Feb. 13, 1968 W. R. POSTLEWAITE 3,368,619

METHOD AND APPARATUS FOR WORKING ON UNDERWATER WELLS

Filed June 13, 1966 3 Sheets-Sheet 1

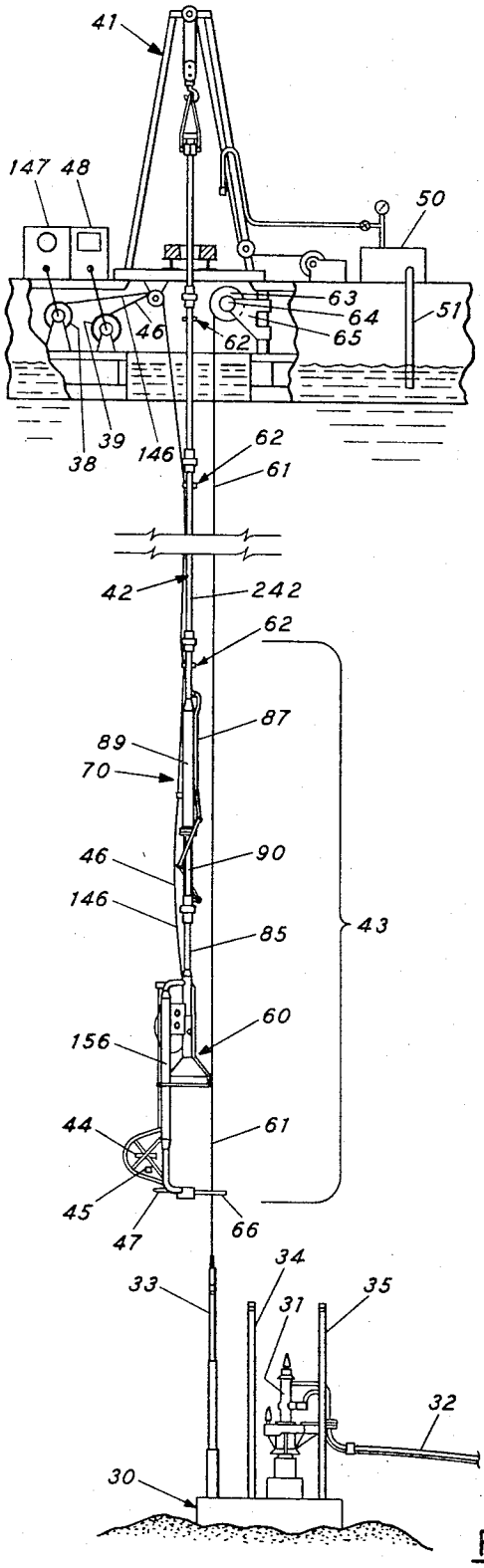


