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(54) Title: MOBILE OFFSHORE PLATFORM

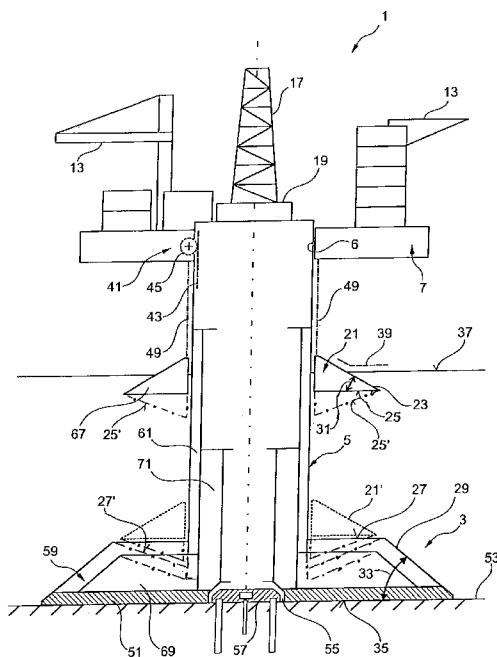


Fig. 2

(57) Abstract: The mobile offshore platform (1) comprises a floatable foot structure (3) adapted to be supported on the sea floor, a single vertically extending tubular column (5) affixed at its lower end to the foot structure (3) and a jack-up deck unit (7) having therethrough an opening for the passage of the column and being movable along the column (5) by means of a jack-up mechanism (41). A floatable annular cone element (21) having a substantially frusto-conical upper surface (23) and a substantially flat, or inversely coned, lower surface encloses the column (5) and is movable along the column (5) relative to the deck unit (7) between a lowermost position at which the cone element (21) rests on the foot structure (3) and an elevated position remote from the foot structure (3). Under ice-free environmental conditions, the cone element is positioned in its lowermost position to lower wave-induced forces. If the sea is covered with ice, the cone element (21) is raised to a position at the surface level (37) of the sea to lift and break drifting ice. In transit of the platform (1), the cone element (21) is lowered onto the foot structure (3) to increase the water-plane area and thus the floating stability of the platform (1). The platform (1) floats due to the buoyancy of the foot structure (3), the column (5) and the cone element (21) alone without floating assistance of the deck unit (7).

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Mobile Offshore Platform

10 The invention relates to a mobile offshore platform and a method of operating the platform.

For exploration and production of hydrocarbons offshore in a moderate water depth, typically up to some hundred meters, "jack-up" offshore platforms are used. A typical jack-up platform has a deck which rests on at least three vertically extending legs which are fixed to a gravity foot structure and/or are piled to the sea bed. The legs are positioned at the extremities of the perimeter of the deck. To enable the platform to be moved to and from the drilling position, the deck of known mobile offshores platforms is a floatable construction. When in transit, the legs are lifted above the deck. Once on location, the legs are lowered until they reach the sea bed or the previously positioned foot structure. Thereafter, the deck is jacked up along the legs up to an operational altitude above sea level.

25 Offshore platforms installed in an Arctic environment must be adapted to withstand the load of ice pushing against the platform structure. The ice may develop a thickness of several meters. Even in case of land-fast ice, the ice may move laterally because of thermal expansion and contraction and of wind forces and currents at sea. The platform structure must be adapted to withstand the crushing forces of drifting sea ice.

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From US 3,807,179, an offshore platform for use in Arctic environments is known. The platform comprises a foot structure piled to the sea bed and its single column is secured at its lower end to the foot structure. Above the sea

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level, the column supports a deck with a drilling rig mounted thereon. The column protects the drilling string and/or production string extending therethrough. The column supports a ring which slidably encircles the column. The ring has the form of a double cone and is movable along the column by hydraulic cylinders. By reciprocating upward and downward movement, the ring continuously breaks the ice adjacent to the column to protect the column from dynamic forces otherwise exerted against the column by moving ice.

10 A similar offshore platform is known from SU 1 749 375 A1. On a single central column of the platform, a cone element is supported at sea level. The cone element has an upper conical surface carrying a plurality of vertically pivotable arms which extend along the generatrix of the conical surface to upwardly lift and break the ice in the vicinity of the column.

