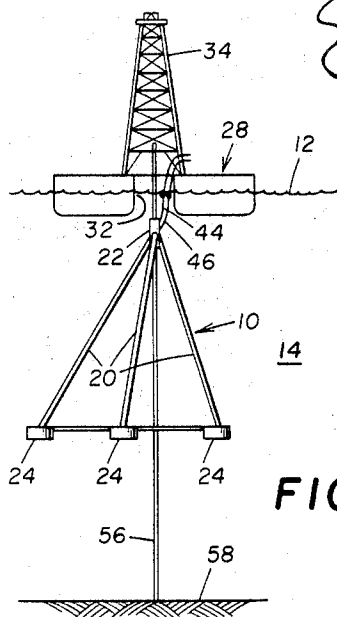
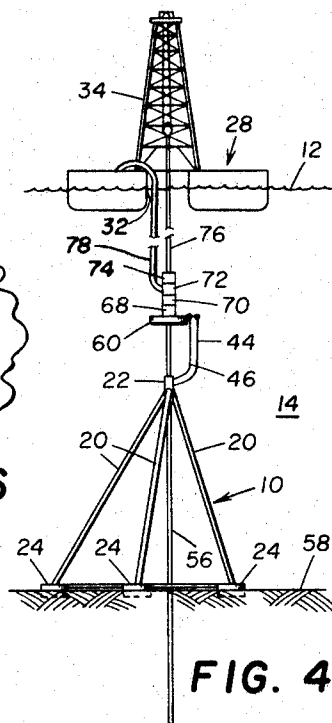
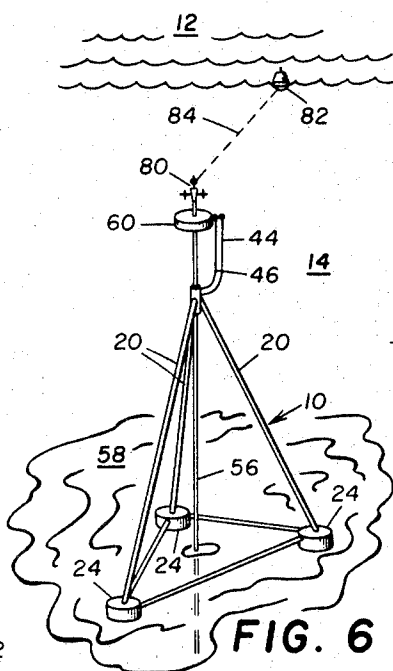
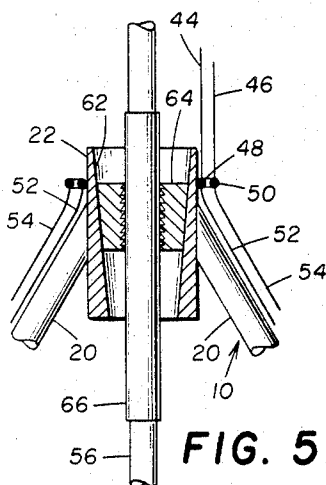
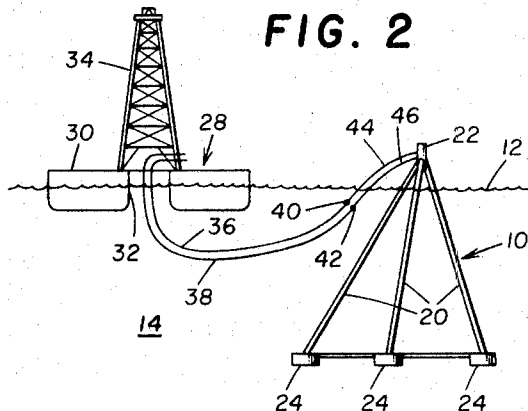
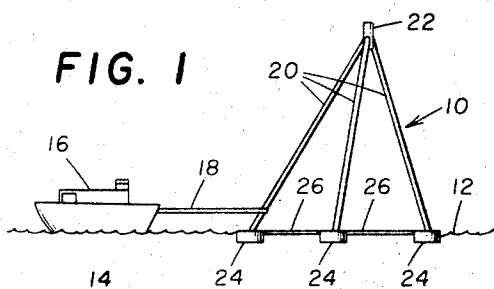


