

PATENT SPECIFICATION

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- (21) Application No. 6274/75 (22) Filed 14 Feb. 1975
 (31) Convention Application No. 740 521 (32) Filed 15 Feb. 1974 in
 (33) Norway (NO)
 (44) Complete Specification published 25 May 1977
 (51) INT. CL.³ B63C 11/34
 (52) Index at acceptance
 EIH 28
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(54) DIVING ARRANGEMENT

(71) I, THOR OVE HAAVIE, a Norwegian subject of Incognito Terrasse 1 II, Oslo 2, Norway, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Drilling for oil on the bottom of the sea has lately been developed to such an extent that it also includes ocean depths where human beings cannot stay without using special equipment like diving bells, submarines, pressure resistant working and dwelling chambers etc.

Deep diving mainly takes place using diving bells which are lowered from fixed platforms, surface diving vessels or the like. The diving bells are equipped for, if necessary, bringing divers and equipment down to very great depths for underwater work. The bells may be used as inspection and maintenance base and may also transfer personnel to well heads, sea floor living quarters or the like for performance of maintenance, installation and disassembly work at these locations, inspection of traces for the installation of pipe lines, inspection of existing pipe lines and installation of pipe lines etc. Using the present technical aids it is possible for a diver to work at depths down to about 250 m. The transportation of divers down to and up from this depth takes place by means of diving bells. Diving without diving bells is not normally done down to greater depths than 60-70 m.

Underwater work in calm sea areas and close to shore does not cause any great problems. However, discovery of oil sources at increasingly greater distance from the coast and in greater depths is increasing the requirements for better equipment. The oil production in the North Sea area shows for instance, that with the strongly varying sea and wind conditions,

the hitherto used equipment is unsatisfactory and partially unusable in open sea areas even under good weather conditions. Underwater work in for instance the North Sea is therefore today largely limited to the summer season, and for the future oil production in this area and other open sea areas it is not acceptable to be unable to perform necessary repairs, inspections, new installations etc. on a year round basis and at any moment.

Today supply ships, converted trawlers, fishing boats or similar vessels are used as mother vessels for diving operations. The motion characteristics for these and other previously known mother vessels are not good enough to ensure continuity in underwater work even under moderate weather conditions, and the vessels must often leave the area and seek harbour until the weather conditions improve, leading to delays, increased costs and other negative investments. The hitherto known mother vessels are mainly equipped with deck cranes which bring the diving bells out alongside the vessel for lowering, or by the use of movable galleys placed aft and which in lowered, tilted position bring the bell clear of the vessel before the bell is lowered to the desired depth. Both by lowering of a bell from a vessel to a distance below the surface of the sea and by raising the bell from such an underwater position and taking it on board the vessel, unforeseeable, dangerous situations can easily occur even under moderate wind and wave conditions.

Also, mother vessels for diving operations are known where the ship is equipped with lowering or receiving shafts for a diving bell. Such shafts, however, only have guiding influence on the bell, and the drawbacks stemming from wave action and ship motion are not eliminated.

The roll and heave motions of the vessel brought about by wave action easily set

the bell in pendulum motion in the upper water layer or in the air so that the bell is easily damaged by being banged against the side of the vessel. Wave action influences the bell in the wave area resulting in uncontrollable buoyancy motion brought about by the motion amplitude of the water particles near the surface, and in addition the hoisting wire or hawser is slackened or tightened as the relative motion between bell and vessel changes with no possibility of bringing these undesirable influences under control quickly enough. Therefore, there is a danger of snapping the wire, particularly while the bell is situated in the upper water layer or in the air.

These stresses can subject the diving bell to great damage and can represent considerable risk to the lives of the divers in the bell.

The vessel of the present invention removes some of the mentioned drawbacks and reduces the others to such an extent that diving work of any kind and particularly in open sea areas can be performed even under very difficult weather and sea conditions.

According to the present invention there is provided a vessel for use in diving operations by means of a diving bell which may be lowered to and raised from its working position from the vessel, the vessel including a docking chamber for the diving bell, the upper end of said chamber when in use being arranged at such a depth that it always will be positioned below the water level, the chamber when in use being always full of water and surrounded by a dry room, said docking chamber being in open communication with the water at its bottom end and at the upper end being equipped a closeable hatchway having coupling means for tight connection to a diving bell when this is present in the water filled interior of the docking chamber.

In using the vessel of the invention, instead of the usual lowering and taking on board of diving bells from the level of the sea surface, this is carried out below the sea surface so that taking the bell through the water/air boundary layer is completely avoided. The bell is at any time before, during and after a completed diving operation surrounded by water having the prevailing hydrostatic pressure of the surroundings. The bell is also docked in this way at a depth where the motion amplitudes of the water particles are reduced to a value which is sufficiently low for such an operation even under very bad weather and sea conditions.

Another important feature of the preferred embodiment of the invention is to take advantage of the good motion charac-

teristics shown by semisubmersible vessels under bad weather and sea conditions.

