Feb. 3, 1970 R. V. EVANS ET AL 3,492,824

METHOD OF INSTALLING A PIPE NIPPLE IN THE WALL OF A CASING

Filed May 12, 1967 2 Sheets-Sheet 1

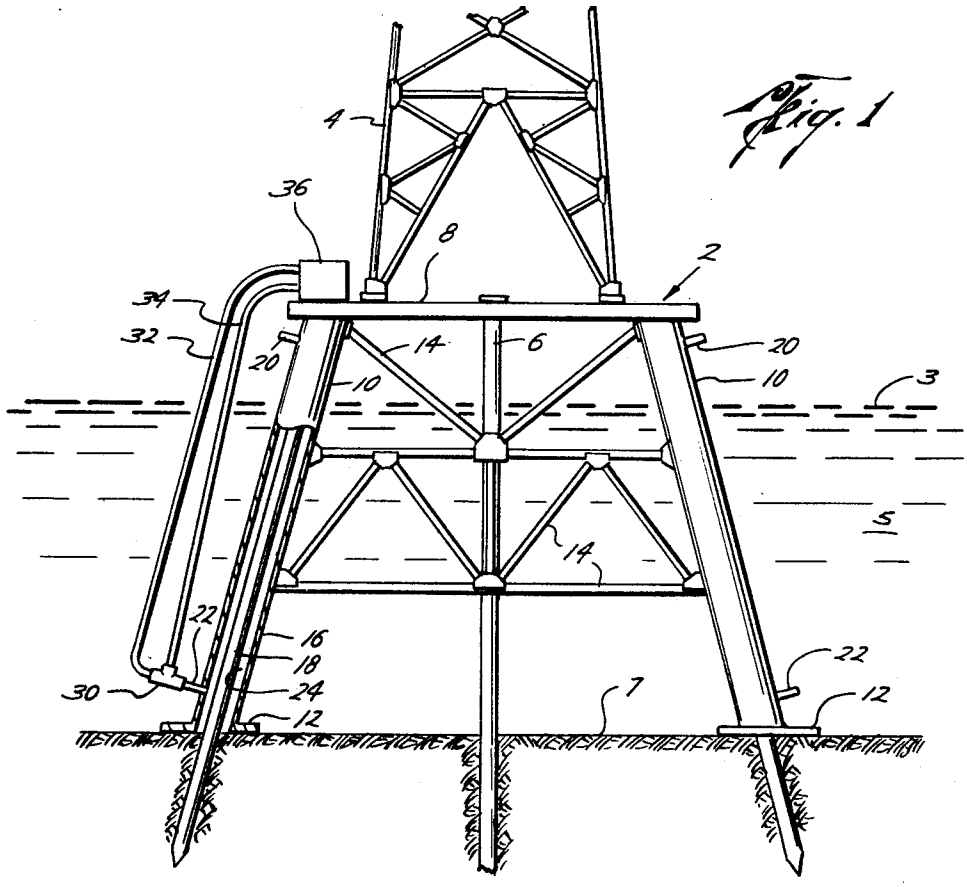


Fig. 1

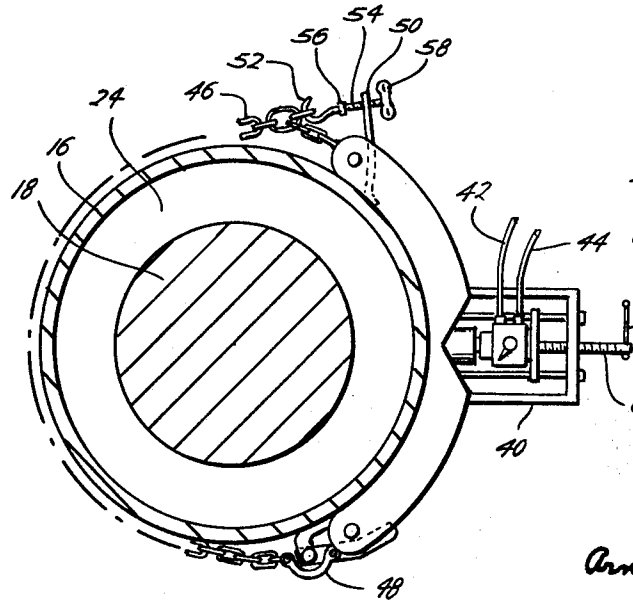


Fig. 2

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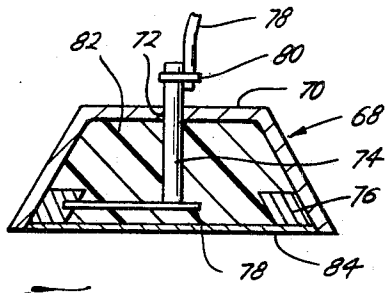
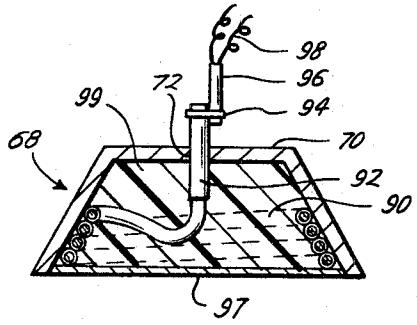


Fig. 3

Fig. 4



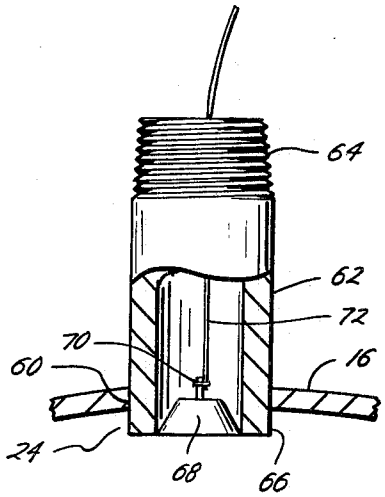


Fig. 5

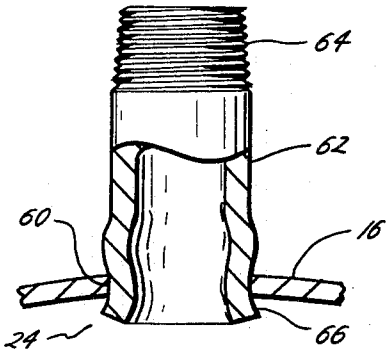


Fig. 6

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METHOD OF INSTALLING A PIPE NIPPLE IN THE WALL OF A CASING

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U.S. Cl. 61—46.5 3 Claims

ABSTRACT OF THE DISCLOSURE

Methods and apparatus for installing a pipe nipple in the wall of a submerged casing in a fluid-tight manner. The casing is tapped by cutting a hole in its wall sufficient that the nipple can be slidably inserted therein. An explosive charge of predetermined magnitude is detonated in the nipple and opposite the casing wall so as to expand the nipple in the hole.

Background of the invention

This invention relates to methods and apparatus for making a pipe T connection, and more particularly relates to methods and apparatus for installing a pipe nipple in the wall of a submerged steel pipe casing.

It is well known that oil and gas wells are drilled into earth formations at offshore locations which may be several hundred feet below the surface of the water. It is also well known that platforms with legs resting on the floor of the ocean are constructed to support the drilling rigs and pipe derricks necessary to such wells. As will hereinafter be explained in detail, the legs of such offshore platforms are each composed of an outside steel casing having a shoe planted on the ocean floor, and a smaller piling inside of the casing and extending deep into the submerged ocean bottom.

As will hereafter be explained, the casings of the platform are interconnected with braces to provide the rigidity necessary to withstand damage by waves. However, the pilings are not directly connected to the braces, since there is an annular space between each pile and the casing which surrounds it. Thus, it is common practice to fill this annular space with cement to form the casing and pile into a unitary leg for the platform.

