

PATENT SPECIFICATION

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(54) METHOD AND APPARATUS FOR CONNECTING A FLEXIBLE CABLE TO A SUBSEA STATION

(71) We, SOCIETE NATIONALE ELF AQUITAINE (PRODUCTION), Tour Aquitaine - 92400 Courbevoie, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to an apparatus and a method of connecting or attaching a flexible cable or line to a subsea station at virtually any depth of water and without assistance of divers or diver robots having manipulating means. The invention particularly relates to an apparatus for making such a connection and for a method or technique by which such a connection is reliably and effectively accomplished.

It is often necessary to locate subsea installations or stations on a sea floor at great water depths; that is, beyond the depth at which a diver may assist in the connection of the various well equipment and also beyond the depth the which diver capsules or submarines may be conveniently operated for such purpose. Subsea stations on the sea floor are remotely controlled; and to effect such control, it is necessary to bring electric cable or lines for power and control circuits to operate equipment on the subsea installation or equipment associated therewith at satellite subsea wellheads. Flexible cables or lines are often difficult to handle, guide, align and secure the end of a flexible bendable line to a fixed receptor on the subsea station.

Prior proposed apparatus and methods for connecting an end of a flexible cable or line to a fixed receptor on a subsea station have usually required the assistance of a diver or of a robot having manipulating means for effecting such a connection. Such prior proposed systems, when employed at great water depths, were time-consuming and difficult to accomplish.

According to one aspect of the invention there is provided an apparatus for connecting a flexible line apparatus for connecting a flexible line carried by a first vessel and having an end connector on one end thereof to a subsea station having guide posts connected by guide lines to a second vessel positioned above said subsea station, the apparatus comprising a guide frame

including guide sleeves slidably cooperable with said guide lines and releasably engageable with said guide posts, whereby said guide frame is adapted to be guided by said guide lines for movement between said second vessel and said subsea station:

said guide frame including a socket having a longitudinal axis, arranged to receive said end connector in the direction of said axis while said guide frame is at the surface and to retain said end connector in said socket with said flexible line extending from the end connector in the socket laterally with respect to said longitudinal axis;

mounting means on said guide frame for said socket for allowing pivotal movement of said socket is selected angular relation relative to said guide frame during lowering of the guide frame and for allowing vertical displacement of said socket when said longitudinal axis of said socket is parallel to the longitudinal axes of said guide sleeves; and locking means arranged in the latter position of said mounting means to lock said socket in that position, thereby enabling said socket and said end connector to receive a further connector lowered thereto along said guide lines in longitudinal alignment with the longitudinal axis of the socket.

Another aspect of the invention provides a method of connecting a flexible line carried by a first vessel to a subsea station below a second vessel, which comprises providing guide lines extending between the subsea station and said vessel, providing a guide frame slidably cooperating with said guide lines and including a pivotally mounted socket, said method including the steps of:

placing a first connector at one end of said flexible line in said socket with said flexible line extending from the end connector in the socket laterally with respect to said longitudinal axis;

lowering the guide frame along the guide lines to the subsea station while the socket pivotally adjusts to the angular position of the flexible line which extends from the first vessel during lowering of the guide frame;

releasably attaching the guide frame to said

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subsea station;

locking said socket in a selected position in which said longitudinal axis is parallel with the longitudinal axes of said guide sleeves;

lowering a second connector from said second vessel along said guide lines into said socket in said selected position to establish engagement with said connector;

and producing mutual engagement between said connectors within said socket.

The guide frame structure is advantageously adapted to carry an electric cable end having an end connector thereon to the subsea station and to releasably connect the guide frame structure to said station.

In a preferred embodiment, the electrical connector guide frame structure has socket-like container means which are provided for pivotal movement relative to the frame structure whereby changes in position and loading imparted to the socket container by the flexible cable will normally not be transmitted to guide lines along which the frame structure moves during lowering thereof to the subsea station and whereby the frame structure is not subjected to forces which would tend to cause binding of the frame structure on the guide lines.

In a preferred embodiment of the invention, the attachment or connection to a subsea station is effected by the use of a running tool releasably connected to the cable connector guide frame and including latch means arranged interlockingly to engage the guide sleeves of said connector frame and there being a releasable further latch means interlocking said guide sleeves and guide posts.

This preferred embodiment provides a construction of a running tool and cable connector guide frame structure is provided whereby the guide frame structure may be conveniently lowered and interlocked with the guide posts on the subsea station and may be retrieved when necessary for service and maintenance.

Features and advantages of a preferred embodiment of the invention will become apparent from the description hereafter by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a schematic elevational view of a subsea station, a vessel above said station, and a cable laying vessel illustrating one step in the practice of the method of this invention.

Figure 2 is a fragmentary enlarged perspective view of a portion of the subsea station and a guide frame structure and landing tool therefor in a position just before engagement with the subsea station.

Figure 3 is an enlarged fragmentary sectional view taken in the plane indicated by line III—III of Figure 2 and showing trunnion pivotal mounting means.

Figure 4 is an enlarged fragmentary perspective view of a subsea station with the landing tool in retrieved position.

Figure 5 is an enlarged fragmentary sectional

view of the subsea station guide post, a guide funnel of the guide frame structure latched thereto and a latching arrangement for the running tool releasably latched to the guide funnel of the frame structure.

Figure 6 is a fragmentary view similar to Figure 5 with the latch mechanism of the running tool removed from the guide post and guide funnel assembly of the guide frame structure.

Figure 7 is a fragmentary perspective view illustrating a completed electrical connection at the subsea station.

Figure 8 is a fragmentary sectional view taken in the same plane as Figure 3, but showing the trunnion member in cooperable locked position.