June 11, 1968

W. F. MANNING

3,387,459

SELF-ADJUSTING TRIPOD STRUCTURE FOR SUPPORTING AN
UNDERWATER WELL CONDUCTOR PIPE
Filed Dec. 13, 1965



WILLIAM F. MANNING
INVENTOR

BY *Alan E. Paul*
ATTORNEY

1

3,387,459

SELF-ADJUSTING TRIPOD STRUCTURE FOR SUPPORTING AN UNDERWATER WELL CONDUCTOR PIPE

William F. Manning, Springdale, Conn., assignor to Mobil Oil Corporation, a corporation of New York
Filed Dec. 13, 1965, Ser. No. 513,285
9 Claims. (Cl. 61—46.5)

ABSTRACT OF THE DISCLOSURE

This specification discloses a method and apparatus for drilling and completing a subaqueous well in deep water such that the wellhead equipment is located just below the surface turbulent zone where it can be serviced easily by a diver. A tripod structure, with buoyant footings, is installed on the marine bottom from a floating vessel. The tripod structure has a slip bowl in a central connector portion in the upper end thereof for installing a pair of slips to hold a well conductor pipe, terminating just above the support structure, in tension. A well drilled through the conductor pipe is completed underwater at the upper end of the well conductor pipe.

The invention relates to a method and apparatus for drilling a subaqueous well in deep water and completing the well beneath the surface at diving depth. More particularly, the invention relates to a self-adjusting tripod structure that will support in tension a well conductor pipe extending upward from the subaqueous borehole and terminating at a depth beneath the surface that a diver can easily reach.

Present offshore exploration efforts of the oil and gas industry are being extended to underwater areas where bottom-supported surface drilling structures or installations are neither as economically nor technologically feasible as on the continental shelf in the Gulf of Mexico, where such facilities are rather commonplace. In depths of three hundred feet or more the statically or dynamically positioned floating drilling vessel is dominating the scene. One method of drilling with such a vessel is to utilize a riser or conductor pipe system connecting the drilling ship with the borehole, to guide the drill pipe to the subaqueous borehole and to provide a drilling mud return conduit. Another method of drilling from a floating vessel entails the use of an open drill pipe and a mud circulating head mounted on a landing base on the marine bottom directly over the borehole. The mud is returned to the vessel from the borehole through the circulating head and an interconnecting flexible line. The drill pipe is guided between the vessel and the borehole by flexible guidelines secured to the landing base and releasably connected to the vessel.

Both of the above-described methods have their drawbacks. The riser or conductor pipe system extending to the surface does not allow the rapid disengagement of the drilling vessel when storms or other conditions require that the vessel be removed from the site as quickly as possible. Also, the unsupported length of the riser or conductor pipe is prone to buckling from the weight of the drilling mud contained therein while drilling proceeds therethrough from the vessel. When utilizing an open drill pipe, the unsupported drill pipe and mud return lines are points of possible mechanical failure. Also, a malfunction of the equipment on the landing base, far beneath on the marine bottom, might necessitate the abandonment of an uncompleted well.

Wells that have been drilled in deep water, by either of the above-discussed methods, are usually completed near the mudline, regardless of the fact that it may be

2

far below the depths at which a diver can work. While robotic and TFL (through flowline) tools have been developed and are available for routine servicing and work-over operations, these devices are complicated and expensive and are, at this time, only used for a few limited tasks. For production purposes it is desirable to complete a well so that certain servicing, repair, and work-over operations, not as easily accomplished by remote controlled equipment, can be handled by a diver.

One method for overcoming the described difficulties is to mount a support structure or submerged platform over the well site, the structure extending from the marine bottom to a point beneath the surface which a diver can easily reach. Such a structure would not need to be as large as platform extending completely to the surface and furthermore would not need to be as massive, since the most violent wave forces occur at the surface or just therebeneath; furthermore, such a structure would not be a hazard to navigation.

One of the drawbacks of utilizing a submerged support structure or platform is the large capital outlay necessary when the structure is permanently anchored on the marine bottom prior to the drilling of a well, or wells, therethrough. The economics of permanently locating an expensive structure on the bottom, before a well is proven, has resulted in the unacceptability of such a device. Moreover, it has not been considered practicable to submerge a prefabricated platform over a well, after drilling, since it is very difficult to locate properly such a structure with respect to the upstanding conductor pipe. Furthermore, a comparatively light and narrowly based support structure would necessarily be rather prone to shifting and settling due to scouring of the marine bottom. Such movement could cause the support structure to exert a compressive force on the riser or conductor pipe at the point of connection, rather than a tensioning force as desired.