15 Another offshore platform is known from US 4,451,174. The platform comprises a gravity-type foot structure having a plurality of watertight compartments which are controllably ballastable with sea water between an unballasted buoyant state which allows floating of the platform during transit and a ballasted state while stationary at the use site. The foot structure 20 rigidly supports a single central column extending through a central opening of a deck which is movably supported on the column. The deck carries a plurality of jack-up legs to move the deck relative to the foot structure along the column. During transit of this mobile offshore platform, the deck is 25 lowered to a position adjacent to the foot structure with the platform floating on the foot structure alone.

While the mobile offshore platform known from US 4,451,174 floats on the foot structure during transit, the platform has to float on the deck while 30 lowering the foot structure during installation at the production site. Tanks necessary to provide the buoyancy of the deck limit otherwise usable space at the deck and raise manufacturing costs. The known platform only has

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limited capability of withstanding ice-induced forces. At sea level, the column is armed by an additional sleeve.

5 It is a primary object of the invention to provide a mobile offshore platform with an improved capability to withstand wave-induced forces during ice-free open-water conditions of the sea and dynamic forces induced during ice conditions.

The mobile offshore platform according to the invention comprises:
10 a floatable foot structure adapted to be supported on a sea floor;
a single vertically extending tubular column affixed at its lower end to the foot structure; and
a jack-up deck unit having therethrough an opening for the passage of the column and being movable along the column by means of a jack-up
15 mechanism.

The platform is characterized by a floatable annular cone element having a substantially frusto-conical upper surface,
wherein the cone element encloses the column and is movable along the
20 column relative to the deck unit between a lowermost position in which the cone element rests on the foot structure and an elevated position remote from the foot structure.

According to the invention, the cone element and the deck unit can be
25 moved along the column independently of each other. This allows the platform to be used in relatively shallow water up to some hundred meters' water depth both under ice-free open-water conditions and during ice conditions. During open-water conditions, the cone element rests, in its lowermost position, flatly on the foot structure. Due to its frusto-conical upper
30 surface, excessive wave-induced forces which may act on the lower end of the column and/or the foot structure are avoided. This is particularly true if, as provided in a preferred embodiment, the foot structure has an upper surface comprising a central portion adapted to receive a geometrically

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5 mating lower surface of the cone element in the lowermost position thereof and further has a substantially frusto-conical portion enclosing the central portion so that the cone element in its lowermost position and the foot structure, in common, have a domed upper contour. The domed contour lowers wave-induced forces, in particular if the surface level of the sea is below or only moderately above the upper end of the cone element.

10 The lower surface of the cone element and the central portion of the front structure geometrically mating to the lower surface can be substantially flat or inversely coned with respect to the frusto-conical upper surface of the cone element.

15 During ice conditions, the cone element is raised to a stationary position in which the frusto-conical upper surface breaches the sea surface at approximately half the height of the cone element. Horizontal forces arising from ice drift will be reduced as the ice will break in bending and not in crushing as would be the case if the ice hits the vertical structure of the column. If the platform is operated in very shallow waters, the cone element can also rest on the foot structure during ice conditions if the water-line otherwise does not extend above the top of the cone element. Also under these conditions, an overall domed shape of the foot structure and the cone element is preferred for ice-breaking behaviour.

25 The cone element assists the mobile offshore platform during transit, i.e. movement to or from a production site. The platform does not rely on the deck unit for floatation, but only on the floating properties of the foot structure and the cone element and, possibly, on the floating properties of the column. During transit, the cone element is lowered to its lowermost position on the foot structure, where it increases the water plane of the floating construction and thus the floating stability. The deck unit is lowered towards the foot structure, but remains above the sea level and, therefore, in a preferred embodiment, the deck unit as such is a non-floatable deck unit to lower construction costs of the platform.

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During installation or deinstallation of the platform at the site, the cone element is maintained at the surface level of the sea while lowering or raising the foot structure. During the installation or deinstallation operation, the cone
5 element increases the water-plane area and thus the floating stability of the platform. Under this operation condition, the cone element may be fixed to the deck element while the column and the foot structure are jacked up relative to the deck unit.

10 The cone element preferably has a cone angle which is larger than the cone angle of the frusto-conical portion of the foot structure. In this way, not only a preferred shape of the domed structure is provided, but also a relatively flat angle is maintained to improve ice-breaking properties of the cone element. Preferably, the cone angle is between 110° and 140°.