Unless special provision is made to seal the casing to the pile in the vicinity of the shoe, it will be apparent that the annulus in the casing will be filled with water. Thus, it is impractical to inject cement into the top of the casing since the water trapped in the annulus will oppose the input of the cement. On the other hand, even if there is no water in the annulus, the inflowing cement will tend to trap air and thus produce cavities in the cement throughout the length of the casing.

Accordingly, it is the present practice to install a pipe nipple in the wall of the casing at both its top and bottom. Air is then injected into the casing through the top nipple until the water in the annulus is expelled through the bottom nipple. Thereafter, cement is injected into the bottom nipple until the annulus is completely filled. Since the annulus is filled from the bottom of the casing, it will be apparent that the cement will not tend to trap any air in the annulus. Instead, the cement will simply displace the air out through the top nipple as it rises to the top of the casing.

The present manner of installing a nipple in the submerged bottom end of the casing is substantially the same as in any other case. A hole is cut in the wall of the casing by conventional means, and the nipple is then welded or threadedly inserted into the hole. In the case of the top nipple, the foregoing top nipple is easily installed by this technique, since the top end of the casing is not submerged and is quite accessible. The bottom nipple must be installed in the submerged end of the casing, and this fact creates many difficulties which are not ordinarily encountered when making a casing tap above the surface of the ocean. Accordingly, the cost of installing a nipple at the submerged bottom end of each casing is many times greater than that of installing a nipple in the upper end of the casing.

In the first place, the hourly pay scale of a diver operating deep below the surface of the water is many times greater than that of a pipeline worker or the like who does his work in a normal environment. Second, it is necessary to the safety of a diver that he work quite slowly by conventional working standards, and thus the expense is greatly increased for this reason.

Third, and perhaps most significantly of all, it is essential that the nipple be installed or fitted to the casing in a manner such that there is no leak whatsoever between the nipple and the casing. There is considerable water pressure at the bottom of the casing, and even a very thin hairline crack or hole will permit the water to flow into the annulus. Moreover, if the annulus is permitted to fill with water before the cement is inserted, it will be apparent that the thin cement slurry being pumped into the annulus through the pipe nipple will tend to be expelled back out through the crack or hole instead of lifting the water in the annulus out through the top of the casing.

Preferred form of the invention

These disadvantages of the prior art are overcome with the present invention and novel methods and apparatus are provided herewith for installing a pipe nipple in the wall of a submerged casing. In a preferred embodiment of the present invention, a hole is first cut in the wall of the casing into which the nipple may be inserted. An explosive charge of predetermined intensity and shape is then exploded inside of the nipple in a manner so as to flare the contained end of the nipple and to expand the section of the nipple adjacent the casing. Thus, the nipple is sealed or fixed to the casing wall in a fluid-tight manner. As will be apparent this technique can be used to install a nipple in the submerged end of the casing in a fraction of the time required by any of the techniques of the prior art. Furthermore, this technique has been found much more dependable in providing for a fluid-tight seal between the casing wall and the outside surface of the nipple.

Objects

Accordingly, it is an object of the present invention to provide improved methods and apparatus for installing a pipe nipple in the wall of a casing.

It is also an object of the present invention to provide improved methods and apparatus for installing a pipe nipple in the wall of the submerged portion of a steel casing employed as a structural member.

It is a specific object of the present invention to provide a method of installing a pipe nipple in a hole in the wall of a submerged casing, said method comprising the steps of cutting a hole in said wall of said casing, inserting said nipple into said hole in said casing, and explosively expanding the portion of said nipple adjacent said casing wall radially into fluid-tight engagement with said casing.

It is another specific object of the present invention to provide novel apparatus for installing a pipe nipple in a hole in the wall of a submerged casing, said apparatus comprising expansion means insertable in said nipple adjacent said casing wall to explosively expand said nipple into fluid-tight engagement with said casing, and actuating

means operable from a location remote of said nipple for actuating said expansion means in said nipple.

These and other objects and features of the present invention will be apparent from the following detailed descriptions, wherein reference is made to the figures of the accompanying drawings.