Accordingly, it is an object of the present invention to provide a means for supporting a subaqueous well conductor pipe which extends from beneath the marine bottom to a point within a body of water at diving depth.

It is another object of the invention to provide a support structure for a subaqueous well conductor pipe which may be easily removed without damage thereto if the well should prove unproductive.

It is a further object of the invention to provide a self-adjusting support structure for a well conductor pipe extending upwardly from a marine bottom.

It is a still further object of the invention to provide a support structure for holding a subaqueous conductor pipe in tension at all times regardless of the possible shifting of the pipe or the support structure itself.

It is another object of the invention to provide a method for installing a conductor pipe support structure on a marine bottom at a well site.

Other objects and advantages of the invention will be readily apparent from the following description, when taken in conjunction with the accompanying drawings that illustrate useful embodiments in accordance with this invention:

FIGURE 1 is a schematic side elevation of a tripod support structure, according to the present invention, being towed to a subaqueous well site;

FIGURE 2 is a schematic side elevation of the support structure being directed into position beneath a floating drilling vessel;

FIGURE 3 is a schematic side elevation of the support structure located under the drilling vessel just beneath the surface, with a well conductor pipe extending there-through to the marine bottom;

FIGURE 4 is a schematic side elevation of the support structure bracing a well conductor pipe extending from a

point beneath the marine bottom to a terminus below the surface of the body of water and above the support structure, and a floating drilling vessel having a drill pipe extending down therefrom into the conductor pipe;

FIGURE 5 is a detailed side elevation of the means for interconnecting the support structure and the conductor pipe to keep the pipe continuously in tension; and

FIGURE 6 is a pictorial view of the support structure as utilized as a production platform for a well completed above the marine bottom but below the surface of the body of water at diving depth.

The support structure of the instant invention consists of a tripod arrangement of tubular members converging at the upper ends thereof and spaced at the lower ends by means of horizontal braces therebetween. A buoyant footing is fixed at the lower end of each leg of the tripod structure to support the structure on the marine bottom. The legs of the tripod structure terminate at the upper end in a central connector element having a vertical passage therethrough adapted to embrace loosely a conductor pipe and comprising an upwardly diverging slip bowl in the shape of an inverted cone that will retain a set of slips used to hang the conductor pipe.

Lines extend from the buoyant footings to the upper end of the support structure terminating in free ends that can be brought to within a hundred feet of the surface when the support structure is fixed on the marine bottom. The lines include conduits connected to the hollow interiors of the footings, and adapted to communicate operatively with pumps aboard an adjacent drilling vessel, for adjusting the air-water ratio therein to control the buoyancy of the footings, and jetting lines also adapted to be operatively communicative with equipment aboard the drilling ship for washing the footings down into the marine bottom to set fixedly the structure in place. The lines may either be fastened at intervals along the outside of the tubular legs or they may be supported within the legs themselves in certain instances. Each of the lines has a releasable coupling portion at the terminus of its free end.

When it has been determined to drill a subaqueous well, the tripod structure is towed to the site. The hollow footings are filled with air to provide maximum buoyancy so that the structure may be towed easily by a tugboat. When the towed support structure reaches the drilling site it is located, by the tug, adjacent the floating drilling vessel which is positioned above the site on the marine bottom. The free ends of the lines, secured to the support structure, are connected by intermediate lines, having corresponding releasable coupling portions, to the equipment on the drilling vessel through the moon pool therein. By controlling the buoyancy of the footings the structure is slowly submerged and by means of wire lines can be drawn to a point beneath the moon pool of the drilling vessel. A conductor pipe is made up through the moon pool and down through the slip bowl in the central connector element of the support structure while the support structure floats just beneath the moon pool. When the conductor pipe has reached the marine bottom, the weight of the pipe will temporarily anchor it there while the tripod support structure is fully submerged by readjusting the buoyancy thereof. The support structure rides down the conductor pipe and settles into the marine bottom. The jetting lines are then used to anchor firmly the footings.