15 To become independent of the direction of ice or wave drift, both the cone element and the foot structure have an at least approximately circular outer circumferential contour seen in vertical direction.

20 The foot structure is a gravity-type structure and preferably has a lowermost gravity base plate, for example, made of concrete or the like. Of course, the foot structure can additionally be piled to the sea floor.

As mentioned above, the column is preferably a floatable column comprising
25 a float-chamber structure floodable with water and extending around the circumference of the column. Preferably, also the foot structure comprises a float-chamber structure floodable with water and extending around the column. The float-chamber structures allow controlling the buoyancy and the ballasting of the column and/or the foot structure during transit, installation
30 and deinstallation. It is further preferred that the float-chamber structures comprise a plurality of individually floodable float chambers distributed in circumferential direction to allow balancing the gravity center of the platform during transit, installation and deinstallation. The float-chamber structure of

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the column preferably extends above the sea level of the platform installed at the site, so that this chamber structure can be used for additionally ballasting the platform by ballast water above the sea level.

5 In a preferred embodiment, the column and/or the foot structure can contain storage tanks to buffer the production of oil or for storage of any operational fluids.

10 Known jack-up mechanisms have freely extending legs guided on the deck unit. Since the offshore platform is intended for use in ice conditions, in a preferred embodiment of the invention, the jack-up mechanism comprises a plurality of vertically extending, toothed racks distributed around and mounted to the column and pinions provided on the deck unit for meshing with the racks. The racks are protected against ice forces by the cone
15 element, which, under ice-water conditions, also protects the column. Preferably, the racks are arranged in recessed channels of the column to improve protection.

20 Under a second aspect, the invention provides a method of operating a mobile offshore platform as described above, wherein, during transit movement of the platform and/or during stationary operation of the platform, under ice-water conditions, the cone element is positioned with its frusto-conical upper surface partially above the water level while the deck unit is positioned at a distance above the water level. At this position, the cone
25 element not only reduces ice loads acting on the structure of the platform, but also increases the water-plane area of the platform and thus its stability, in particular during floating. During stationary operation of the platform, under ice-free water conditions, the cone element is positioned at its lowermost position resting on the foot structure, thus lowering the gravity
30 center of the platform structure and the influence of wave-forces acting on the foot structure, in particular in very shallow waters.

A preferred embodiment of a mobile offshore platform according to the

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invention will now be described with reference to the accompanying drawings.

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In the drawings:

Figure 1 is a perspective view of a mobile offshore platform according to the invention;

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Figure 2 is a schematic sectional view of the platform positioned at a drilling and/or production site under ice conditions; and

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Figure 3 is a sectional view of the platform during transit to or from the drilling and/or production site.

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Figures 1 and 2 show a mobile offshore platform 1 at a drilling and/or production site in shallow sea water. The platform 1 comprises an essentially flat gravity-type foot structure 3 having a circular contour seen in vertical direction and a single tubular column 5 of approximately circular cross-section. The column 5 extends vertically and is rigidly fixed to the foot structure 3 in a coaxial position thereof. The column 5 extends through an opening 6 of a deck unit 7 which is of a jack-up type and is vertically movably guided on the column 5. The deck unit 7 carries usual equipment for drilling and/or production of a gas and/or oil well, for example, accommodation structures 9, storage houses 11 for storage of drill pipe and casing sections, cranes 13 and a helicopter deck 15. A derrick 17 is positioned on a drilling floor 19 at the top of the column 5. The derrick 17 is stationary with respect to the column 5, but, of course, may be adapted to be moved to the deck unit 7.

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In between the deck unit 7 and the foot structure 3, a cone element 21 is provided which, independently of the deck unit 7, can be moved along the

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column 5 between a lowermost position in which the cone element 21 rests on the foot structure 3, as shown in Figure 1 or in dashed lines at 21' in Figure 2, and an elevated position remote from the foot structure 3, as shown in Figure 2 in full lines. The cone element 21 serves a plurality of purposes depending on the operation conditions of the platform 1, as explained below in more detail.