In the drawings:

FIGURE 1 is a pictorial representation, partly in cross section, of the basic structural details of an offshore drilling platform of the type hereinbefore described.

FIGURE 2 is a pictorial representation, partly in cross section, of a perferred form of mechanism for making a tap in the submerged section of casing employed as a leg member of an offshore drilling platform.

FIGURE 3 is is a cross-sectional representation of one form of explosive charge suitable for installing a nipple in a casing in a fluid-tight manner.

FIGURE 4 is a cross-sectional representation of a modified form of the apparatus depicted in FIGURE 3.

FIGURE 5 is a cross-sectional representation of a nipple inserted in a tapped casing and containing the apparatus depicted generally in FIGURE 3.

FIGURE 6 is a cross-sectional representation of the nipple depicted in FIGURE 5 after the nipple has been fixed to the casing by means of the present invention.

Detailed description

Referring now to FIGURE 1, there may be seen a pictorial representation of the general features of a typical offshore drilling platform **2** for supporting a pipe derrick **4**, drill pipe **6**, and such other drilling equipment as may be desired. The platform **2** may be seen to generally include a floor **8** supported by at least four leg members **10** each having a shoe **12** planted on the submerged earth or rock bed **7** of the ocean in which the platform **2** is erected.

Although the floor **8** of the platform **2** may be seen to be positioned well above the surface **3** of the water **5**, a substantial portion of each of the legs **10** will be submerged depending upon the depth of the water at the particular location. Consequently, it is preferable to brace these legs **10** by means of the struts **14** depicted in FIGURE 1, or the like, to give the platform the rigidity necessary to resist damage resulting from twisting due to laterally directed force from the water **6**.

As may also be seen in FIGURE 1, it may be seen that each leg **10** is composed of a steel casing **16** of relatively large outside diameter (such as 33 inches) to which the struts **14** are connected. Inside each casing **14**, however, is a piling **18**, which is driven deep into the bed **7** of the ocean, and which bears its proportion of the weight of the floor **8** and the equipment located thereon. Since each piling **18** has an outside diameter which is at least a little smaller than the inside diameter of its casing **16**, it will be apparent that it is capable of moving independently of the casing **16** in which it is housed. Thus, it is necessary to bind the casing **16** and its piling **18** together into a unit in order for these two components to constitute a leg member **10**.

As hereinbefore explained, it is common practice to install a nipple **20** in the wall of the casing **16** above the surface **3** of the water, and to install a second nipple **22** in the wall of the casing **16** adjacent its shoe **12**, to provide means for filling the annulus **24** in the casing **16** with cement. In particular, a three-way valve **30** may be connected to the second nipple **22** and to hoses **32** and **34** which are connected to air pressuring and cementing equipment **36** located on the floor **8** of the platform **2**. Air is first injected into the annulus **24** through hose **34** and the second nipple **22** to drive any water in the annulus **24** out through the top nipple **20**. Thereafter, the valve **30** is repositioned to decouple the air flow through the hose **34**, and to connect the second hose **32** to the nipple **20**. Cement is then injected into the annulus **24** by way of the second hose **32** so as to fill the annulus **24** from the bottom to the top of the casing **16**.

Referring now to FIGURE 2, there may be seen a pictorial representation of a preferred apparatus for cutting a hole or tap in the submerged wall of the casing **16** depicted in FIGURE 1. In particular, there is shown in cross section the piling **18** disposed in the casing **16** so as to define the annulus **24** hereinbefore described. Also depicted is a conventional tapping machine **40** having a pair of hose **42** and **44** connected to a source of hydraulic pressure (not depicted). As is well known, the tapping machine **40** is strapped to the outside of the casing **16** by means of a chain **46** and conventional chain binder **48** which is preadjusted at the surface to fit the casing **16** sought to be tapped.

It is often difficult to fasten the tapping machine **40** securely to the casing **16**, since the submerged surface of the casing **16** usually becomes heavily encrusted with barnacles and other similar marine life after only a relatively short period. Thus, the chain **46** will tend to fit securely about the encruted casing **16** until the chain **46** is snubbed down by the chain binder **48**, whereupon the chain **46** may crush or bite through the crust of barnacles and become slack.