FIG.15

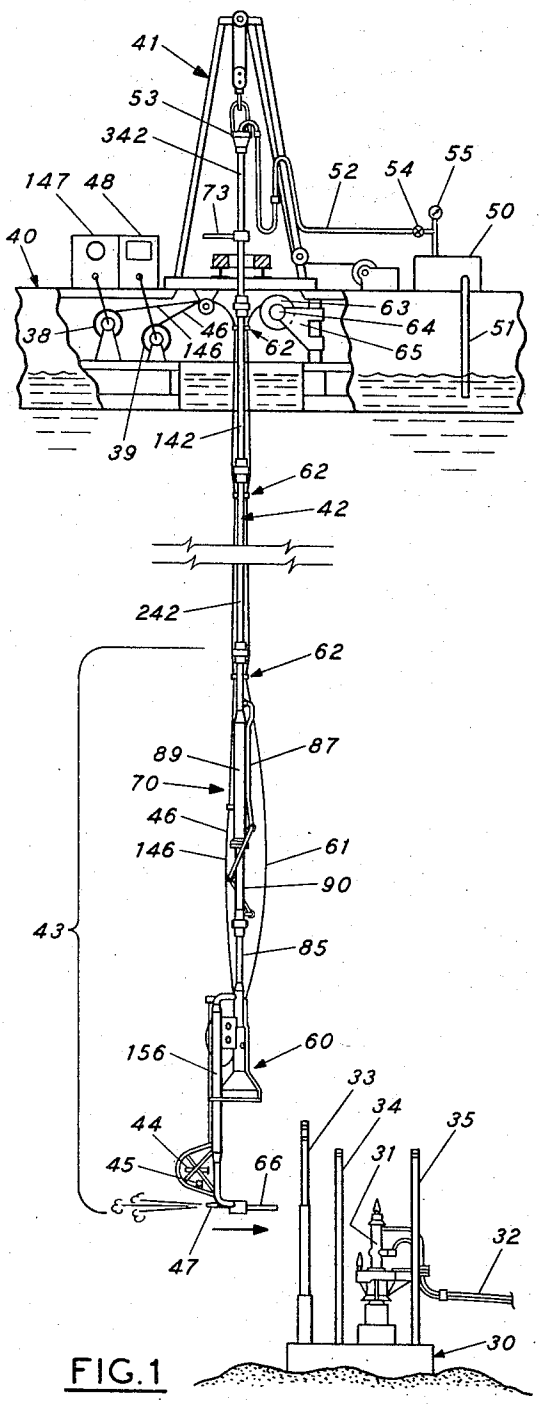


FIG.1

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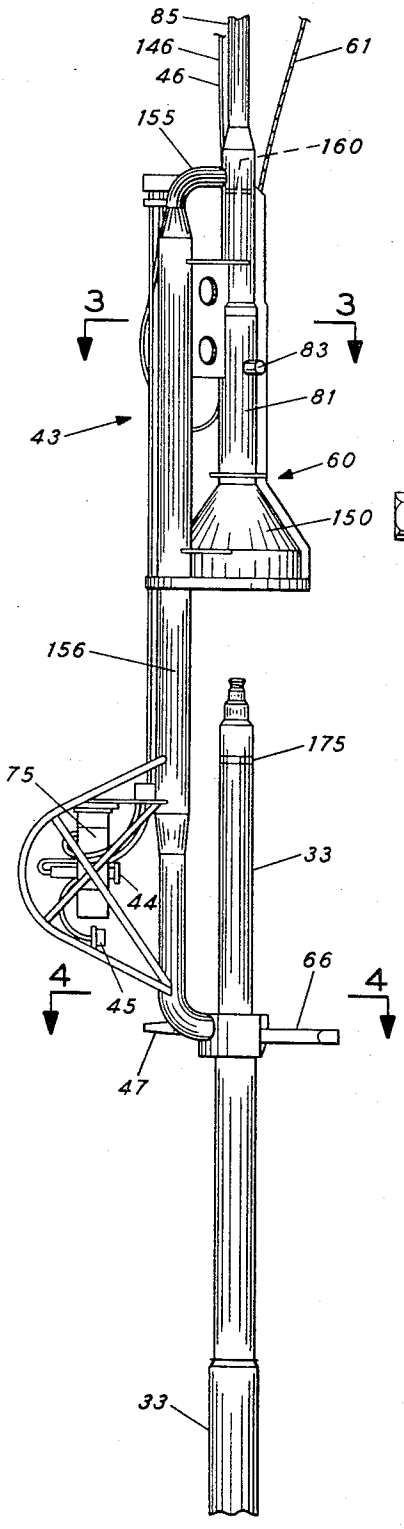


