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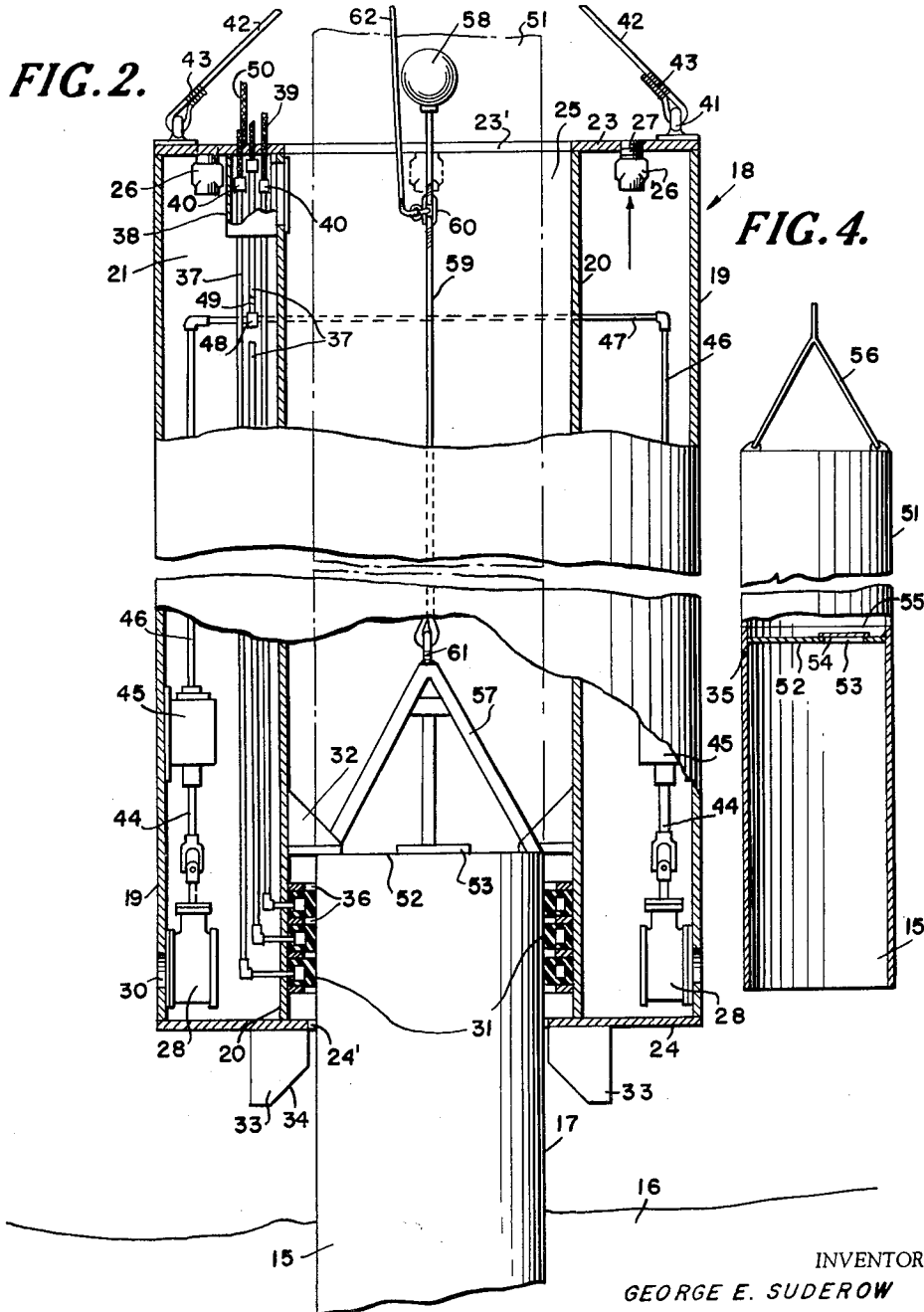
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APPARATUS AND METHOD FOR CONNECTING AN ACCESS
CAISSON TO A SUBMERGED WELL CASING

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APPARATUS AND METHOD FOR CONNECTING AN ACCESS CAISSON TO A SUBMERGED WELL CASING

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5 Claims. (Cl. 166—66.5)

The present invention relates to improved means and method of obtaining access to submerged wells and the like.