Heretofore, it has become necessary in this instance to draw the tapping machine **40** and chain **46** back up to the platform **2** and to readjust the chain binder **48**. However, it is a feature of the present invention to include a so-called "fine adjustment" mechanism comprised of a bracket **50** containing a threaded rod **54** interconnected at one end with a hook **52** and a swivel **56**, and having a butterfly handle **58** or the like at the other end. Thus, if the chain **46** crushes the barnacles on the casing **16** and then grows slack when the chain binder **48** is locked to draw the chain **46** taut about the casing **16**, the threaded rod **54** may simply be twisted by hand to draw up the chain **46** by means of the hook **52**. Thus, the necessity to disconnect the chain **46**, and to send the assembly back to the floor **8** of the platform **2** so that the chain binder **48** can be readjusted, is thereby eliminated.

After the chain **46** is drawn sufficiently tightly about the casing **16**, the cup-shaped bit (not depicted) is revolved by the hydraulic power from the hoses **42** and **44**, and is manually urged against the outside surface of the casing **16** by means of the threaded rod **60** having cross bar handle **62**. After a suitable hole or tap has been cut in the wall of the casing **16**, the chain binder **48** may be unlatched and the chain **46** and tapping machine **40** removed to another leg member **10** or to the surface.

In the present invention, the hole cut in the casing **16** need not be threaded, but need only be of a size such that the nipple may be pushed into the hole by hand. Thus, the nipple to be installed in the casing **16** may be manually inserted in the hole cut by the tapping machine **40** as soon as it is removed from the casing **16**.

Referring now to FIGURE 5, there may be seen a cross-sectional representation of the wall portion of the casing **16** in which a suitable tap or hole **60** has been cut by the tapping machine **40** depicted in FIGURE 2. As may also be seen, a conventional pipe or tubing nipple **62** which may have threads **64** at one end, is slidably inserted in the hole **60**. In this respect, it is preferable that the non-threaded end **66** of the nipple **62** protrude past the inside wall of the casing **16** and into the annulus **24** a small extent such as one-quarter inch, for reasons which will hereinafter be apparent.

As hereinbefore stated, it is the object of the forms of the present invention depicted and described herein to fix the nipple **62** in the hole **60** in an absolutely fluid-tight manner. Accordingly, an explosive charge **68** having a suitable detonator assembly **70** and igniter connector **72** is disposed in the nipple **62** adjacent the non-threaded end **66** for detonation to deform the nipple **62** in a manner to properly fix it to the casing **16**. As will hereinafter be explained in detail, the charge **68** is adapted to expand

the nipple 62 at the portion which is adjacent the casing 16 so as to provide a 360 degree fluid-tight seal or bond between the nipple 62 and the casing 16.

Referring now to FIGURE 6, there may be seen a cross-sectional representation of the nipple 62 and casing 16 as it tends to appear after detonation of a suitable charge 68 such as that depicted in FIGURE 5. In particular, it may be seen that the non-threaded end 66 of the nipple 62 has been flared by the force of the detonation to aid in fixing the nipple 62 in the hole 60 in the casing 16. In addition, the portion of the nipple 62 immediately outside of and adjacent the casing 16 has assumed a bulged or expanded shape which also aids in fixing the nipple 62 to the casing 16. Since the portion of the casing 16 encircling the nipple 62 tends to resist the outwardly expanding force of the detonation, the hole 60 will not be appreciably enlarged by the explosion. However, it will be apparent that the nipple 62 will be pressed or driven into the wall of the casing 16, and that it is this expansion of the nipple 62 in the hole 60 in the casing 16 which achieves the fluid-tight seal or bond between the casing 16 and the nipple 62 which is sought to be obtained.