FIG. 2

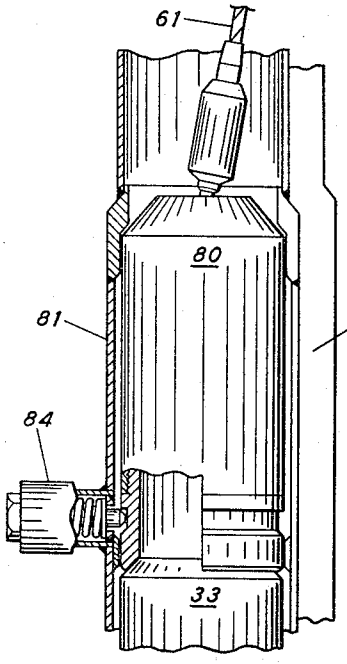


FIG. 6

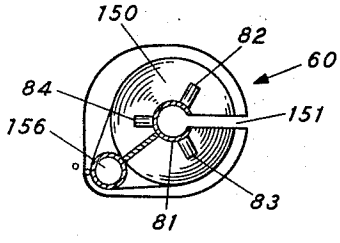


FIG. 3

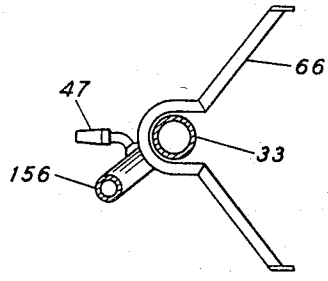


FIG. 4

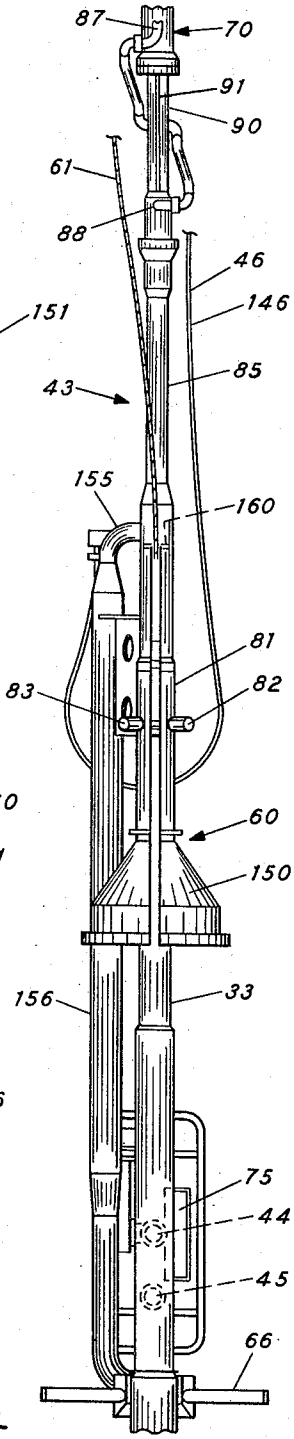


FIG. 5

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METHOD AND APPARATUS FOR WORKING ON UNDERWATER WELLS

Filed June 13, 1966 3 Sheets-Sheet 3

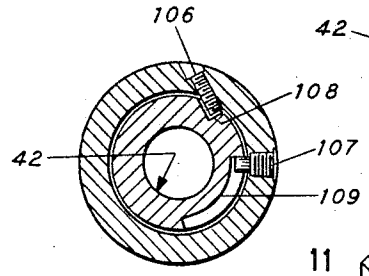


FIG.11

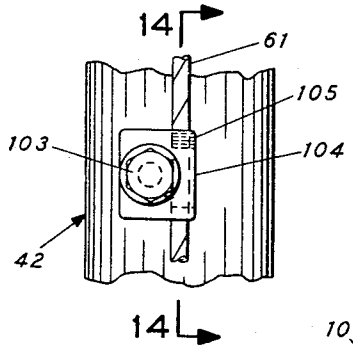


FIG.13

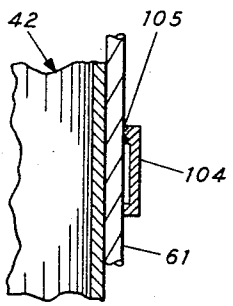


FIG.14

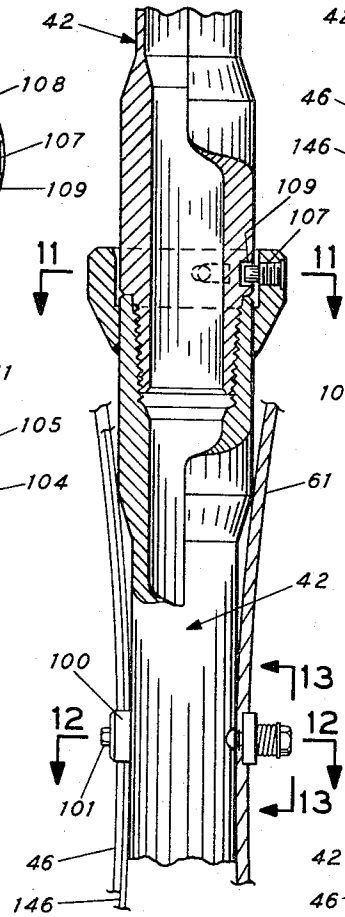


FIG.10

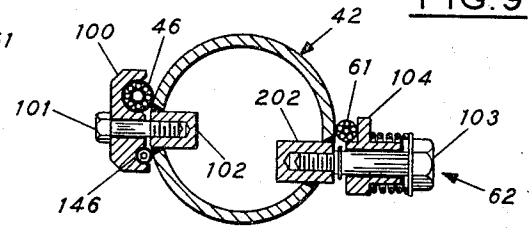


FIG.12

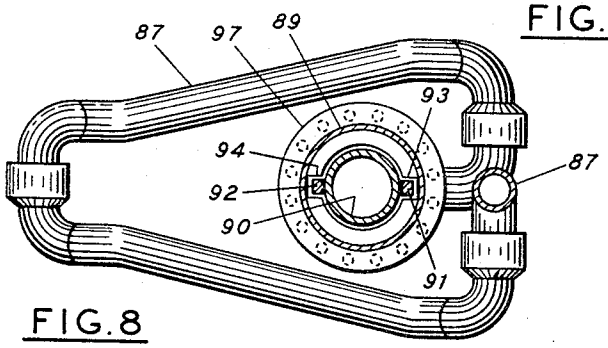


FIG.8

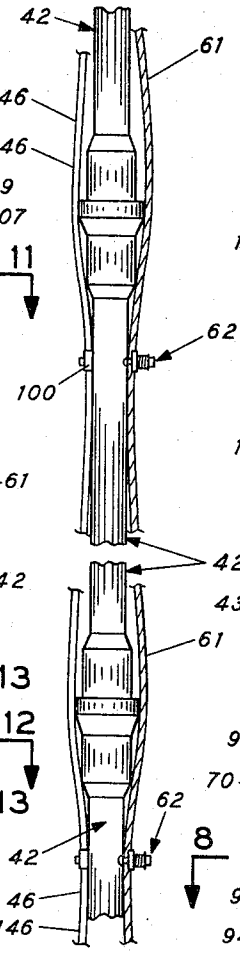


FIG.9

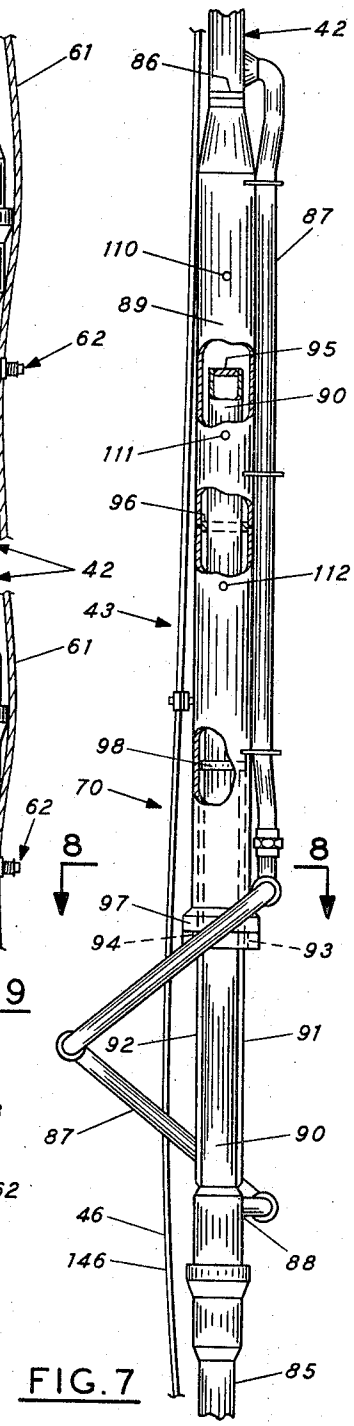


FIG.7

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METHOD AND APPARATUS FOR WORKING ON UNDERWATER WELLS

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6 Claims. (Cl. 166—.6)

This invention relates to underwater wells; and, more particularly, this invention relates to methods and apparatus for use in locating an underwater guidepost and for connecting a guideline to the underwater guidepost from an operational base located at or near the surface of a body of water without the use of divers.

In offshore well operations, it is often desirable to locate an underwater wellhead having one or more well posts and to connect a coupling member thereto. So long as there is a connecting line between a surface location and wellhead, it is not difficult to connect a second cable. However, once contact has been lost with the wellhead, it is an extremely difficult problem not only to locate the wellhead from the surface but to also connect a new cable to the wellhead. This is particularly true where the depth of the water over the wellhead is such that the use of divers is impractical.