The conductor pipe is drilled or washed into the bottom to the specified penetration. If it is deemed necessary the conductor pipe may then be cemented in place. After the conductor pipe is permanently fixed a set of slips, with upwardly slanted teeth, is installed in the slip bowl in the upper connector element of the tripod support structure surrounding the conductor pipe. Due to the shape of the slip teeth and the inverted conical shape of the slip bowl retaining the slips, the slips will permit the conductor pipe to rise upward with respect to the tripod

structure without allowing a compressive force on the pipe. The upper end of the conductor pipe, above the upper end of the tripod structure and within easy diving depth, is now removed. This can be done by cutting off the conductor pipe or by utilizing a left-hand threaded connection at this point.

A walk-around deck is installed by a diver at the upper end of the conductor pipe, which is preferably at a hundred feet below the surface of the body of water. One hundred feet is an arbitrary depth within easy reach of a diver and below the turbulent upper area affected by surface storms. The intermediate lines are now disconnected and the free ends of the lines secured to the support structure are attached to the walk-around deck where they can be reached later. A casinghead is fixed to the upper end of the conductor pipe just above the submerged deck to permit the hanging of casing in the pipe. BOPs (blowout preventers) are now installed on the upper end of the casinghead along with a quick release coupling. A circulating head is mounted above the BOPs and connected to the mud tanks on the vessel by a comparatively short flexible line for circulating the drilling mud up through the annulus of the conductor pipe in conjunction with an open drill pipe extending from the drilling rig above the moon pool down into a receiver head fixed to the upper end of the circulating head and through the BOPs and casinghead and into the conductor pipe. As an alternative, a surface riser pipe may be installed directly between a point in the moon pool and a quick release coupling above the BOPs and the drilling may commence through the conductor pipe without the necessity for a circulating head or a receiver head.

If the well should later prove to be productive, the upper surface riser pipe can be removed along with the BOPs and a Christmas tree (production wellhead) may be mounted over the upper end of the conductor pipe. A small marker buoy floating on the surface would be connected to the Christmas tree by a flexible line so that the well can later be located. Production flowlines from the Christmas tree may be extended to a tanker at the surface or secured along a tripod leg to the marine bottom and along the bottom to a submerged storage tank or ashore.

In the event that a dry hole is drilled or that the production is not sufficient for commercial purposes, the conductor pipe is cut off as close to the subaqueous bottom as possible and is drawn back out through the slips of the support structure to the drilling ship so that undamaged sections of it may be reused. The buoyancy control lines secured on the support structure are reconnected to the intermediate buoyancy control line communicating with the drilling ship, and the support structure is slowly raised to the surface by increasing the buoyancy in each of the footings. After resurfacing, the floating support structure may be towed by a tugboat to another drilling site.

Referring now to the drawings:

FIGURE 1 shows the well conductor support structure, generally designated 10, being towed on the surface 12 of the body of water 14 by a tugboat 16 connected to the support structure 10 by towlines 18. The support structure 10 consists of three legs 20 forming a pyramid with a central connector element 22 fixed in the upper apex and buoyant hollow footings 24 fixed beneath each of the legs. The lower ends of the legs 20 are interconnected by horizontal braces 26. Further bracing members may be connected between the legs 20 at spaced intervals if such appears necessary.

FIGURE 2 shows a drilling vessel, generally designated 28, consisting of a buoyant hull 30 having a moon pool 32 therethrough and with a derrick rig 34 mounted thereover. An intermediate communicating line or conduits 36 for controlling the buoyancy of the footings 24, and an intermediate communicating line or conduits 38, for supplying fluid under pressure for jetting the footings into the marine bottom, are connected by releasable couplings 40 and 42, respectively, to the free ends of a pair of main buoyancy

5

control and jetting lines or conduits 44 and 46, respectively.

As shown in FIGURE 5 the fixed ends of the main lines 44 and 46 are connected into a pair of concentric manifolds 48 and 50, respectively, surrounding the central connector element 22 at the apex of the support structure 10. Individual buoyancy control lines or conduits 52 extend down each of the legs 20 of the support structure from the manifold 48 to the hollow footings 24. Individual jetting lines or conduits 54 also extend from the manifold 50 down each of the legs 20 to jetting ports or nozzles (not shown) at the footings 24.

FIGURE 3 shows a conductor pipe 56 made up between the drilling ship 28 and a marine bottom 58. The submerged support structure 10 has been maneuvered beneath the moon pool 32 in the drilling vessel 28, and the conductor pipe 56 extends loosely through the connector element 22 at the upper end thereof. By reducing the buoyancy of the support structure 10, the support structure is slowly lowered onto the marine bottom 58.