It will be apparent that the shape and size of the charge 68 depicted in FIGURE 5, as well as its position in the nipple 62, will be factors which will control the fixing of the nipple 62 in the casing 16 in the manner sought to be achieved. As may be seen in FIGURE 5, the charge 68 is preferably disposed at the non-threaded end 66 of the nipple 68 so as to achieve the flared shape represented pictorially in FIGURE 6. However, it is desirable that the charge 68 be sufficient to achieve this flaring effect as indicated, and to achieve the bulging effect hereinbefore described, only to the extent necessary to fix the nipple 62 in the hole 60 in a fluid-tight manner, and not to the extent that the nipple 62 is ruptured and the casing is deformed.

Referring now to FIGURE 3, there may be seen a pictorial representation, partly in cross section, of one form of charge 68 which has been found especially suitable for the purpose hereinbefore described. In particular, there may be seen a cup-shaped container 70 having a generally frusto-conical configuration, and having an aperture 72 containing a first detonating cap 74 which is preferably non-electrically actuated, but which may be electrically actuated. As depicted, the first cap 74 is centrally positioned in the closed smaller end of the container 70 so as to extend from the exterior of the container 70 into its interior.

An annular body of suitable detonatable material, such as plastic explosive, may be disposed in the container 70 adjacent its larger end and having imbedded therein a second detonating cap 78 which is preferably non-electrically actuated, but which is preferably coupled for actuation to the lower or free end of the first cap 74. The first cap 74 may be actuated by any suitable means extending to a location remote from the nipple 62. Accordingly, if the first cap 74 is non-electrically detonatable as hereinbefore described, then a flexible length of Primacord 78 may be connected to the first cap 74 by any suitable means such as a metal or plastic clip 80.

The container 70 is preferably non-metallic but may be constructed of any suitable material such as paper or plastic. Inasmuch as the assembled charge 68 is necessarily subjected to considerable external pressure, the container 70 is preferably packed with an inert filler material 82 such as epoxy resin or modeling clay, and a paper or plastic cover 84 may be attached to the open lower end of the container 70 to keep water from penetrating the interior of the container 70.

Referring now to FIGURE 4, there may be seen a pictorial representation, partly in cross section, of an alternative form of the charge 68 generally depicted in FIGURES 3 and 5. In particular, the container 70 is provided with a centrally located aperture 72 as indicated in FIGURE 3, but the active portion of the charge 68 may be composed of about three windings of a suitable explosive material such as Primacord 90, which is connected at one end to a detonatable cap 92. The cap 92, which is preferably non-electrically detonatable, may be connected by means of a metal or plastic ring or clip 94 to another detonating means such as an electrically detonatable cap 96, which, in turn, may be connected to electric leads 98 extending to a remote control location. Alternatively, a length of primacord may be substituted for the cap 96 and leads 98.

Since the water pressure may crush or otherwise deform the assembled charge 68, the container 70 depicted in FIGURE 4 may also be filled with an inert material 99 such as epoxy resin or modeling clay. A cover 97, which may be formed of paper or plastic, or the like, may be disposed in the larger end of the container 68 to prevent water from penetrating the interior of the container 68.

Many other variations and modifications in the structures and methods described herein and depicted in the accompanying drawings without substantial departure from the concept of the invention. Accordingly, it should be clearly understood that the forms of the present invention which are described and explained herein, are illustrative only, and are not intended as limitation on the scope of the invention.

What is claimed is:

1. A method of installing a pipe nipple in a hole in the wall of a submerged hollow casing of a static structure, said method comprising

cutting a hole in said wall of said submerged hollow casing,

inserting said nipple into said hole in said submerged hollow casing, and

explosively expanding the portion of said nipple adjacent said submerged hollow casing wall radially into interlocked fluid-tight engagement with said submerged hollow casing.

2. The method described in claim 1 including

inserting said nipple slidably into said hole in said submerged hollow casing so that one end of said nipple extends into the interior of said submerged hollow casing, and

explosively flaring said extended end of said nipple in said submerged hollow casing.

3. The method described in claim 2, including

explosively bulging the portion of said nipple adjacent the exterior surface of said submerged hollow casing

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U.S. Cl. X.R.

29—421, 523; 285—382.5