The present invention provides apparatus for use in connecting a guideline to an underwater guidepost, which apparatus includes an elongated member adapted to be extended from the surface of the water to a guidepost located beneath the water. The elongated member has an operative means connected to its lower portion, which operative means includes locating means for determining the location of the guidepost with respect to the operative means, and motive means for moving the operative means laterally through the water to align the operative means in a predetermined lateral alignment with the guidepost as the operative means is moved into contact with the guidepost. Prong means are provided on a portion of the operative means to allow selective vertical movement between the operative means and the guidepost while the prong means of the operative means are held in slidable contact with the guidepost. The operative means includes means for detachably holding a connector element and for connecting the connector element, including a guideline attached thereto, to the guidepost after contact has been made between the operative means and the guidepost.

It is a particular object of the present invention to provide a method and apparatus for locating an underwater well post and for connecting a connecting element and a guideline thereto.

Further objects and advantages of the present invention will become apparent from the following detailed description read in light of the accompanying drawings which are made a part of this specification, and in which:

FIGURE 1 is an elevational view with parts broken away for clarity and illustrates a preferred embodiment of apparatus assemled in accordance with the invention.

FIGURE 2 is an enlarged elevational view illustrating a portion of the underwater operative means in contact with a guidepost;

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is a sectional view taken along line 4—4 of FIGURE 2;

FIGURE 5 is an elevational view of the underwater operative means and illustrates the operative means connecting the connector element and the guide cable to the top of an underwater well post;

FIGURE 6 is an enlarged elevational view showing a portion of the apparatus shown in FIGURE 5 with parts broken away for clarity of presentation;

FIGURE 7 is an elevational view of the upper portion of the underwater operative means;

FIGURE 8 is a sectional view taken at line 8—8 of FIGURE 7;

FIGURE 9 is an elevational view illustrating a portion of the elongated member used to connect the surface operational base with the underwater operative means;

FIGURE 10 is an elevational view partially in section illustrating the connecting joints of the elongated member;

FIGURE 11 is a sectional view taken at line 11—11 of FIGURE 10;

FIGURE 12 is a sectional view taken at line 12—12 of FIGURE 10;

FIGURE 13 is a partial elevational view taken at line 13—13 of FIGURE 10;

FIGURE 14 is a sectional view taken at line 14—14 of FIGURE 13; and

FIGURE 15 is an elevational view with parts broken away for clarity and shows the guideline connected to the guidepost and the apparatus of the present invention being withdrawn from the water.

Referring now to the drawings and to FIGURE 1 in particular, an underwater wellhead assembly is shown and is generally designated by the number 30. The wellhead assembly 30 includes wellhead control apparatus 31 having appropriate flow lines 32 extending therefrom. The underwater well assembly 30 also has vertically extending guideposts 33, 34 and 35. In describing the present invention, it will be assumed that contact has been lost with the wellhead assembly and it is desired to connect a guideline to underwater well post 33.

In accordance with the invention, an operational base 40 is established at or near the surface of the water. The operational base has means 41 for making up and running pipe sections, such as setcions 142, 242 and 342, etc., to form an elongated member 42. As is well known in the art, the pipe sections are coupled together and progressively lowered into the water. The elongated member 42 is adapted to be extended substantially vertically downward from the operational base 40 to a location in approximate lateral relationship from a guidepost 33. An operative means, generally indicated as 43, is connected to the lower end of the elongated member 42. The operative means 43 includes locating means for determining the location of a guidepost 33 with respect to the operative means 43. Suitable locating means take the form of TV camera 44 and sonar transducer 45. These devices are connected by means of cables 46 and 146 to appropriate surface control apparatus 147 and 48. The wiring for the sonar and TV is held on drums 38 and 39.

The operative means is roughly laterally aligned with the guidepost 33 by means of laterally moving the elongated member at the operational base 40. Motive means for final alignment of the operative means 43 in a lateral direction in the water and into contact with the guidepost 33 are provided by jet nozzle means 47. Fluid, such as seawater, under pressure is pumped down through the elongated member 42 and is ejected from the nozzle 47 to propel the operative means 43 forward through the water. The seawater may be moved by means of pump 50 to the

jet nozzle 47 through the elongated member 42 and suitable flow lines 51 and 52 which are connected by a swivel joint connection 53 to the upper end of the elongated member 42. Valve 54 and gauge 55 are connected onto the flow lines for use in controlling flow to the nozzle 47.