If the platform is operated in a shallow water depth under ice-free environmental conditions, the foot structure 3 and the column 5 may be exposed to wave-induced forces. To reduce such forces, the cone element 21 is positioned in its lowermost position, as indicated in Figure 1 or at 21' in Figure 2. In this position, the foot structure 3 and the cone element 21, in common, have a domed upper contour. To provide that contour, the cone element 21 has a substantially frusto-conical upper surface 23 (Figure 2) and a substantially flat lower surface 25. The foot structure 3 has an upper surface comprising a substantially flat central portion 27 adapted to receive the lower surface 25 of the cone element 21 in the lowermost position thereof and a substantially frusto-conical portion 29 enclosing the central portion 27. The generatrix of the frusto-conical upper surface 23 and the lower surface 25 of the cone element 21 enclose an angle 31 which is less than a corresponding angle 33 between the frusto-conical portion 29 and a lower base surface 35 of the foot structure 3. Based on the angle 31, the cone angle of the cone element 21 is between 110° and 140°, preferably about 126°.

Alternatively the lower surface 25 and the central portion 27 can have non-flat but mating shapes. For example, as indicated in Fig. 2 in dashed lines at 25', also the lower surface can have a frusto-conical shape inversely to frusto-conical upper surface 23. Correspondingly, the central portion of the foot structure 3 has a geometrically mating frusto-conical surface shape as indicated at 27'.

Under ice conditions, for example, in an operation at Arctic sea, the cone

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element 21 is raised along the column 5 up to the sea level indicated at 37, as shown in Figure 2. The frusto-conical upper surface 23 of the cone element 21 breaks through the surface level 37 with about half the axial height of the cone element 21. Ice drifting on the sea will be bent and broken, as indicated at 39, before it is crushed against the vertical structure of the column 5. Thus, the cone element 21 reduces ice loads on the structure of the platform 1.

The deck unit 7 is movable along the column 5 by means of a jack-up mechanism 41 comprising a plurality of toothed racks 43 which extend vertically along the total length of the column 5. The racks 43 are distributed in circumferential direction of the column 5 and are arranged in recessed channels 47 (Figure 1) to protect the racks against ice damage.

The cone element 21 is fixed to the deck unit 7 by a plurality of hangers 49 (Figure 2) the length of which is adjustable relative to the deck unit 7. Preferably, the hangers 49 are steel cables adjustable by winches. Additionally, the cone element 21, in particular under ice conditions, is adapted to be rigidly connected to the column 5, for example, by wedges or any other suitable means. As explained above, under certain operation conditions, the flexible hangers 49 may be replaced by hangers rigidly connecting the cone element 21 to the deck unit 7 such that the cone element 21 follows a movement of the deck unit 7 relative to the column 5. Rigid connection of the cone element 21 to the deck unit 7 is advisable during transit operation of the platform 1 to and from the operational site.

The platform 1 is a gravity-type platform wherein the foot structure 3 has a base plate 51 made of ballast material, for example, concrete. Of course, the foot structure 3 may alternatively or additionally be piled to the sea floor shown at 53 (Figure 2). The base plate 51 has a central opening 55 to receive usual well head components 57, for example, a blow-out preventer or the like.

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The foot structure 3, the column 5 and the cone element 21, but not the deck unit 7 are floatable components to allow movement of the platform 1 in a transit operation to and from the drilling and/or production site. As shown in Figures 2 and 3, the outer hull of the foot structure 3 forms a float-chamber structure 59 to provide buoyancy to the platform 1. Another float-chamber structure 61 is provided within the column 5 to increase the buoyancy of the platform 1. The float-chamber structures 59, 61 extend around the foot structure 3 and the column 5, respectively. At least one of the float-chamber structures 59, 61 is divided into a plurality of individual floodable float chambers by partition walls 65 as indicated in Figure 1. By individually floating the chambers 63, the gravity center of the floating platform 1 can be radially displaced to balance and stabilize the platform 1 during transit and installation or deinstallation at the drilling and/or producing site. A third float-chamber structure 67 is enclosed by the cone element 21.

The float-chamber structures provide for buoyancy of the platform 1 if they are drained from water. Flooding the float-chamber structures 59, 61, 67 with water ballasts the platform 1. To increase the ballast, the float-chamber structure 61 of the column 5 extends above the sea level 37.

The space within the column 5 and the foot structure 3 is used for buffer-storing produced oil and contains storage tanks 69 and 71, respectively.

