SPECIFICATION

Apparatus for protecting subsea structures

This invention relates to methods and apparatus for protecting subsea well structures, and more particularly to methods and apparatus for preventing damage to these structures by anchors, fishing trawler boards and nets, and other towed objects that could be brought into contact with said structures.

The production of oil and gas from offshore wells has developed into a major endeavor of the petroleum industry. Such wells are now being drilled throughout the world at many locations, some of which are in commercial fishing areas such as the North Sea where anchors, nets, trawl boards and other equipment being towed underwater may come into contact with well heads and the christmas trees attached thereto. An anchor or trawl board can literally tear a christmas tree or wellhead off the well, thereby causing oil and/or gas leakage into the sea. Since the christmas tree of a subsea well can protrude 20 to 30 feet above the sea floor, known protective structures such as steel or concrete domes or pyramids may be as tall as 30 feet with bases as large as 50 to 60 feet in diameter. As the total weight of these structures may approach or exceed 200,000 lbs., this weight is relied upon to retain them in position. Lighter fibreglass structures require some means of anchoring them to the sea floor, and in some of the prior art installations this has been accomplished with screw-type anchors positioned around their perimeter. In all cases the physical size of these prior art structures makes their handling and installation difficult.

According to the present invention there is provided apparatus for protecting structures on the floor of the sea, or other body of water, from physical damage, said apparatus comprising a protective enclosure for mounting around said subsea structure, a plurality of containers attached to said protective enclosure, and means through which said containers can be filled with cement, each of said containers being separately attached to a wall of said enclosure in such a way that each container is capable of being broken away from said enclosure when a net, anchor or other marine equipment snags on said container.

The invention also provides a method for protecting structures on the floor of a body of water from physical damage including the steps of

1) providing a protective enclosure to mount around said subsea structure,

2) attaching a plurality of bag-shaped containers to a wall of said protective enclosure,

3) moving said enclosure and said containers into position around said subsea structure, and

4) filling said bag-shaped containers with cement.

The invention will now be particularly described by way of example, with reference to the accompanying drawings in which:-

Figure 1 is an isometric view of an enclosure for protecting subsea wellheads according to the present invention, showing it releasably connected to a pipe string for lowering it to the sea floor;

Figure 2 is a central vertical section through the protective enclosure of Figure 1, showing it in position around a subsea wellhead, and ready for filling with cement;

Figure 3 is a view similar to Figure 2, showing the enclosure and the bags completely filled with cement, and illustrating how an anchor line will be deflected by the enclosure to lift the anchor flukes out of the sea floor;

Figure 4 is a side elevation of the enclosure of Figure 3, showing how the anchor can ride up over the cement shield;

Figure 5 is a fragmentary view illustrating how a cement filled bag will break away from the enclosure if snagged by an anchor, and

Figure 6 is a view like Figure 5 showing how the detached bag will catch in the anchor and prevent it from becoming fouled on another part of the shield or enclosure.

An apparatus for protecting subsea wells as shown in the drawings comprises an annular protective enclosure 10 with a large open top 11 to allow access to the well, and chamber 14 which can be a single annular chamber or a plurality of chambers, with an inner wall 15, a sloping outer wall 18, and a bottom wall 20. To the enclosure 10 is welded or otherwise secured a guide base 19 that includes a plurality of vertical guide posts 22, and a conductor pipe 49 surmounted by a wellhead 50.

A running string 31, attached to the upper end of a running tool 26 that is releasably secured to the wellhead, and thus the guide base 19 and enclosure 10, by a dog and groove arrangement (not shown) or any other suitable means well-known in this industry, is used to lower the wellhead 50, conductor pipe 49, guide base 19 and the protective enclosure 10 as a unit into position on the solid sea floor 34 (Figure 2). When, as is usually the case, this sea floor 34 is covered by a layer of mud or silt 30, this layer is jetted or otherwise removed from the vicinity of the well by conventional means and the conductor pipe 49 is jetted and/or drilled into the sea floor until the enclosure 10 reaches the position shown in Figure 2. From this position a plurality of guide lines 35, each connected to one of the guide posts 22, extend to a drilling platform or vessel (not shown) at the surface to guide tools and equipment between the platform or vessel and the guide base 19 in the usual manner. The guide base 19 also includes a plurality of pointed plates 38 that stab into the sea floor 34 to assist in holding the base etc., in proper position.