Means 60 for detachably holding a connector element used for connecting a guideline to a guidepost forms part of the operative means 43. The guideline 61 is disconnectably connected along the elongated member 42 by releasing clamps 62. The guideline is held on spool 63 which may be driven by an air motor 64. The arangement is preferably mounted on a swingable hinge member 65 which can be pivoted to swing into normal operating position after the guideline has been connected onto post 33.

Prong means 66 formed of two diverging prongs are provided in the operative means 43 for slidably contacting the guidepost 33. A bumper sub 70 is connected above the prong means 66 to permit independent vertical motion of the lower portion of the operative means 43 relative to the upper portion which follows heaving movements of the surface vessel. A flow bypass line 87 carries fluids past the bumper sub 70 to the jet nozzle 47. The jet nozzle 47 is disposed so that the jet action is in a direction substantially diametrically opposite to the direction of divergence of the guide prong members 66.

In operation, the operative means 43 is lowered into the water by means of suitably connected sections of pipe 142, 242, 342, etc. to the approximate location of the underwater well site 30. In most instances, the approximate location of the underwater well site can be determined from the surface so that the operative means should be within 100 to 800 feet of the well site. The location of the operative means 43 in relation to the post 33 which it is desired to contact is determined first by means of sonar for long range and TV sensing for the last 30 to 40 feet. The azimuth of the operative means is known and is adjusted by means of turning handle 73. Final forward movement of the operative means is accomplished by jet propulsion from jet nozzle 47. The operative means is moved to a position where prong means 66 contacts the post 33, and lateral contact is then forcibly maintained by jet reaction from nozzle 47.

Referring specifically to FIGURES 2–4, prong means 66 is shown in slidable contact with guidepost 33. As indicated above, the sonar sensor 45 and the TV camera 44, along with floodlight 75, were used to determine the location of the operative means 43 with respect to the guidepost 33. In this regard, a fluorescent or white band 175 may be provided near the top of the guidepost 33 to assist in the underwater detection, particularly so that the operative means can be adjusted to proper working vertical relationship with the post 33 for proper engagement. The prong means 66 in contact with the guidepost 33 cooperates with the guidepost to provide for relative vertical movement between the operative means 43 and the guidepost 33. This is so while the prong means 66 is held in contact with the post 33 and is maintained in substantial lateral alignment therewith by the crotch shape of the prong means 66. The crotch shape formed by the converging prongs serves as a centering member when it receives the guidepost in partial circumferential engagement.

After the centering portion of the prong member 66 has been slidably engaged against the guidepost 33, the operative means 43 is lowered to the position shown in FIGURES 5 and 6. A carrying means 60 detachably holding a connector element is positioned vertically in line above the centering portion of prong member 66. Thus the connector element 80 contacts the upper end of post 33 and is connected to the top of guidepost 33. The connector element may take any suitable form. One suitable connector element is illustrated in my U.S. Patent No. 3,236,-302 issued Feb. 22, 1966. The connector element should be of the form which locks on downward action.

The connector element 80 is disconnectably connected in the carrying means 60 of the operative means 43. The carrying means 60 includes a guide funnel 150 which is secured to the lower portion of the operative means. The larger opening of the guide funnel 150 is positioned downwardly with respect to the operative means. The lower portion of the funnel is sized and shaped to engage and capture the top of a post 33 despite sizable inclination of the carrying means 60 and operative means 43 due to ocean current drag or due to overtravel or undertravel of the operational base 40 in its advance. A sleeve 81 adapted to accommodate a connector element communicates with the interior of the funnel 150 and extends axially upwardly therefrom. An axially disposed slot 151 is formed through the circumferential wall of the funnel and the sleeve and extends through the lower edge of the funnel to facilitate release of the guide cable from the funnel and sleeve. In one form, the connector element 80 is releasably held by means of sleeve 81 and spring-loaded piston members 82, 83 and 84. After the connector element 80 has been connected to the top of the guidepost 33, the guide cable 61 is disconnected from the elongated member 42 and the operative assembly 43 is raised causing the connector element 80 to be released from sleeve 81 and spring-loaded piston members 82, 83 and 84. The guide cable can then be released from the sleeve and funnel through slot 151.