This application is a continuation of my copending application Serial No. 514,223, filed June 9, 1955.

Heretofore, in underwater drilling, when a well comes in and is free flowing, the "Christmas Tree" is fitted to the top of the well above the water level, and pipes are provided for conducting the oil from the well to storage tanks located either ashore or on off-shore platforms. As a result, signal lights or other warning means must be connected to the well casing, since otherwise it creates a hazard to navigation. Moreover, since the well and the "Christmas Tree" extend above the water, they are subject to damage by vessels and by wave action, notwithstanding the warning means. It is obvious, therefore, that it would be desirable to enclose such "Christmas Tree" or other well head structure in a submerged casing positioning well below the draft depth of marine vessels anticipated in the vicinity of the well. A "Christmas Tree" and its appurtenances, as well as the well head, must be accessible, however, for inspection, repair, adjustment, and well-reworking purposes.

Accordingly, an important object of this invention is to provide novel means for providing access to a submerged well casing, so that wherever desirable, a submarine well may be provided with a submerged well casing and the products of the well may be conducted from such casing, via submerged conduits, to storage tanks that are located ashore or on off-shore platforms.

Another object of this invention is to provide an improved method and apparatus for providing access to a submerged well casing with a minimum expenditure of time, effort, and cost.

Other objects and advantages of the invention will become apparent from the following description and accompanying drawings.

Referring to the drawings in which is shown a preferred embodiment of the invention:

FIGURE 1 is a fragmentary side view of a drill barge, with which is associated an access caisson and a submerged well casing, showing in full and dotted lines the different positions assumed by the access caisson when in its horizontal floating position, its initial downward tilted position, and finally in its vertical clamped position on the upper end portion of the submerged well casing;

FIGURE 2 is an enlarged, fragmentary side view, with parts in section, showing the connection of the access caisson to the well casing when the former is in its vertical clamped position;

FIGURE 3 is a detailed plan view, with parts in section, of the upper portion of the access caisson and the top of the well casing; and

FIGURE 4 is a detailed side view, with parts in section, of the well casing prior to the upper portion thereof being removed.

Referring now to the drawings, there is shown in FIGURE 1 a drilling barge 10 of the type that can be raised above water level 11 on a plurality of supporting caissons, piles, or columns 12 and supported in such raised

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position on such columns to provide a stable working platform. The elevation of the barge 10 may be accomplished by suitable jack mechanisms (not shown) engaging the columns 12 in the manner disclosed in the copending Pointer applications, Serial No. 143,627 (now abandoned) and Serial No. 283,567, now Patent No. 2,775,869. The barge 10 may carry a derrick 14 mounted on a drilling substructure 13 that is shiftable on the deck of the barge into a position wherein the derrick will overhang one end of the barge, as is shown in FIGURE 1. Thus, the barge 10 and the derrick 14 can be manipulated into a position wherein the derrick is substantially directly above a cylindrical submerged well casing 15, which has an above-bottom portion 17 enclosing the well head, etc. (not shown). As will be seen best in FIGURE 1, the top of the well casing 15 is disposed well below the surface of the water 11, and at a depth preferably well below the draft of marine vessels expected in the vicinity.