Surrounding the enclosure 10 and attached to its outer wall 18 are a plurality of bags or bag-like containers 39. A plurality of spaced ports 42 (Figures 2 and 3) through the outer wall 18 provide communication between the interior of the bags 39 and the enclosure's chamber 14. Also in communication with the chamber 14, and thus with the bags 39, are a plurality of spaced hoses, pipes, or other tubular conduits 43 that extend between the enclosure 14 and a source of cement, such as the drilling platform or vessel (not shown). The conduits 43 preferably are releasably connected to the enclosure 10 by quick

release couplings 44 so that they can be removed when their function has been fulfilled.

Once the enclosure 10 and the guide base 19 have been positioned on the sea floor 34, and the conductor pipe 49 has been cemented to the borehole 48 by pumping cement 52 down the pipe and up the space between it and the borehole to secure the pipe in place, cement is then pumped through the conduits 43 into the chamber 14 from which it flows through the ports 42 into the bags 39, filling the bags and causing them to expand into the shape shown in Figures 3 and 4. The bags 39 are shaped to provide a smoothly contoured concrete shield 60 around the enclosure 10 when they are filled with cement, thereby reducing the possibility that anchors and other marine equipment under tow will become fouled as they come into contact with the shield. Should such fouling occur, however, the bag or bags 39 that are snagged will break away from the shield 60 and let the anchor, etc., proceed on its way up and over, or around, the shield and enclosure so that no damage is incurred by the enclosure or the wellhead.

After the chamber 14 and the bags 39 are filled with cement, the cement conduits 43 are disconnected from the enclosure 10 and retrieved to the surface, and a cap 53 (Figure 3) is lowered and guided into position on top of the enclosure 10 by the guide lines 35. The guide lines 35 can then be disconnected from the guide posts 22 in the usual manner.

Figures 3-6 illustrate the manner in which the cement-filled bags break away from the shield 60 as they are snagged by moving marine equipment, thereby protecting the subsea wellhead. As an anchor 56, being pulled along the sea floor 34 by an anchor chain 57, approaches the enclosure 10 the chain 57 contacts the cap 53 (Figure 3) causing the anchor shank and flukes to be lifted from the sea floor. As the anchor then makes contact with the cement-filled bags 39 (Figure 4) their smooth contour prevents small anchors from fouling on their outer surface and allows these small anchors to ride up the shield 60 in response to continued pulling by the anchor chain 57. However, when the anchor or other marine equipment is large and/or heavy, and if a bag or bags 39 is/are snagged by an such anchor, etc., as shown in Figure 5 the bag or bags will break away from the shield 60. Should an anchor be involved, the dislodged bag or bags will jam into the area between the anchor shank 56b and flukes 56a, thereby preventing further fouling of the anchor on the shield or enclosure and facilitating its continued movement over or around and past the enclosure without damage to it or the protected well equipment.

The cement contained in the chamber or chambers 14, and in the bags 39, advantageously increase the overall weight of the protective enclosure 10 and aid in anchoring it in place, yet this added weight does not have to be supported by the running string 31 since it is pumped or conducted into position after the enclosure 10 has been run and installed. Thus, a considerable savings in equipment costs, by not having to employ special and heavier running apparatus, also is achieved by the present invention.

Although the drawings illustrate only a wellhead within the protected environment of the enclosure 10, it should be clearly understood that the enclosure also can be constructed to adequately protect a christmas tree, whether the tree extends above the wellhead whereby the enclosure will have a much taller profile, or whether a subsurface tree that is located below the sea floor 34 is being protected.

CLAIMS

1. Apparatus for protecting structure on the floor of the sea, or other body of water, from physical damage, said apparatus comprising a protective enclosure for mounting around said subsea structure, a plurality of containers attached to said protective enclosure, and means through which said containers can be filled with cement, each of said containers being separately attached to a wall of said enclosure in such a way that each container is capable of being broken away from said enclosure when a net, anchor or other marine equipment snags on said container.

2. Apparatus according to claim 1 wherein said means through which said containers can be filled include a conduit extending away from said containers.