The upper portion of the operative means 43 is shown in greater detail in FIGURES 7 and 8. A bumper sub 70 is used to allow independent motion of the lower portion of the operative means. A preferred form of the bumper sub is shown in FIGURES 7 and 8. In this embodiment, the bumper sub 70 connects tubular member 85 with the lower portion of the elongated member 42. A blank 86 closes off the lower end of the elongated member 42 to fluid flow so that fluid is diverted into a tubular bypass 87. The tubular bypass includes a hinged tubular bypass connection joint to allow for contraction and extension of the bumper sub. The tubular bypass directs fluid flow into tubular member 85 at joint 88.

The bumper sub 70 includes two concentrically arranged pipe members 89 and 90. The upper pipe member 89 is usually the lower pipe of the elongated member 42. The inner pipe member is provided with splines 91 and 92 which ride in suitable keyways 93 and 94 formed in a lower flange 97 of the outer pipe member 89 to prevent the pipe members from rotating and to so maintain orientation of the prong member 66 relative to handle 73. The upper end of the inner pipe member 90 is blanked off by means of blank 95. Insert guide ring 96 and flange 97 fixedly connected to the exterior pipe member 89 coact with stop ring 98 formed on the inner pipe member 90 to limit the longitudinal travel between the pipe members. The chamber formed in the upper end of pipe member 89 and the annular space between the outer and inner pipe members are vented by means of holes 110, 111 and 112 to allow seawater to enter these spaces to provide for free axial movement of pipe 89 relative to pipe 90 when operative means 43 rests on and is supported by post 33.

The guide funnel 150 and sleeve 81 are connected to the lower end of pipe member 90 by suitable means, such as pipe 85. Seawater is flowed into the interior of pipe 85 from bypass tubular member 87. The pipe member 85 is blanked off by blank 160 above the funnel and below pipe joint 155 which connects to a rigid conduit 156 which is disposed in parallel relationship to pipe member 85. Thus fluid flow is diverted into the conduit 155 which in turn communicates with the jet nozzle 47. The rigid conduit is blocked off so that fluid flow must go through the jet 47.

Referring now to FIGURES 10, 12, 13 and 14, the means for connecting the cables for TV, sonar and lights to the elongated tubular member 42 are shown as are means for releasably connecting the guide cable to the elongated tubular member 42. The elongated tubular

member 42 is made up of a number of pipe sections 142, 242, 342, etc. As each pipe section is attached to the preceding lower section, the connections for the power cables and the guidelines are also made. The TV cable 46 and the sonar cable 146 are fixedly connected to the pipe sections by means of clamp 100 and bolt 101 which screws into boss 202. Electricity for the lights can be supplied through the multiple conductor TV cable. The guideline 61 is releasably held to pipe string 42 by means of clamp 62 which is formed by bolt 103, spring-loaded slide clasp 104 and clamping face 105. The upper portion of the spring-loaded clasp 104 is knurled, as indicated by 105, so that when the guide cable 61 is pulled finally downward relative to the pipe string 42, the slide clasp 104 rotates 90 degrees around bolt 103. The cable is easily slipped out from behind this narrow portion of the clasp.

FIGURE 11 shows the make-up joints for consecutively orienting the pipe sections 142, etc. These joints are locked in place by means of set screws 106 and 107 which fit into specially cut slots 108 and 109 in the pin end of the pipe coupler. This insures that the pipe sections will not inadvertently rotate with respect to one another and thus the operator on the surface will always know the direction of the prong means 66.

FIGURE 15 illustrates the guideline operably connected to the guidepost and the operative means 43 being removed from the well site.

Although only selected embodiments of the present invention have been described in detail, the invention is not to be limited to any such specific embodiment but rather only by the scope of the appended claims.