FIGURE 4 and the detailed view of FIGURE 5 show the support structure 10 as utilized in conjunction with the conductor pipe 56 as a submerged drilling platform. The serially joined jetting lines 38, 46, and 54 (as shown in FIGURES 2 and 3) have been activated to seat firmly the footings 24 in the bottom 58 after which the conductor pipe 56 has been drilled or jetted into the marine bottom to the specified penetration. A walk-around deck 60 is installed just below the upper end of the conductor pipe 56. The free ends of the main buoyancy and jetting lines 44 and 46, respectively, are now fixed to the walk-around deck 60 so that a diver thereon can disconnect them from the intermediate lines 36 and 38 extending from the drilling ship 28 and later may reconnect them, also from the walk-around deck.

FIGURE 5 shows the detailed view of the interconnection between the conductor pipe 56 and the support structure 10. As seen in this view the legs 20 are welded or are in any other way rigidly attached to the outside of the connector element 22. A vertical inverted conical aperture comprising an upwardly diverging slip bowl 62 extends down through the element 22 to embrace loosely the conductor pipe 56 and to retain a set of surrounding slips 64. Due to the downwardly converging shape of the aperture 62 the slips 64 will allow the conductor pipe 56 to be moved upwardly with respect to the element 22 but will clamp the pipe 56 tightly if it tends to move downwardly. A protective sleeve 66 is welded over the conductor pipe 56 to prevent notching or crushing.

A casinghead 68 (see FIG. 4) is mounted on the conductor pipe just above the walk-around deck 60 and has means for hanging the required well casing (not shown) therein. Atop the casinghead 68 is a BOP stack 70 upon the upper end of which is fixed a circulating head 72. Above the circulating head 72 is a drill string receiver 74. The circulating head 72 permits the recirculation of drilling mud which has been pumped down through a hollow drill string 76 made up on the vessel 28 and lowered through the receiver 74, the circulating head 72, the BOP stack 70, the casinghead 68, and into the conductor pipe 56 and the subaqueous borehole. The mud is returned to the drilling vessel by means of flexible line 78 operatively connected between the annulus of the well at the circulating head 72 and the mud tanks (not shown) on the drilling vessel 28.

FIGURE 6 shows the support structure 10 being utilized as a submerged production platform in conjunction with the upstanding conductor pipe 56. A Christmas tree (production wellhead) 80 is mounted on the upper end of the conductor pipe 56, above the walk-around deck 60, and a buoy 82 floating on the surface 12 of the body of water 14 is connected to the Christmas tree 80 by a flexible line 84 to permit relocating of the subaqueous Christmas tree when it requires servicing or workover. Resistance to lateral loads on the support structure 10 is provided by the footings 24 implanted in the bottom. Resist-

6

ance to overturning of the frame is provided by a couple made up of two vertical forces: up, from one or two footings bearing in the bottom, and down, from the pullup on the conductor pipe resulting from the coaction with the slips 64.

When it is desired to remove the support structure 10 from the bottom, the conductor pipe 56 is cut off, preferably just above the bottom 58, although it could be at any point below the slips 64, and the main buoyancy control line 44, terminating at the walk-around deck 60, is reconnected with a floating surface vessel by the intermediate communicating line 36. Water may now be evacuated from the footings 24, being displaced by air being pumped down through the lines, until the support structure 10 has risen to the surface 12 at which time it may be towed to another subaqueous site.

Although the present invention has been described in conjunction with details of specific embodiments thereof, it is to be understood that such details are not intended to limit the scope of the invention. The terms and expressions employed are used in a descriptive and not a limiting sense and there is no intention of excluding such equivalents in the invention described as are encompassed within the scope of the claims. Now having described the method and apparatus herein disclosed, reference should be had to the claims which follow.

What is claimed is:

1. A subaqueous support structure for a vertical conductor pipe extending upwardly from a marine bottom comprising: a vertically apertured central connector element for loosely embracing a vertical conductor pipe, a plurality of legs diverging downwardly from said connector element, each of said legs terminating in a hollow, buoyancy controlled footing adapted to bear on said marine bottom for the support of said structure, said aperture in said connector element comprising an upwardly diverging slip bowl in the shape of an inverted truncated cone whereby a plurality of slips set in said slip bowl will coast with the embraced conductor pipe to grip said pipe and hold said pipe therebeneath in tension as said pipe tends to move in a relatively downwardly direction with respect to said support structure but will permit said pipe to move in a relatively upwardly direction with respect to said support structure and means for controlling the buoyancy of said support structure by regulating the air-water ratio within said footings whereby the support structure will float on the surface of a body of water when said footings are filled with air and will rest on the marine bottom when said footings are filled with water.