Figure 3 shows the floating platform 1 during transit. The float chamber structures 59, 61 and 67 are depleted of water to provide buoyancy to the platform 1. The cone element 21 rests, in its lowermost position, adjacent to the foot structure 3 and is fixed to the deck unit 7 by rigid hangers 49. The deck unit 7 is positioned on the column 5 near the foot structure 3, but above the surface level 37 of the sea, so that the major part of the column 5 extends above the deck unit 7 including the derrick 17, which remains stationary on top of the column 5 even during transit. Since the cone element 21 at least partially extends above the surface level 37, the cone element 21 increases the water-plane area of the floating platform 1 and thus improves

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the floating stability of the platform 1.

In order to install the platform 1 at the drilling and/or production site, the float-chamber structures 59 and 61 of the foot structure and the column 5, respectively, are flooded with water to ballast the structures while the jack-up
5 mechanism 41 lowers the foot structure 3 and the column 5 towards the sea floor 53. Also during installation, the platform 1, the cone element 21 increases the water-plane area and provides for better floating stability. After the foot structure 3 has reached the sea floor 53, the deck unit 7 is jacked up
10 towards the upper end of the column 5 and the cone element 21 is positioned relative to the deck unit 7, as shown in Figure 1 for ice-free conditions or as shown in Figure 2 for ice conditions.

Deinstalling the platform 1 is performed vice versa.

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Claims

1. Mobile offshore platform comprising:
5 a floatable foot structure (3) adapted to be supported on a sea floor (53),
a single vertically extending tubular column (5) affixed at its lower end to the foot structure (3), and
a jack-up deck unit (7) having therethrough an opening (6) for the
10 passage of the column (5) and being movable along the column (5) by means of a jack-up mechanism (41),
characterized by
a floatable annular cone element (21) having a substantially frusto-conical upper surface (23),
15 wherein the cone element (21) encloses the column and is movable along the column (5) relative to the deck unit (7) between a lowermost position in which the cone element (21) rests on the foot structure (3) and an elevated position remote from the foot structure (3).
- 20 2. Offshore platform according to claim 1, wherein the deck unit (7) as such is a non-floatable deck unit.
3. Offshore platform according to one of claims 1 or 2, wherein
the foot structure (3) has an upper surface comprising a central portion
25 (27) adapted to receive a lower surface (25) of the cone element (21) in the lowermost position thereof and a substantially frusto-conical portion (29) enclosing the central portion (27), wherein the cone element (21) in its lowermost position and the foot structure (3) in common have a domed upper contour.
- 30 4. Offshore platform according to claim 3, wherein the central portions (27) of the upper surface of the foot structure (3) geometrically mates the lower surface (25) of the cone element (21).

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5. Offshore platform according to claim 4, wherein the lower surface (25) of the cone element is substantially flat or inversely coned with respect to the frusto-conical upper surface (23).
- 5 6. Offshore platform according to any one of claims 3 to 5, wherein the cone element (21) has a cone angle which is larger than a cone angle of the frusto-conical portion (29) of the upper surface of the foot structure (3).
- 10 7. Offshore platform according to any one of claims 1 to 6, wherein the cone element (21) and the foot structure (3) have an at least approximately circular outer circumferential contour seen in vertical direction.
- 15 8. Offshore platform according to any one of claims 1 to 7, wherein the foot structure (3) has a lowermost gravity base plate (57).
9. Offshore platform according to any one of claims 1 to 8, wherein the column (5) is a floatable column comprising a float-chamber
20 structure (61) floodable with water and extending around the circumference of the column (5).
10. Offshore platform according to any one of claims 1 to 9, wherein the foot structure (3) comprises a float-chamber structure (59) floodable
25 with water and extending around the column (5).
11. Offshore platform according to claim 9 or 10, wherein the float-chamber structure (59, 61) comprises a plurality of individually floodable float chambers (63) distributed in circumferential direction.
- 30 12. Offshore platform according to any one of claims 1 to 11, wherein the column (5) and/or the foot structure (3) contain storage tanks (69, 71).

