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(54) METHOD AND MOBILE MARINE PLATFORM APPARATUS HAVING FLOATING SUBMERGED MAT STABILISATION

(71) We, DRESSER INDUSTRIES INC., a corporation organised and existing under the laws of the State of Delaware, United States of America, of Republic National Bank Building, Dallas, Texas, United States of America, 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:—

This invention relates to mobile marine platform apparatus.

The present invention seeks to provide a new mobile marine platform apparatus having good stability, both in the transit and in the working positions. Thus, according to the present invention, there is provided a mobile marine platform apparatus, comprising a platform structure adapted to support supplies and equipment; a plurality of telescoping columnar support members, each being fixedly secured at its upper end to said platform structure, whereby the profile of the platform structure remains substantially constant regardless of the telescoping positions of said support members; and submersible means fixedly secured to the lower ends of said support members for extending said support members beneath the sea while maintaining said platform structure at or above the surface of the sea.

In order that the present invention may be well understood there will now be described some embodiments thereof, given by way of example only, reference being had to the accompanying drawings, in which:

Figure 1 is a side elevational view of a first embodiment of the invention in the transit mode of operation;

Figure 2 is a similar view showing the embodiment of Figure 1 in the working mode of operation with its pontoon structure lowered;

Figure 3 is a bow elevational view of the embodiment according to Figure 2;

Figure 4 is a plan view of a deck or mat and pontoon structure of the embodiment illustrated in Figures 1—3;

Figure 5 is an elevational view of a damper or action snubber associated with one or more of the support columns;

Figure 6 is a more detailed cross-sectional view of a portion of the action snubber illustrated in Figure 5;

Figure 7 is a detailed cross-sectional view of a portion of an alternative action snubber; and

Figure 8 is a schematic view, partly in section, of apparatus useful in lowering, raising, and maintaining stability of the columns.

Referring now to the drawing in more detail, especially to Figure 1, there is illustrated a side elevational view of the apparatus 10 illustrated in the transit mode of operation. The apparatus 10 includes an elevated work platform 12 which is positioned above the surface 14 of the ocean at all times in normal use. As will be explained hereinafter, the platform 12 is maintained fairly flat, with a low profile, except for the superstructure area 16 associated with the crew's quarters and auxiliary equipment such as the illustrated crane assembly. Although not illustrated, a drilling derrick, mast, or other rig equipment can also be mounted on the platform 12, for example, as in U.S. Patent No. 3,078,680 to Wepsala issued on February 26, 1963.

The platform 12 is supportedly mounted on six vertical telescoping columns 18 which in turn are connected to two buoyant, ballastable structures 20, three columns to each structure 20 (better seen in Figure 4). Each of the pontoon structures 20 is equipped with a propeller 22 for causing the apparatus 10 to move through the seas in the transit mode. The propellers 22 can be driven by a conventional power plant and transmission

(not shown) from the superstructure area 16. It should be appreciated that a guidable rudder (not shown) can be suitably disposed on the structure 20 if desired to aid the propellers 22 in guiding the apparatus 10 while underway. It should further be appreciated that the apparatus 10 can also be placed on location by other conventional means, such as with the employment of tugs and/or other assisting equipment if it be desired to aid or even eliminate the internal propulsion system.

Attached intermediate the upper and lower ends of the columnar members 18 is a buoyant structure 24, comprising, for example, one or more "counter-buoyancy" tanks. As shown in Figure 1, the buoyant structure 24 is above the water level 14 during the transit mode of operation. This structure 24 runs both fore and aft, on both sides of the apparatus, and also transversely, as viewed in Figure 3.

Figure 2 illustrates the apparatus 10 in the working mode of operation, i.e. with the pontoon structure 20 ballasted down beneath the surface 14 of the water. Means for selectively and controllably ballasting and deballasting the structure 20 are well known in the art and need not be mentioned here in detail except to note that the inner tube 26 of each column 18 telescopes within its outer tube 28 of column 18, the telescoping action being solely a function of ballasting or deballasting the structure 20, as by adding or pumping out seawater. It should be appreciated, however, that the upper end of column 18 is fixedly secured to the upper platform structure 12, whereas the lower end of column 18 is fixedly secured to the ballastable structure 20. As ballast is added to the structure 20, it begins to be submerged beneath the surface of the water. The initial partial flooding of the structure 20 causes the apparatus 10 to take a new waterline near the buoyant structure 24 and continued flooding extends the columns 18 further beneath the water. When fully extended, the columns come against stops (not shown) which align the upper and lower units of the apparatus, and prevent further extension. Continued flooding, after the column stops have been reached, brings the apparatus 10 to the desired working waterline.

