points , one at the bottom and
10 one at the top. In particular, such fingerboards may be made in the aforesaid wall 30, used as a vertical support element of the drill floor.

[0068]. In this phase the strings are always handled in a vertical position to prevent them from bending under
15 their own weight and being damaged, by special machines called smartrackers which claw the string which is prepared under the main hook and previously screwed by a machine known as a roughneck, shifting the string into place in the fingerboard of the setback.

20 **[0069]**. From this moment the strings are ready to begin their cycle of introduction and extraction from the oil well, moved by means of the smartracker from the fingerboard to the hoisting hook at the centre of the drill deck and vice versa.

25 **[0070]**. At the end of the drilling operations, in a

reverse operation to the one described above, the strings are unscrewed from each other by the roughneck and singly replaced in the storage stacks using a special dedicated horizontal chute called catwalk.

5 **[0071]**. As shown in Figure 5, the drill strings 54 may be stored on one side of the floating unit, in order to be inclined towards midship, one by one, until the upper end is at the centre of the moonpool vertically beneath the hoisting hook; the string is then raised and inserted in
10 the central hole on the drill deck and lowered into the hole of the oil well below on the sea bed.

[0072]. The invention permits numerous advantages to be obtained, some of which already pointed out above.

[0073]. A floating unit for drilling operations
15 according to the invention, in particular a drill ship, may be fitted with one or more drilling towers of the box-like type with drilling devices outside the tower without necessarily having a structurally oversized drill floor or drill deck in terms of load capacity.

20 **[0074]**. A floating unit for drilling operations made according to the invention, may be fitted with one or more drilling towers of the box-like type with drilling devices outside the tower positioned so as to respect both the operating functions and the distribution of the loads
25 coming from the static weights and from the dynamic

accelerations of the tower.

[0075]. The invention thus conceived thereby achieves the intended objectives.

[0076]. Obviously, its practical embodiments may assume
5 forms and configurations different from those described while remaining within the sphere of protection of the invention.

[0077]. Furthermore, all the parts may be replaced with technically equivalent parts and the dimensions, shapes
10 and materials used may be varied as required.

AMENDED CLAIMS - SUBSTITUTE SHEETS

1. Floating unit for offshore drilling operations comprising at least one floating structure (2) which defines a main deck (3), above which a drill floor (4) is placed, and at least one drilling tower (5) having a box-like structure which extends above the drill floor (4) next to at least one moonpool (6) which vertically crosses the floating structure at the drill floor (4) as far as the bottom (8) of said floating structure, characterised in that the drilling tower (5) is directly supported by a support structure (10) structurally integrated with the floating structure (2) and in that the support structure (10) of the tower (5) and/or the tower (5) crosses the drill floor (4), the drill floor being structurally supported by the support structure (10) of the tower and/or by the drilling tower itself, the support structure (10) of the tower extending vertically inside the floating structure (2), wherein:
- the support structure (10) is structurally integrated with the main deck (3) resting thereon; or
 - the floating structure (2) defines one or more secondary decks (7) positioned below the main deck (3), the support structure (10) of the tower being structurally integrated with one of said secondary decks (7) resting thereon; or
 - the floating structure (2) is provided with a bottom (8)

the support structure (10) of the tower being structurally integrated with the bottom (8) of the floating structure (2) resting thereon.

2. Floating unit according to one or more of the previous
5 claims, wherein the support structure (10) of the tower is a column structure.

3. Floating unit according to one or more of the previous claims, wherein the support structure (10) of the tower is a tubular or box-like structure.

10 4. Floating unit according to one or more of the previous claims, the support structure (10) of the tower (5) comprises a main portion (11) which extends along a main vertical extension axis (X), laterally to said moonpool (6).

15 5. Floating unit according to claim 4, wherein the support structure (10) of the tower (5) comprises a portion (12) of interface and connection with the base (5') of the tower (5), said interface portion (12) being offset in relation to the main vertical extension axis (X) of the
20 support structure (10) and being at least partially overlapped with the moonpool (6), by means of the interface (12) portion the support structure (10) supporting the tower (5) at least partially to overhang above the moonpool (6).

25 6. Floating unit according to claim 5, wherein the

drilling tower (5) is fitted with at least one hoisting hook (50) of the drill strings, associated to the top of the tower (5) and positioned externally thereto and wherein said interface portion (12) extends in the
5 moonpool so that the hoisting hook (50) is positioned above the moonpool (6), and is preferably aligned with the main vertical extension axis (Y) of said pool.

7. Floating unit according to claim 5 or 6, wherein the tower (5) is aligned perpendicular to the interface
10 portion (12) of the support structure (10).

8. Floating unit according to claim 5, 6 or 7, wherein the support structure (10) of the tower (5) comprises a fitting portion (13) between the main portion (11) and the interface portion (12), said fitting portion (13)
15 extending from the main portion (11) towards the moonpool (6) deviating from the main vertical extension axis (X) of the support structure (10) of the tower (5).

9. Floating unit according to one or more of the claims from 5 to 8, wherein the base (5') of the tower (5) and
20 the interface portion (12) of the support structure (10) penetrate each other.

10. Floating unit according to one or more of the claims from 5 to 9, wherein the base (5') of the tower (5) is attached to the interface portion (12) by means of a
25 flanged coupling.

11. Floating unit according to one or more of the previous claims, characterised in that it is a ship (1), comprising a hull which extends along a longitudinal axis (Z) between a bow (21) and a stern (22), said floating
5 structure being the hull (2) of the ship (1).
12. Floating unit according to claim 11, wherein said at least one drilling tower (5) is positioned asymmetrically in relation to the longitudinal centreline axis (Z) of the ship (1), the tower (5) being shifted towards a first side
10 (23) of the ship.
13. Floating unit according to claim 12, wherein the drill floor (4) is supported by at least one structural support element (30) which extends vertically from the main deck (3) next to the second side (24) of the ship,
15 opposite the drilling tower (5) in relation to the longitudinal centreline extension axis (Z) of the ship (1).
14. Floating unit according to claim 13, wherein said structural support element (30) is composed of a wall,
20 which delimits the storage and assembly area of the drill strings next to the tower (5).
15. Floating unit according to claim 14, wherein said wall extends vertically beyond the drill floor (4).
16. Floating unit according to claim 11, wherein said at
25 least one drilling tower (5) is positioned on the

longitudinal centreline axis (Z) of the ship.

17. Floating unit according to one or more of the claims from 1 to 10 characterised in that it is a semi-submersible platform (100).