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- 5 13. Offshore platform according to any one of claims 1 to 12, wherein
the jack-up mechanism (41) comprises a plurality of vertically extending
toothed racks (43) distributed around and mounted to the column (5)
and pinions (45) provided on the deck unit (7) for meshing with the
racks (43).
- 10 14. Offshore platform according to claim 13, wherein
the racks (43) are arranged in recessed channels (47) of the column
(5).
- 15 15. Method of operating a mobile offshore platform as claimed in any one
of the claims 1 to 14, wherein,
during transit movement of the platform (1) and/or during stationary
operation of the platform (1) under ice-water conditions, the cone
element (21) is positioned with its frusto-conical upper surface (23)
partially above the water level (37) while the deck unit (7) is positioned
at a distance above the water level (37).
- 20 16. Method according to claim 15, wherein,
during stationary operation of the platform (1), under ice-free water
conditions, the cone element (21) is positioned at its lowermost position
resting on the foot structure (3).
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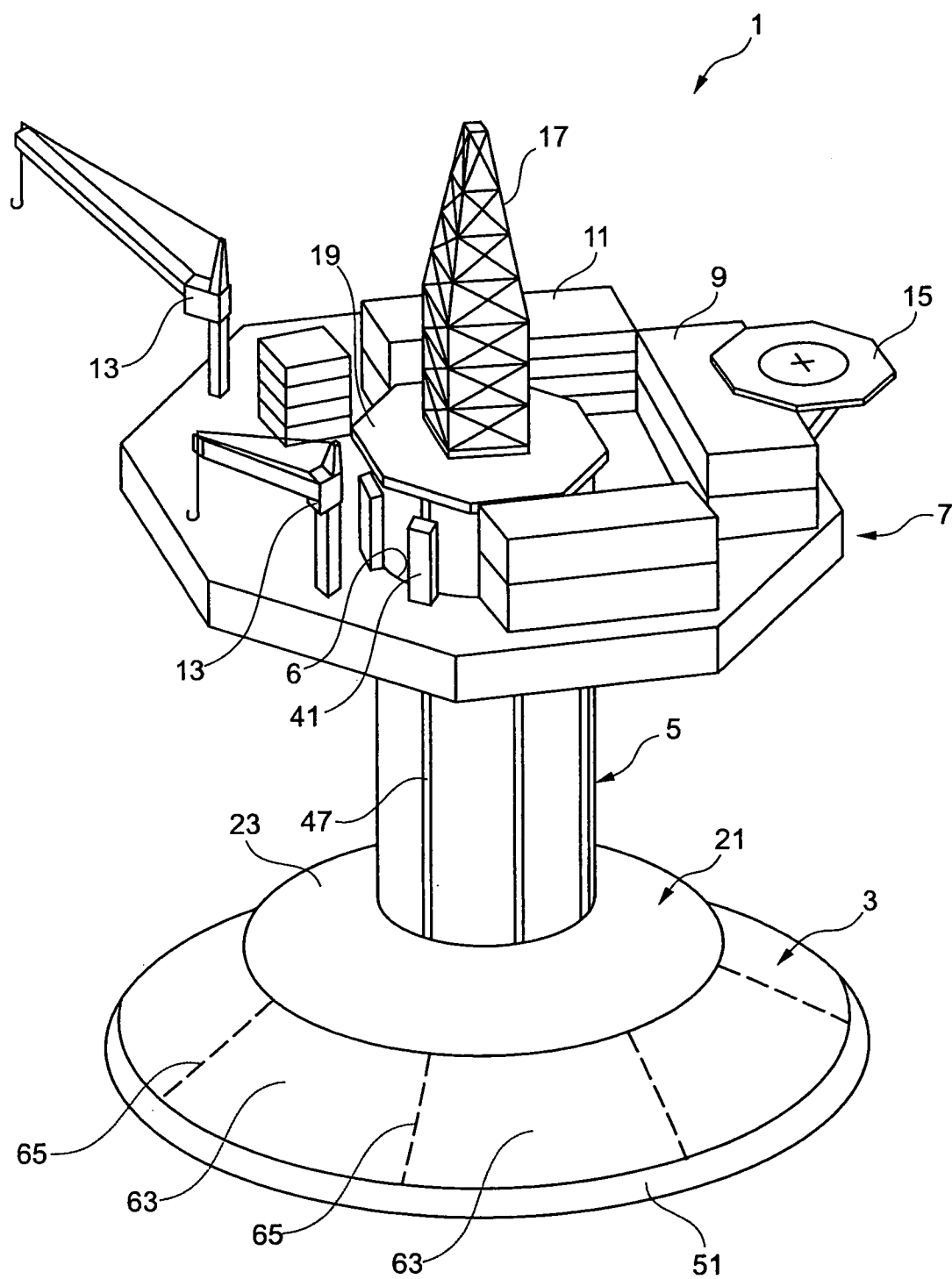