It should be appreciated that the ballast pumps (not shown) bring about the apparatus change in configuration. Removal of the ballast returns the structure 20 to the water's surface since no column lock is necessary in the fully extended position, i.e. the weight of the ballast water maintains the columns fully extended. However, as explained hereinafter with respect to Figure 8, it is sometimes helpful to use ratchet means, or the like, while raising, lowering, or maintaining the lower structure submerged.

Figure 3 illustrates a bow elevational view of the apparatus 10 in the working position, i.e. with ballast added to the ballastable structure 20. As will be better seen in Figure 4, a deck or mat structure 30, with support frames 32, extends between the pontoons 20. As will be explained hereinafter with respect to Figures 5, 6 and 7, the dampers or action snubbers 60 help provide additional stability to the apparatus 10 in heavy seas. It should be appreciated that a bow elevational view (not shown) of the apparatus 10 in the transit mode would show a catamaran configuration, wherein the mat 30 and buoyant structure 24 are preferably completely out of the water to provide improved towing characteristics.

Figure 4 illustrates in a plan view the mat 30 connecting the two pontoon structures 20. The mat 30 is actually composed of a pair of mats having a plurality of freeing holes 31 therein to lessen the resistance of the mat to vertical movement in the water. However, if desired the mat 30 could be one continuous (except for the holes 31) member, without the gap 33 as illustrated. The cross frames 32 are used to provide additional strength for the overall structure. Furthermore, the mat 30 can be a solid structure (no holes 31) if desired.

Figure 5 illustrates in an elevational view an action snubber 60 positioned relative to the columnar support member 18. In general, the action snubber 60 is comprised of cylinder 61 attached at its lower end to the pontoon 20. An internal piston 62 has a piston rod 63 attached at its upper end to the outer tube 28 of the column 18. It should be appreciated, however, that the piston rod 63 could be alternatively attached to the pontoon 20 and the cylinder 61 to the outer tube 28. The fully extended length of the cylinder and piston rod is chosen to be greater than the predetermined distance that the column 18 can be extended to prevent a tension load being applied to the action snubber.

The action snubber 60 is filled with a fluid, for example, hydraulic oil, water or another suitable fluid 64. Means are provided, as is exemplary illustrated in Figures 6 and 7, to allow the fluid 64 to be displaced from the upper end, as shown, to the lower end, or vice versa, and a tank 65 is provided, with suitable valving, to add fluid to the cylinder or to allow fluid to be displaced from the cylinder 61.

While the preferred embodiment of the invention contemplates the use of one or more such action snubbers with each of the columns 18, fewer can be used if desired. The four corner columns 18, in the case of the apparatus described in Figure 1, are the most important in providing optimized stability. It should be appreciated that the snubbers can be placed inside the columns 18 or mounted external to them in a multiplicity of effective locations. The action

snubbers can be attached to the lower hull 20, as well as to the outer tube 28 of the column 18, by welding, with pins, bolts or any such manner.

In the operation of the snubbers, it should be appreciated that they prevent any quick or fast relative movement between the lower pontoon structure 20 and the middle buoyant structure 24. In the working mode of operation, the mat 30 and pontoon structure 20 are below the surface of the water and are not subject to action of wind or wave. As the intermediate structure 24 and upper deck 12 attempt to rise or fall with a swell or wave, the submerged mat 30 and pontoon structure tend to remain stable at a depth where the amplitude of the wave action is considerably reduced.

However, without the action snubber or some analogous means, the columns 18 would be constantly extending and retracting. In so doing, the upper structures would move about with instability despite the stability of the submerged structure. That is, the stability of the submerged structure would not be transferred to the upper structures. With the action snubbers, the submerged and surface structures react as one structure, improving the vertical steadiness of the entire vessel.