2. The subaqueous support structure of claim 1 designed to be completely submerged when supporting a vertical conductor pipe, wherein said means for controlling the buoyancy of said structure comprises, in part, first conduit means operatively connected between each of said hollow footing and the upper end of said support structure at a prescribed depth beneath the surface when said support structure is supporting a vertical conductor pipe, and releasable coupling means affixed to the upper end of said first conduit means, for operatively connecting said first conduit means with a source of fluid pressure on a surface vessel through a second conduit means whereby the buoyancy of said support structure can be controlled from a surface vessel.

3. A subaqueous support structure as recited in claim 2 wherein there is means for jetting said footings into said marine bottom, said jetting means comprising third conduit means operatively connected between each of said footings and the upper end of said support structure at a prescribed depth beneath the surface when said support structure is supporting a vertical conductor pipe, and releasable coupling means affixed to the upper end of said third conduit means for operatively connecting said third conduit means with a source of fluid pressure on a surface vessel through a fourth conduit means whereby the jet-

ting of said support structure into a marine bottom can be controlled from a surface vessel.

4. A subaqueous platform comprising a support structure as recited in claim 1, a vertical conductor pipe extending upwardly from a subaqueous well in a marine bottom through said connector element of said support structure beneath the surface of a body of water, slips in said vertical aperture embracing said conductor pipe and holding said pipe therebeneath in tension, a walk-around deck erected on said conductor pipe above said support structure and just below the upper terminus of said vertical conductor pipe whereby a diver may service equipment at the upper terminus of said conductor pipe by standing on said walk-around deck.

5. The subaqueous platform of claim 4 wherein said platform is used for drilling a subaqueous well in a marine bottom comprising a casinghead mounted on said upper end of said conductor pipe, and a blowout preventer stack mounted on said casinghead, said casinghead and said blowout preventer stack being located under the surface of the body of water.

6. The subaqueous platform of claim 4 wherein said platform is used for oil and/or gas production from a completed subaqueous well located beneath said marine bottom, and said equipment at the upper end of said conductor pipe comprises at least a production wellhead located under the surface of a body of water.

7. A method for installing said support structure of claim 2 from a surface vessel located over a subaqueous well site comprising the following steps:

- (a) adjusting the buoyancy of said support structure to float said structure substantially on said surface;
- (b) locating said support structure adjacent said surface vessel;
- (c) connecting said releasable coupling means between said first conduit means on said support structure and said second conduit means to provide a fluid path between said surface vessel and said hollow footings for adjusting said buoyancy of said support structure;
- (d) readjusting the buoyancy of said support structure to completely submerge said support structure and locating said support structure just beneath said surface vessel;

(e) lowering a section of conductor pipe through said loosely embracing aperture in the connector element of said support structure and making up said conductor pipe until said pipe at least engages said marine bottom;

(f) readjusting said buoyancy of said support structure to allow said support structure to descend to said marine bottom and rest thereon;

(g) extending said conductor pipe into said marine bottom to the specified penetration with the upper terminus of said conductor pipe being submerged and above said vertical aperture in said connector element of said support structure; and

(h) after steps (f) and (g), setting said slips in said slip bowl to hold said conductor pipe in tension.

8. The method of installing said support structure as recited in claim 7 comprising the following additional step:

(i) installing a walk-around deck on said conductor pipe just beneath the upper submerged terminus thereof.

9. A method for removing said support structure of claim 2 from said well site after the installation of a conductor pipe through said support structure and the setting of said slips in said slip bowl in said connector element of said support structure to hold said conductor pipe in tension, comprising the following steps:

- (a) cutting off said conductor pipe beneath said connector element of said support structure;
- (b) lifting said upper cut off portion of said conductor pipe out of said support structure; and
- (c) adjusting the buoyancy of said support structure to raise said support structure to the surface so it can be towed to another well site.

References Cited

UNITED STATES PATENTS

3,127,198	3/1964	Orund	285—146
2,176,477	10/1939	Varney et al.	61—63 X
2,552,899	5/1951	Manes	61—46.5
3,125,171	3/1964	Stewart	175—7 X

JACOB SHAPIRO, *Primary Examiner*.