An elongated buoyant access caisson 18, of a length sufficient to extend from the top of the casing 15 to above water level, is adapted to be carried on or towed by the barge 10 to a location above the site of the well casing 15. Normally, the caisson 18, when in the water, floats in a horizontal position as is best shown in dotted lines in FIGURE 1. As is best shown in FIGURE 2, the caisson 18 is of double-wall construction having outer and inner concentric cylindrical shells 19 and 20, which together with annular end plates 23 and 24, provide an internal watertight buoyancy chamber or compartment 21. The caisson may be reinforced by radially disposed, circumferentially-spaced stiffening plates 22 that extend between and are secured to the outer and inner shells 19 and 20, as shown in FIGURE 3. The circular opening 23' in the annular plate 23 at one end of the caisson 18, which may be termed the upper end thereof, together with the interior of the inner shell 20 and the circular opening 24' in the other annular end plate 24, define an access passageway 25 extending longitudinally through the caisson. It will be noted that the interior diameter of the inner shell 20 may be equal to the diameter of the opening 23' in the plate 23 and both of these diameters may be larger than the exterior diameter of the well casing portion 17. Preferably, however, the diameter of the opening 24' in the plate 24 at the lower end of the caisson 18 is only slightly larger than the exterior diameter of the well casing portion 17, for reasons later described.

The upper end of the buoyancy chamber 21 can be vented by a plurality of circumferentially-spaced check valves 26 which are disposed within the chamber and have their outer ends connected, as at 27, to corresponding openings in the plate 23. A plurality of sea valves 28, which may be of the gate type, are mounted in the chamber 21 adjacent the lower end plate 24 for controlling communication through corresponding openings 30 in the outer shell 19. These valves 28 are controlled by fluid pressure operated motors 45 that are mounted within the chamber 21 and their piston rods 44 connected to the stems of the corresponding valves 28. Fluid pressure for operating the motors 45 is supplied thereto through corresponding pipes 46 that may be connected to a manifold pipe 47 from which extends a supply pipe 49.

The inner shell 20 is provided, within that end thereof adjacent the end plate 24, with a plurality of longitudinally-spaced inwardly-extending circumferential flanges 36 which, together with the shell 20, define a plurality of channels. Disposed in each channel is a hollow resilient ring or gripper 31, which may be similar to those disclosed in the aforementioned Pointer applications. The inner diameter of such rings 31, when relaxed, is somewhat greater than the outer diameter of the well casing portion 17 and it will be seen that when fluid pressure is in-

roduced into these rings, via the pipes 37, the rings will expand radially both inwardly and outwardly. Secured within the shell 20 somewhat inwardly of the rings 31, are a plurality of circumferentially-spaced stops 32. The exterior of the end plate 24 is provided with a plurality of downwardly-extending guide members 33 that are disposed about the opening 24' and have downwardly and outwardly inclined inner sides 34 for a purpose more fully described hereinafter.

Preferably, the ends of the pipes 37 and 49 terminate in threaded ends disposed within a coupling box 38 located inwardly of the end plate 23 and between the shells 19 and 20 so that flexible supply hoses 39 and 50 may be detachably connected, respectively, to the ends of such pipes 37 and 49 by coupling elements 40 within the box, to thereby prevent damage to the ends of the pipes when the hoses are not connected thereto. The top or upper end of the caisson 18 preferably is provided with a plurality of circumferentially spaced eyelets 41 to which a lifting bridle 42 may be attached, as at 43.

When a well comes in and is free flowing, a casing 15 is positioned about the well pipe (not shown) and extends between the marine bottom 16 to a point above the surface of the water 11. Thereupon, by working within the casing 15, from which the water has been pumped, a "Christmas Tree" and its appurtenances may be mounted on the well pipe as close to the marine bottom 16 as is practicable, in any event at a depth below the surface of the water 11 in excess of the draft of vessels expected in the vicinity. After the "Christmas Tree" and its appurtenances have been connected to the well pipe and any portions of the latter extending above the "Christmas Tree" have been removed, a transverse partition plate 52 (FIGURE 4) is welded into the casing 15 at a point therein only slightly above the "Christmas Tree." The plate 52 is provided with an access opening or manhole 53 normally closed by a removable watertight cover 54. A tripod-like guiding assembly 57 (FIGURES 2 and 3) is then secured to the top of the plate 52, with the ends of the legs of the assembly firmly secured to such plate closely adjacent its periphery so that the apex of the assembly is uppermost. Preferably, this apex is provided with an eyelet 61.