The movement of fluid within the snubber is controlled by the size of the component parts thereof. The preferred embodiment contemplates the snubber action requiring about two minutes (120 seconds) end-to-end, as compared to the longest seas, such as in swells having wave periods of approximately 15 seconds; with the snubber action desirably being at least 15 seconds for such seas. With such an arrangement, the stability of the mat 30, with its plurality of freeing holes, is transferred to the upper structures 24 and 12. Since the overall apparatus is designed to have an extremely long natural period, as compared to the longest waves, the result is a small vertical movement, if at all, even in long swells and rough seas.

It should be appreciated, however, that the action snubber does not assist in lowering or raising the pontoon structure 20 and mat 30. It does maintain the relationship between the submerged and upper structures after the columns 18 are extended, since the snubbers are not fully extended and therefore are not subjected to a tension loading. Also, the snubbers control the rate of sinking and of re-floating the pontoons 20.

Referring again to Figure 2, a plurality of cup-shaped compartments 70 are formed in the pontoon structure 20, one for each of the columns 18. The lower end 71 of the outer tube 28 is rounded to fit within the compartment 70. The column 18 is also formed to correspond to the shape of the pontoon 20, as is seen in Figure 3.

The effect of the columns 18 extending during ballasting is the same as if upper structures 12 and 24 were relieved of the weight of pontoon 20, and the upper structures may become quite active during the ballasting operation due to surface wind and waves. The rise and fall of the upper structures may extend and retract the columns 18 at this point in the cycle. Should this happen, the compartments 70 act as cushion chambers and prevent the two parts from slamming together with any real damaging force. As the shaped end portion 71 enters the cushion chamber 70, it must clear out the water trapped therein. The clearance between the two parts is sized to permit the column ends 71 to enter the compartment 70 relatively slowly and thus prevent damage.

Referring now to Figure 6, there is illustrated a portion, in cross section of an exemplary action snubber 60. The piston 62, mounted on the piston rod 63, has an orifice 80 in the end thereof and a pair of holes 81 and 82 are provided in the side of the hollow portion 83 of the piston rod 63. Thus, as explained with respect to Figure 5, the movement of the piston 62 is slowed down an appreciable amount as the fluid passes through the orifice 80 and holes 81 and 82, the direction of fluid flow being dependent upon relative movement between the submerged pontoon structure 20 and the upper structures 24 and 12.

Figure 7 illustrates an alternative piston configuration for the action snubber, the piston 85 having an orifice 86 dividing into two passageways 87 and 88 for allowing fluid exchange as the piston is moved in either direction.

Although not illustrated, other forms of action snubbers will become apparent from the embodiments illustrated. For example, instead of flowing through the piston, the piston can be sized to permit fluid to flow around it to either end of the cylinder. Also, an external piping arrangement connecting the two ends of the cylinder produces analogous results.

Figure 8 illustrates schematically a means for aiding the raising, lowering and maintaining of the mat structures variously descirbed herein. The column 120 has a series of ratchet teeth 121 on one side of the column and a second series of ratchet teeth 122 on the other side of the column. For ease of illustration, the column 120 is shown as being movable with respect to an elevated work platform 123. However, those skilled in the art will appreciate the double ratcheting means as being readily adaptable to the telescoping columnar configuration of Figure 2, wherein one portion of the telescoping column can be controlled with respect to the other portion.

Referring again to Figure 8, the column 120 is seen to pass through a hole 124 in

the platform 123. Fixedly attached to the platform 123 is a pair of air cylinders 125 and 126. The "DOWN RATCHET" cylinder 125 has a piston rod 127, to which a ratchet dog 128 is pivotally attached by pin 129. A spring 130 is attached to both the piston rod 127 and the ratchet dog 128. In operation, the dog 128 can pivot down against the spring 130, but is blocked from pivoting up against the piston rod 127.

In a similar manner, the "UP RATCHET" cylinder 126 has a piston rod 135, to which a ratchet dog 136 is pivotally attached by pin 137. A spring 138 is attached to both the piston rod 135 and the ratchet dog 136. In operation, the dog 136 can pivot up against the spring 138, but is blocked from pivoting down against the piston rod 135.