3. Apparatus according to claim 1 or claim 2 wherein said containers comprise bags shaped, at least when filled with cement, to form a smooth continuous contour around said protective enclosure to reduce the chances of moving marine equipment snagging on said enclosure.

4. Apparatus according to claim 3 wherein said protective enclosure has hollow walls, said bag-shaped containers being attached to a wall of said enclosure, and said hollow walls forming part of the means through which said bag-shaped containers can be filled with cement.

5. Apparatus according to claim 4 wherein said protective enclosure includes an inner wall, an outer wall, and an annular chamber therebetween, ports in said outer wall between said chamber and each of said containers, and means through which cement can be introduced into said chamber for flow into said containers.

6. A method for protecting structures on the floor of the sea, or other body of water, from physical damage including the steps of

1) providing a protective enclosure to mount around said subsea structure,

2) attaching a plurality of bag-shaped containers to a wall of said protective enclosure,

3) moving said enclosure and said containers into position around a subsea structure, and

4) filling said bag-shaped containers with cement.

7. A method according to claim 6 wherein said enclosure has hollow walls and the cement is caused to flow into said hollow walls.

8. A method according to claim 6 or claim 7 which further comprises attaching said containers to said wall of the enclosure by means permitting each container to be detached therefrom by a predetermined amount of force.

release couplings 44 so that they can be removed when their function has been fulfilled.

Once the enclosure 10 and the guide base 19 have been positioned on the sea floor 34, and the conductor pipe 49 has been cemented to the borehole 48 by pumping cement 52 down the pipe and up the space between it and the borehole to secure the pipe in place, cement is then pumped through the conduits 43 into the chamber 14 from which it flows through the ports 42 into the bags 39, filling the bags and causing them to expand into the shape shown in Figures 3 and 4. The bags 39 are shaped to provide a smoothly contoured concrete shield 60 around the enclosure 10 when they are filled with cement, thereby reducing the possibility that anchors and other marine equipment under tow will become fouled as they come into contact with the shield. Should such fouling occur, however, the bag or bags 39 that are snagged will break away from the shield 60 and let the anchor, etc., proceed on its way up and over, or around, the shield and enclosure so that no damage is incurred by the enclosure or the wellhead.

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The cement contained in the chamber or chambers 14, and in the bags 39, advantageously increase the overall weight of the protective enclosure 10 and aid in anchoring it in place, yet this added weight does not have to be supported by the running string 31 since it is pumped or conducted into position after the enclosure 10 has been run and installed. Thus, a considerable savings in equipment costs, by not having to employ special and heavier running apparatus, also is achieved by the present invention.

Although the drawings illustrate only a wellhead within the protected environment of the enclosure 10, it should be clearly understood that the enclosure also can be constructed to adequately protect a christmas tree, whether the tree extends above the wellhead whereby the enclosure will have a much taller profile, or whether a subsurface tree that is located below the sea floor 34 is being protected.

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2. Apparatus according to claim 1 wherein said means through which said containers can be filled include a conduit extending away from said containers.

3. Apparatus according to claim 1 or claim 2 wherein said containers comprise bags shaped, at least when filled with cement, to form a smooth continuous contour around said protective enclosure to reduce the chances of moving marine equipment snagging on said enclosure.

4. Apparatus according to claim 3 wherein said protective enclosure has hollow walls, said bag-shaped containers being attached to a wall of said enclosure, and said hollow walls forming part of the means through which said bag-shaped containers can be filled with cement.

5. Apparatus according to claim 4 wherein said protective enclosure includes an inner wall, an outer wall, and an annular chamber therebetween, ports in said outer wall between said chamber and each of said containers, and means through which cement can be introduced into said chamber for flow into said containers.

6. A method for protecting structures on the floor of the sea, or other body of water, from physical damage including the steps of

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4) filling said bag-shaped containers with cement.

7. A method according to claim 6 wherein said enclosure has hollow walls and the cement is caused to flow into said hollow walls.

8. A method according to claim 6 or claim 7 which further comprises attaching said containers to said wall of the enclosure by means permitting each container to be detached therefrom by a predetermined amount of force.

9. A wellhead protective enclosure substantially as hereinbefore described with reference to the accompanying drawings.

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