On the completion of this operation, which can be accomplished in the dry, the casing 15 is cut off at a point 55 just above the transverse partition 52, as by a diver using an underwater torch (not shown). Thereupon, the upper cut off portion 51 of the casing may be lifted free and removed, as by a crane (not shown) operating from the deck of a drilling or derrick barge and having its line attached to a lifting bridle 56 on the upper end of the casing portion 51. After this cutting operation has been performed, or even therefore, a buoy 58 is connected by a buoy line 59 to the eyelet 61 on top of the tripod assembly 57 in order to mark the location of the well casing 15. Quite obviously, the buoy line 59 preferably is longer than the mean water depth from the surface 11 to the eyelet 61. Preferably, the buoy line 59 is provided, a short distance below the buoy 58, with a coupling link 60 for attaching a separate line 62 to the buoy line at this point.

When it is desired to service, inspect, repair, etc., the well within the casing 15, the barge 10 may be moved to a proper position adjacent the casing, as indicated by the buoy 58, and raised to its elevated position above the water, as is shown in FIGURE 1. Thereupon, the drilling substructure 13 can be moved along the deck of the barge 10 to position the derrick 14 in an overhanging relation with the well casing 15. The access caisson 18, which may have been towed to the site by the barge 10 or carried on the deck of the barge and thereafter lifted into the water, is then maneuvered, as by a lifting line 64 running from the derrick 14 to the lifting bridle 42 of the caisson, to a position where the lower end of the caisson 18 is adjacent the buoy 58. At this time a line

62 is run from the derrick 14 through the upper end out of the lower end of the passageway 25 through the caisson 18 and the end of such line 62 is secured to the coupling member 60 on the buoy line 59. If desired, the buoy 58 may then be disconnected from the coupling link. At the same time, or before the caisson was lifted into the water, suitable compressed air hoses 39 and 50 are connected to the pipes 37 and 49 within the coupling box 38 by the detachable coupling elements 40. These hoses 39 and 50 may be controllably supplied with compressed air or other pressure fluid from the barge to thereby remotely control the operation of the sea valves 28 and the sealing rings 31.

The sea valves 28 are then opened so that the compartment 21 will be initially flooded at the lower end thereof, while air therein is vented through the check valves 26. As water flows through the valves 28 into the chamber 21, a pull is exerted on the line 64 so that the caisson 18, as it partially sinks, will be turned into an upright floating position. The initial stages of this operation are shown by the dot-dash lines in FIGURE 1. The valves 28 are then closed to prevent complete submergence of the caisson 18 and the latter is then maneuvered by the line 64 into a position directly over and in alignment with the well casing 15. This maneuver is facilitated by the line 62 which serves as an indicator or marker for the center of the well casing 15.

After the caisson 18 has been so centered, the valves 28 can be operated to admit more water into the chamber 21 so that the caisson will sink deeper and eventually telescope over the well casing 15 until the stops 32 seat on the top thereof, as is shown in FIGURES 1 and 2. During this sinking of the caisson 18, it will be seen that if it is off-center relative to the casing 15, the tripod assembly 57 will engage the edges of the opening 24' in the lower plate 24 to positively center the caisson with respect to the well casing, and at the same time the inner edges 34 of the guiding members 33 will engage against the upper edge of the well casing to further facilitate such centering so that the caisson will telescope over the casing.

After the caisson 18 has thus been seated upon the well casing 15 as is shown in FIGURE 2, fluid pressure may be supplied to the sealing rings 31 to expand the latter into tight sealing engagement with the bottoms of their channels and the outer cylindrical surface of the well casing. At the same time, it will be seen that the rings 31 will exert a strong grip upon the casing 15 to firmly clamp the caisson 18 thereto and thus inhibit any rocking motion which may be imposed on the caisson by wave action or the like. In this position of the parts, it will be seen that the passageway 25 will be full of water. Accordingly, the passageway 25 is pumped out, by any suitable means (not shown) to enable a workman to be lowered or to descend, as by means of a ladder (not shown) into the passageway and down onto the top of the well casing 15 that is formed by the partition or plate 52. The workman can then remove the cover 54 and enter the well casing 15 to perform any necessary operations therein.