The invention is not limited to diving bells only but may also be used for any other form of equipment, bodies or submarine vessels which are to be lowered or raised from a vessel and where it is desirable and/or necessary to protect this from wave action or other forces influencing an object which has to pass through the water/air interface.

These and other important features of the invention will be described more closely in the following with reference to the accompanying drawings in which:—

Fig. 1 shows a vessel of the semisubmersible type having a docking chamber positioned in one column.

Fig. 2 shows on a larger scale a section corresponding to the circled section on Fig. 1.

Fig. 3 shows on even larger scale a section through the details of a docking chamber for a diving bell.

Fig. 4 shows schematically a top view of the arrangement of winches for the system according to the invention.

Fig. 5 shows an alternative location of the system.

As is shown in Figs. 1, 3 and 5 the preferable mother vessel consists of pontoons 35 for the support of columns 34 which carry a platform 37 at suitable height above the sea surface 36, said vessel being equipped with means for filling and emptying of ballast in the pontoons 35 and/or the columns 34 in order to bring the vessel from the fully surfaced condition, down to and/or up from the semisubmerged position, as shown in Figs. 1 and 5. The vessel is equipped with propulsion means 41 in addition to two or more thrusters 45. The vessel can be made of concrete or a combination of concrete and steel or other material, for example pontoons of concrete and columns with a platform 37 entirely or partly of steel.

A docking chamber 15 for a diving bell 3, 4 is arranged in the middle of the pontoon 35 where a column 42 is arranged, in which column is placed a boarding chamber 2 and decompression chambers 1 and 5 in closed relationship with each other and the docking chamber 15.

The column 42 and parts of the pontoon 35 form a closed room 46 around the chambers 1, 2, 5 at atmospheric pressure with open connection to the deck, from which deck the chambers 1, 2, 5 may be lowered down through the column 42 and be placed on top of the docking chamber 15 or elevated up to the deck for inspection or the like.

In the case of accidents where for instance a diver is hurt and must be brought

quickly away from the vessel, the diver is placed via the chamber 1 in the decompression chamber 5 or in a emergency chamber on deck (not shown), which then is disconnected while the desired pressure is maintained, whereafter the decompression chamber 5 is hoisted up to the deck for further transportation. Preferably a reserve decompression chamber 5 is now placed in connection with decompression chamber 1, and diving work can continue. The decompression chamber 5 is served by means of separate hoisting wires and winches (not shown) which are independent of similar equipment for the chambers 1 and 2.

Hatches 47 and 48 form in a way known per se a closable connection between the decompression chambers 5 and 1, while hatches 49 and 50 form a similar connection between the decompression chamber 1 and the boarding chamber 2. Hatch 51 also gives access in a way known per se to the decompression chamber 5 and hatch 52 to the decompression chamber 1, while hatch 53 gives access to the boarding chamber 2, all at atmospheric pressure.

The docking chamber 15 is in the form of a watertight, pressure resistant truncated cone as shown in Fig. 3 with the largest opening 38 directed downwardly and in open contact with the surrounding body of water so that the pressure in the docking chamber at any time corresponds to the prevailing hydrostatic pressure. Any air that may have collected in the upper part is led out through the valve 54 so that the docking chamber at all times is completely filled with water.

As mentioned previously, the vessel and thereby the pontoons are lowered to a depth where the amplitudes of the water particles are greatly reduced in the water area where the docking operation is to be performed. The amplitude of the water particles is further reduced in the interior 21 of the docking chamber which is filled with water. Thus, lowering or raising of or docking of the diving bells 3, 4 which are fixedly attached to each other practically takes place in calm water. Motion of the vessel, for instance heave, is reduced to a level where they only to a small extent effect or hinder these operations due to the construction of the vessel and the draft of the pontoons.

The upper section of the docking chamber 15 terminates in a side wall 23 consisting of a cylindrical section being fixedly attached to the chamber 15.

At the top of the side wall a flange 19 is arranged for coupling to the boarding chamber 2, and at the lower edge a flange 17 is arranged for coupling to the diving bell. Level with the flange 17 there is, in a

way known per se, arranged a preferably hydraulic coupling arrangement 18 with pistons 29 which in sealing relationship 28 extend through the wall of the docking chamber 15. Inside the chamber 15 the pistons carry clawlike coupling means 27 having inclined faces cooperating with corresponding inclined faces of a flange 16 of the diving bell 3 and the flange 17 of the side wall 23. Axial displacement of the pistons 29 press the two flanges against each other to form a tight connection. Connecting means 18, 29, 28, 27 are arranged in suitable mutual distance in a number of 2-6 around the periphery of the docking chamber 15.

The docking chamber 15 is furthermore equipped with a number of inspection glasses 20 and an access hatch 44. At the top of the chamber there is arranged an air release valve 45.

Hoisting and guiding wires to be described more closely in the following are run internally in separate tubes 62 for the respective wires into the docking chamber 15. The tubes 62 are fixedly and tightly connected with the walls of the chamber 15, and each separate tube extends continuously from these up to a level above the largest draught, preferably up to deck level. Thus, the tubes form an open connection for the wires into the docking chamber 15 and thereby eliminate the sealing problems which otherwise would occur by running the from a space filled with air to a space filled with water.