Fig. 1

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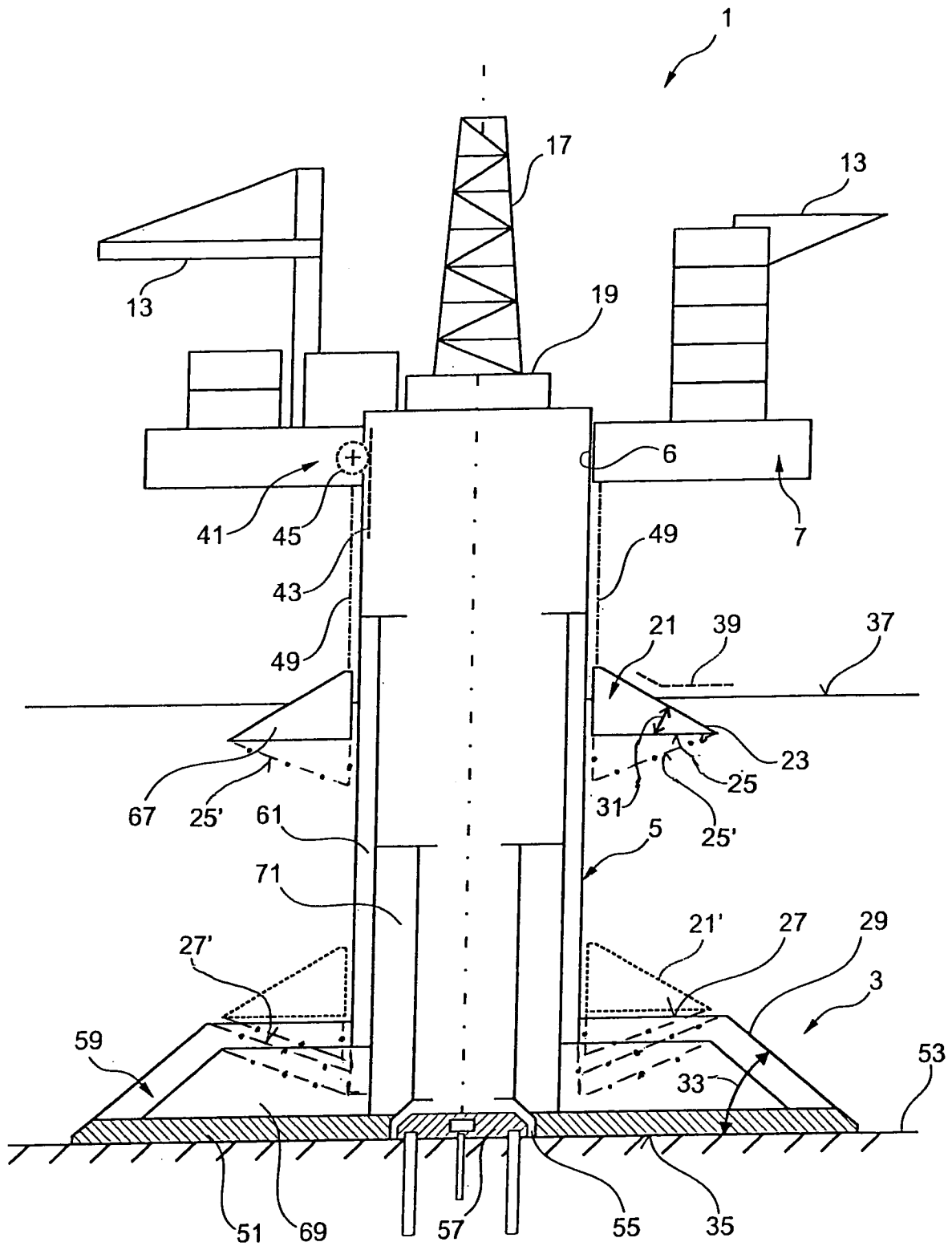