After the completion of such operations within the casing 15, the workman can ascend through the access opening 53, reclose and seal the cover 54, and then may climb or be lifted out of the passageway 25 in the caisson 18 and back onto the barge 10. The interior pressure in the rings 31 may then be relieved so that they will release their grip upon the well casing 15, and the caisson 18 may be lifted off of the well casing by the line 64 running from the derrick 14. During this operation, the sea valves 28 are opened so that water will drain from the interior chamber 21 of the caisson 18. After such drainage has been accomplished, the caisson may be stowed on the barge 10 or again lowered back to the water into horizontal floating position for towage from the site. The buoy 58 may be re-attached to the buoy line 59 and the guide line 62 detached from the latter, either before or after the caisson 18 is disengaged from the casing 15.

After the caisson 18 is drained, the hoses 39 and 50 are uncoupled from the pipes 37 and 49 and the upper ends of the latter closed by appropriate caps or plugs (not shown) to protect their threaded ends against any possibility of damage thereto. The barge is then lowered back down into the water, and the supporting columns raised so that the entire assembly may be floated to another site of operations.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. A caisson for providing access in the dry to a submerged well having its head enclosed in a casing provided with a removable watertight closure in the top thereof, comprising spaced inner and outer concentric shells closed at their ends to form an airtight buoyancy chamber therebetween, said inner shell forming a longitudinal through access opening, valve means for controlling the introduction of fluid into said chamber, one end of said longitudinal opening being arranged to fit over the end of a submerged well casing, sealing means within said inner shell and engageable with the well casing to provide a watertight connection therewith when the caisson is fitted over and around the upper end of the casing, stop means on said caisson for limiting the downward movement thereof onto the well casing, and means for controlling the operation of the valve means.

2. The structure defined in claim 1 in which means are provided for guiding the lower end of the caisson onto the upper end of the well casing.

3. Means for providing access in the dry to a submerged well having its head enclosed in a cylindrical casing provided with a removable water-tight closure in the top thereof, comprising: an elongated tubular body of a length greater than the submerged depth of the casing top and having an open-ended access passageway extending longitudinally therethrough, the lower end of said passageway being adapted to snugly fit over the upper end of the casing; means defining an interior buoyancy chamber within said body extending substantially the entire length thereof for floating said body in a substantially horizontal position; controllable means on said body for admitting water to said chamber at one end thereof, in order to cause said body to float in an upright position, and for controlling the buoyancy of said body to control its draft in said position; means defining an interior circumferential channel within the lower end of said passageway; a resilient hollow inflatable ring disposed in said channel for sealing and clamping engagement with the cylindrical outer surface of the casing adjacent the upper end thereof on inflation of said ring; and stop means within said passageway inward of said ring for engagement with the top of the casing to limit downward movement of said body relative thereto.

4. The structure defined in claim 3 including conduit

means connected to the ring and extending from the body for remotely controlling the admission of pressure fluid to said ring for inflating the same.

5. Means for providing access in the dry to a submerged well having its head enclosed in a watertight casing terminating at its upper end in an upright cylindrical portion having in its top an access opening provided with a removable watertight closure, comprising: an elongated tubular body of a length greater than the submerged depth of the casing top and having an open-ended access passageway extending longitudinally therethrough, the lower end of said passageway being adapted to snugly fit over the upper cylindrical portion of the casing; means defining an interior buoyancy chamber within said body extending substantially the entire length thereof for floating said body in a substantially horizontal position; controllable means on said body for admitting water to said chamber at one end thereof, in order to cause said body to float in an upright position, and for controlling the buoyancy of said body to control its draft in said position; control lines connected to said controllable means and extending from the upper end of said body for remotely controlling said controllable means; means defining an interior circumferential channel within said passageway lower end; a resilient hollow inflatable ring disposed in said channel for sealing and clamping engagement with the outer surface of the cylindrical casing portion, when the latter is received within said passageway lower end, on inflation of said ring; and conduit means connected to said ring and extending from the upper end of said body for remotely controlling the admission of pressure fluid to said ring for inflating the same.

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