I claim:

1. Apparatus for use in connecting a guideline to a submerged guidepost comprising an elongated member adapted to be extended vertically downwardly from an operational base near the surface of a body of water to a guidepost submerged in said water beneath said operational base, an operative means connected to the lower end of said elongated member, said operative means comprising means for determining the location of said guidepost in relation to said operative means, means for moving said operative means in a lateral direction through said water and into contact with said guidepost and for holding said operative means in contact with said guidepost and means for guiding said operative means into substantially a predetermined lateral alignment with said guidepost as said operative means is moved laterally into contact with said guidepost, means permitting selective vertical movement between said operative means and said guidepost while said operative means is held in contact with said guidepost in said substantially predetermined lateral alignment therewith, means for detachably holding in said operative means a connector element for connecting a guideline to said guidepost, and means for guiding said operative means into a predetermined vertical alignment with said guidepost as said operative means is lowered in contact with said guidepost to place said connector element in mating engagement with a complementary connector element on the top end of said guidepost.

2. Apparatus in accordance with claim 1 comprising remote control means locatable on said platform for controlling the operations of said operative means and means operatively connecting said control means and said operative means.

3. Apparatus for use in connecting an end of a flexible guideline to an end of a submerged guidepost comprising a string of pipe adapted to be extended vertically downwardly from a floating platform positioned above a submerged guidepost, a guide funnel secured to the lower end of said pipe with the larger opening of said funnel positioned downwardly in relation to said pipe, a sleeve communicating with the interior of said funnel and extending axially upwardly therefrom and adapted to accommodate a guideline coupling member therein, an axially disposed slot formed through the circumferential wall of said funnel and said sleeve and extending through the lower edge of said funnel, means for detachably holding said guideline coupling member in said sleeve with a guideline attached to said member and disposed through said slot, a rigid conduit member having an interior passage therein and disposed in parallel relationship to said pipe and connected at one end to the lower end portion of said pipe with the interior passage of said conduit member connected in fluid communicating relationship with the interior passage of said pipe, means blocking the interior passage of said pipe at a location below the connection of said conduit member and said pipe, said conduit member extending downwardly from said pipe to dispose the lower end thereof below said funnel, guidepost engaging means affixed to the lower end of said conduit member, said guidepost engaging means comprising prong members extending in diverging relationship to each other radially outwardly in relation to a vertitcal axis, a centering member connecting said guide members adjacent the converging end portions thereof and proportioned to receive a guidepost in partial circumferential engagement therewith, a jet device connected adjacent the lower end of said conduit member and in fluid communication with the interior passage thereof and disposed to direct a jet of fluid from said conduit member in a direction substantially diametrically opposite to the direction of divergence of said guide members, means blocking said passage through said conduit member at a location below the connection of said jet device thereto, direction sensing means mounted on said conduit member with said sensing means directed toward the axis of divergence of said guide members, control means for said direction sensing means and locatable at a location remote therefrom, means connecting said sensing means with said control means and means for rotating in a unitary manner said string of pipe and the apparatus attached thereto.

4. Apparatus in accordance with claim 3 comprising means incorporated in said string of pipe to permit relative axial movement between the lower and the upper end portions of said string of pipe while preventing relative rotary movement between the said end portions of said pipe.

5. Apparatus in accordance with claim 3 comprising means blocking the passage through said string of pipe at the location of the said means permitting relative axial movement between the said end portions of said pipe and a flexible tubular means having an interior passage and connected to and in fluid communication at one end with the interior passage of said pipe above said means blocking said passage through said pipe and at the other end connected to and in fluid communication with the interior passage of said pipe below said means blocking said passage through said pipe to provide a continuous fluid passage between the upper and the lower end portions of said string of pipe as said end portions are moved axially relative to each other.

6. The method of connecting a guideline to a submerged guidepost comprising detachably mounting a guideline coupling element adjacent the lower end of a string of pipe, said coupling element having a guideline connected thereto, lowering said string of pipe vertically from said platform to place said lower end in the vicinity of said guidepost while retaining the upper end portion of said string of pipe at said platform, determining the position of said lower end of said string of pipe in relation to said guidepost, moving the lower end of said string of pipe toward and into contact with a side wall of said guidepost in a position oriented to dispose said coupling element approximately axially above said guidepost, lowering said string of pipe from said platform

while maintaining said contact between the said lower end of said string of pipe and said wall of said guidepost, lowering and guiding said connector element into coaxial alignment with said guidepost while continuing the lowering of said string of pipe until said connector element is placed in mating engagement with a complementary connector element on said guidepost to connect said guideline to said guidepost and raising said string of pipe to said platform while leaving said guideline connected to said guidepost.

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