Fig. 2

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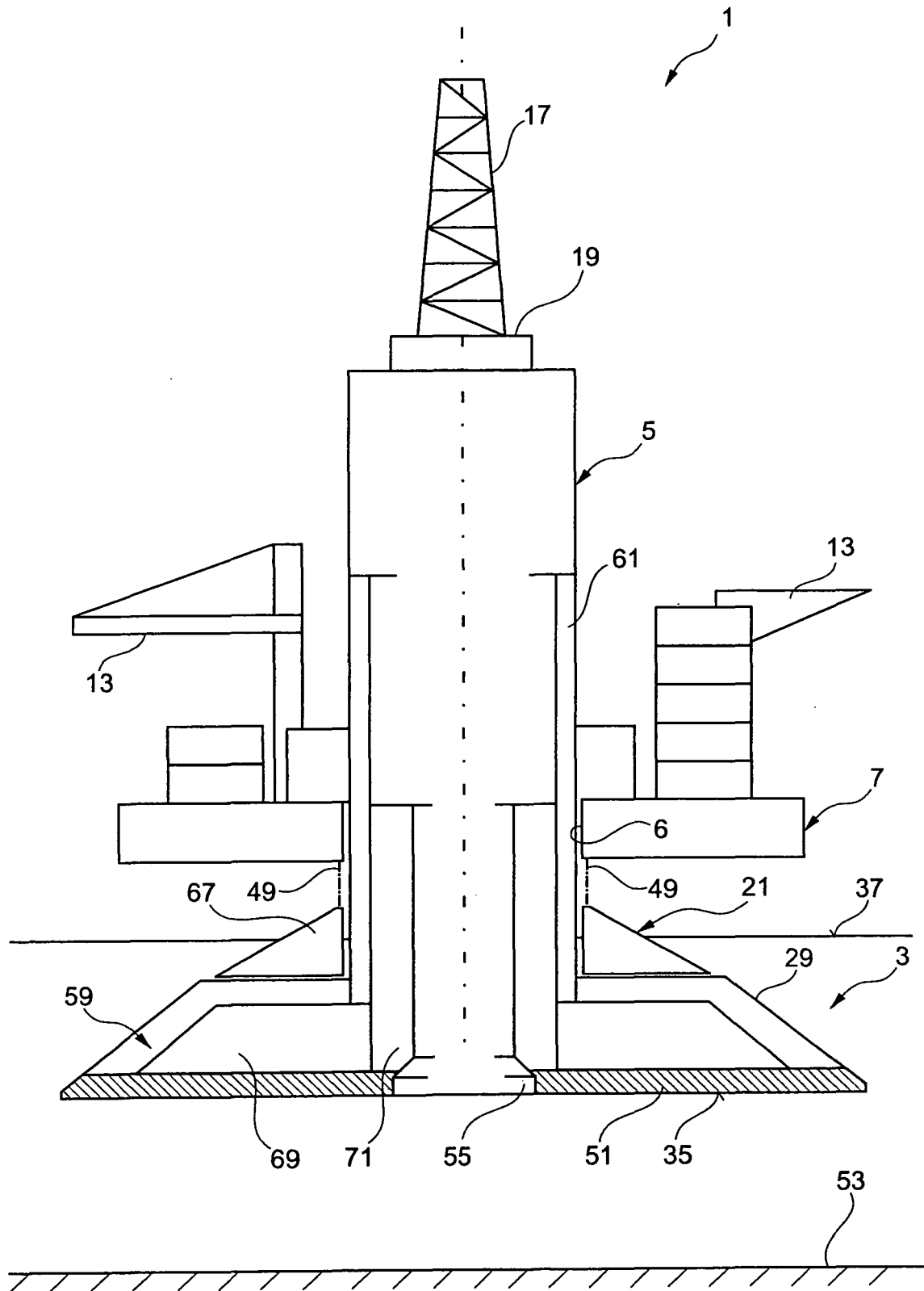


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/000525

A. CLASSIFICATION OF SUBJECT MATTER

INV. E02B17/00 E02B17/02 E02B17/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	UA 13 074 U (NAT ACADEMY OF ENVIRONMENTAL A [UA]) 15 March 2006 (2006-03-15) figure 1 & DATABASE EPODOC EUROPEAN PATENT OFFICE, THE HAGUE, NL; abstract -----	1, 8, 13, 15
Y	US 4 627 767 A (FIELD ALMERON J [US] ET AL) 9 December 1986 (1986-12-09) columns 3-8, 15; figures 1-7 ----- -/-	1, 2, 5, 7, 8, 10, 11, 15



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Date of the actual completion of the international search

14 October 2009

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Horst, Werner

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/000525

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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