The diving bells 3, 4 are interconnected in a way known per se, the bell 3 being a ballast bell and the bell 4 being the dwelling place for divers during the lowering and raising operations. Around the connecting nozzle 56 gas containers 57 for emergency air supply are arranged in a way known per se.

The introduction of a supply cable 11 is done via a tube from deck level the same way the wires were introduced into the inners of the docking chamber. The supply cable supplies the diving bell 4, in a way known per se, with breathing gases, electrical energy, telephone and television cables etc.

A circular frame 58 is arranged around the outer periphery of the diving bell and has a form and diameter approximately corresponding to the diameter at that level of the diving bell in connecting position. The purpose of the frame 58 is to centre the diving bell 3 for correct connection.

Around the equator of the diving bell 4 a guiding ring 59 is arranged in a way known per se, to which ring the hoisting wires 7, 8 are attached. Guiding holes for guiding wires 9, 10 are arranged in the guiding ring. At the bottom side of the

guiding ring 59 stoppers 22 are arranged near the guiding holes for the guiding wires 9, 10. The purpose of these stoppers is to cooperate with corresponding stoppers 60 on the guide wires placed in predetermined positions on these in order to determine maximum hoisting position of the base plate 6 of the diving bell when it is hoisted into the docking chamber 15. In addition, maximum lowering of the diving bell 3, 4 toward the base plate when it is resting on the sea floor 63 may thereby be determined.

In the example the wires are shown attached to a base plate of known design. By the use of a diving bell for operations on a depth where the divers cannot leave the diving bell due to the prevailing hydrostatic pressure and instead are to be transferred to a body of any kind resting on the sea floor, the guiding wires will preferably be fixed to this body in such a way that the stoppers contact each other when the coupling arrangement 61 of the diving bell is in close proximity to a corresponding coupling arrangement on the body.

During submerging trials of the vessel without installed chambers and bells, a blanking plate 43 is used to shutoff the interior 21 of the docking chamber and the surrounding air filled room 46 as shown in Fig. 3, the clamp 27 holding the plate 43 in place on the flange 17.

Fig. 4 indicates how the respective winches for manoeuvring the diving equipment preferably are arranged. The hoisting winch 12 with hoisting wires 7, 8 is thus arranged 90° with respect to the winch 13 for the diving wires 9, 10, while the drum 14 for the supply cable 11 is arranged near the winch 13. All the wires and the supply cable 11 are guided down into the column 42 over the guide wheels 64.

The invention may be modified in several ways within its frame. Thus, other forms of docking chambers than those having the form of a truncated cone may be used. Furthermore, two or more such chambers with auxiliary equipment may find place in one and the same vessel.

WHAT I CLAIM IS:—

1. A vessel for use in diving operations by means of a diving bell which may be lowered to and raised from its working position from the vessel, the vessel including a docking chamber for the diving bell, the upper end of said chamber when in use being arranged at such a depth that it always will be positioned below the water level, the chamber when in use being always full of water and surrounded by a dry room, said docking chamber being in open communication with the water at its bottom end and at the upper end being equipped with a closeable hatchway having

coupling means for tight connection to a diving bell when this is present in the water filled interior of the docking chamber.

2. A vessel as claimed in claim 1, wherein the docking chamber is part of the lower or subsurface structural parts of a vessel formed of a platform supported by pontoons and interconnecting columns.

3. A vessel as claimed in claims 1 or 2, wherein said coupling means includes a flanged opening adapted to be connected to a corresponding flanged opening on said diving bell.

4. A vessel as claimed in any preceding claim, wherein the docking chamber has a frustoconical form, the larger diameter end of which being in open communication with the water.

5. A vessel as claimed in any preceding claim wherein an air release valve is provided in the upper part of the docking chamber.

6. A vessel as claimed in claim 3 wherein a blocking plate is provided which is adapted to fit across the flanged opening of said coupling means when necessary.

7. A vessel as claimed in any preceding claim, wherein lifting wires and connecting cables for said diving bell are introduced into the docking chamber through tubes in fluid-tight communication with the chamber, said tubes extending from the chamber to above the lowest draught of the vessel.

8. A vessel as claimed in any preceding claim, wherein a plurality of guide wires are provided between said docking chamber and a base plate positioned, when in use, on the sea bed, the base plate when in the raised position forming a closure for the lower part of the chamber.

9. A vessel as claimed in any preceding claim, wherein the dry room is part of a column in open communication with the deck of the vessel.

10. A vessel as claimed in any preceding claim, wherein the necessary winches for raising and lowering the diving bell are arranged on or in the deck of the vessel.

11. A vessel as claimed in any preceding claim, wherein a circular centering frame is arranged around the outer periphery of the diving bell.

12. A vessel for use in diving operations substantially as hereinbefore described with reference to Figures 1 to 4 or Figures 5 and 6 of the accompanying drawings.

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