The air cylinders 125 and 126 are each connected by compressed air lines 140 and 141 to a ratchet control panel 142.

In the operation of the ratcheting apparatus of Figure 8, if the air cylinders 125 and 126 are both activated, the pistons 127 and 135 are extended, the dogs 128 and 136 are engaged, respectively, with the ratchet teeth 121 and 122, and the column 120 will not move with respect to the platform 123. If it is desired, to move the column 120 down, the air cylinder 126 is deactivated, thus disengaging the ratchet dog 136. The ballast being added to the lower section of the column, or the mat, for example (not shown in Figure 8), thus causes the column 120 to move down with respect to the platform 123. However, since the column cannot move up because of the engaged ratchet assembly, the system will not respond "up and down" to the heavy seas. The column can only go down. In an analogous manner, in raising the column, the air cylinder 126 is the only one activated, thus allowing the column to move up only. Should the mat be in the desired position, such as fully extended down, both cylinders can be activated to prevent movement in either direction. It should be appreciated that the double ratcheting mechanism can be used, if desired, in conjunction with the action snubber systems elsewhere described herein; the latter damping movement due to slack in the ratcheting mechanism.

Thus there has been illustrated and described herein various semi-submersible offshore vessels having vastly improved stability characteristics during the working mode of operation, some of which have the catamaran's stability and speed on the surface during the transit mode. By having a submerged mat structure maintained off the ocean floor, the entire apparatus is observed to be only slightly affected by the most severe weather. Again, by using action snubbers in co-operation with the telescoping columns designed to have time constants longer than the longest seas, an even higher degree of stability is achieved.

WHAT WE CLAIM IS:—

1. A mobile marine platform apparatus, comprising a platform structure adapted to support supplies and equipment; a plurality of telescoping columnar support members, each being fixedly secured at its upper end to said platform structure, whereby the profile of the platform structure remains substantially constant regardless of the telescoping positions of said support members; and submersible means fixedly secured to the lower ends of said support members for extending said support members beneath the sea while maintaining said platform strutcure at or above the surface of the sea.

2. Apparatus according to claim 1, wherein said submersible means includes ballasting means.

3. Apparatus according to claim 2, wherein the ballasting means comprises a pair of parallel pontoons.

4. Apparatus according to claim 2, wherein the ballasting means is an annular pontoon.

5. Apparatus according to any of the preceding claims including a submersible buoyancy structure fixed in relation to the platform.

6. Apparatus according to any preceding claim, including at least one action snubber member operable to damp the relative movement of the telescopic parts of a support member.

7. Apparatus according to claim 6, wherein said action snubber comprises a liquid filled piston and cylinder having means for said fluid to move from one end of said cylinder to the other end of said cylinder as said platform apparatus moves vertically with respect to said submersible means.

8. Apparatus according to claim 7, wherein said piston requires a period of time to move from one end of the cylinder to the other end of the cylinder longer than the longest wave period of seas to be encountered by said apparatus.

9. Apparatus according to claim 8, wherein said period of time is at least 15 seconds.

10. Apparatus according to any of claims 2 to 4, wherein the ballasting means includes a cup-shaped chamber for each of said

the platform 123. Fixedly attached to the platform 123 is a pair of air cylinders 125 and 126. The "DOWN RATCHET" cylinder 125 has a piston rod 127, to which a ratchet dog 128 is pivotally attached by pin 129. A spring 130 is attached to both the piston rod 127 and the ratchet dog 128. In operation, the dog 128 can pivot down against the spring 130, but is blocked from pivoting up against the piston rod 127.

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6. Apparatus according to any preceding claim, including at least one action snubber member operable to damp the relative movement of the telescopic parts of a support member.

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8. Apparatus according to claim 7, wherein said piston requires a period of time to move from one end of the cylinder to the other end of the cylinder longer than the longest wave period of seas to be encountered by said apparatus.

9. Apparatus according to claim 8, wherein said period of time is at least 15 seconds.

10. Apparatus according to any of claims 2 to 4, wherein the ballasting means includes a cup-shaped chamber for each of said

* C L M S *

plurality of columnar support members and each of said support members has a member rounded at one end for fitting into said chamber, whereby said telescoping action is slowed down as said rounded member enters said chamber.

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