In Figure 1 a subsea station is generally indicated at 20 and may include wellhead, production, and control modules (not shown). Above subsea station 20 is positioned a vessel 21 having a derrick 22, a moon pool 23 that is, a well extending vertically through the vessel, below said derrick and through which a drill pipe string 24 may be extended to lower a cable connecting guide frame structure 25 to subsea station 20. Guide frame structure 25 is guided to guide posts 26 on station 20 by a pair of guide lines or cables 27 wound around constant tension winch means 28. The method of connecting each guide line 27 to the top of guide post 26 is accomplished by well-known means and is not part of this invention.

A cable laying vessel 30 includes a cable drum 31 around which cable 32 may be wound and stored. Cable 32 is fed from cable drum 31 over a stinger member 33 and has at its free end a cable connector 34. Cable 32, in this example, is a flexible electrical cable carrying a plurality of circuits for control of certain operations at the subsea station 20. The other end of cable 32 is connected to a station remote from subsea station 20, such remote station may be a satellite wellhead, an offshore platform installation, or an onshore installation.

Guide frame structure 25 is best seen in Figures 2, 4 and 7. Frame structure 25 includes spaced guide sleeves 36 which receive the spaced guide posts 26. Guide sleeves 36 include outwardly flared bottom ends 37 to facilitate guiding of sleeves 36 onto post 26. Guide sleeves 36 are interconnected by a U-shaped frame portion 38 having outwardly turned top portions 39 welded to sleeves 36 and reinforced by suitable gussets 40. Outwardly turned end portions 39 at their interior ends provide pivotal mounting means 42 for trunnions 43 of a socket-like container means 44 pivotally movable about the mounting 42. Socket container means 44 includes a part-cylindrical hollow body 46 having a longitudinally extending slot 47 open at its top end and extending into proximity with the bottom end of socket container 44. The bottom end of socket container 44 carries an axial projection 48 which serves as a lock element when the socket con-

tainer 44 is in a selected position, in this example a vertical position. Transverse member 50 of the U-shaped frame portion 38, is provided with a cylindrical collar 51 which defines a lock recess 52 for reception of lock element 48 as later described. The upper end of part-cylindrical body 46 is provided with an outwardly flaring truncated lip guide portion 54 to facilitate entry of equipment into socket container 44.

Pivotal mounting means 42 is schematically illustrated in Figures 3 and 8. In Figure 3, mounting means 42 includes a key shaped chamber 56 having part-circular bearing surfaces 57 for rotatably supporting trunnion 43 which may have a generally elongated rectangular cross-section provided with arcuate end surfaces 58 and parallel flat side surfaces 59. Chamber 56 includes a key lock recess 60 adapted to receive a portion of trunnion 43 when the socket container 44 is vertically disposed and the major axis of the rectangular cross-section is likewise vertically disposed. Under such positioning of socket container 44, the projecting lock element 48 is aligned with a lock recess 52; and as shown in Figure 8, the trunnions 43 will drop downwardly into the key lock recess 60 to thereby lock and hold socket container 44 in vertical position.

The capability of socket container 44 to pivotally move in pivotal mounting 42 when not in vertical position facilitates lowering the frame structure 25 when the electrical cable 32 is carried thereby since the pivotally mounted socket container 44 will rotate or turn into inclined position, as shown in Figure 1 and 2 to adjust to loads imposed thereon by cable 32 when cable 32 is connected to vessel 30 and the frame structure 25 is being lowered to the subsea station 20. It will be apparent that under some conditions during lowering frame structure 25 with electrical connector 34 associated therewith, the socket container 44 is free to turn on its supporting trunnions, as long as socket container 44 does not move into vertical position. Thus, the frame structure 25 is relieved of any forces tending to tip the frame structure and cause possible binding of the sleeves 36 on the guide lines 27. Later, during laying of cable 32 on the sea floor, the socket container 44 is moved into vertical position and locked therein as above described.

Electrical connector 34 may be a typical subsea electrical connector having a T head 65 slidably received within socket container 44, the stem of the T head having a flange 66 coupling with flange 66a on socket body member 68. Flange 66a defines a narrow neck portion 67 adapted to be received within slot 47. Flanges 66, 66a secure the terminal socket body member 68 of cable connector 34 to the T head 65. Connector 34 is secured in the lower portion of socket container 44 by a plurality of screw bolts 69 which extend through part-cylindrical wall 46 and interlock with the

lowermost end portion of the T head 65. Connector 34 is thus fixedly secured to the socket container 44.

As best seen in Figure 7, the upwardly directed end face of T head 65 mates with a plug assembly 70 having a key 71 on its outer surface for aligning engagement with slot 47 in the socket container 44. Plug assembly 70 is held in pressure engagement with the mating connector 65 by a container 72 filled with a heavy material, such as lead. Between container 72 and plug assembly 70 may be provided a cable reel 73 from which a suitable length of cable may be drawn for making the necessary connection to equipment on the subsea station.

Frame structure 25, with associated electrical receptacle connector 34 and the cable 32, may be landed and associated with the subsea station 20 in a novel manner. As seen in Figure 2, cable connector 34 is fixedly associated with the socket container 44 on the frame structure while this structure is at the vessel 21. Cable 32 is supplied from a reel 31 on cable laying vessel 30. Frame structure 25 is lowered along the constant tension guide lines 27 by a drill pipe string 24. When the frame structure 25 reaches the subsea station 20, guide sleeves 36 receive guide posts 26. As shown in detail in Figure 6, guide sleeves 36 are releasably latched to guide posts 26 and thereby provide means for retrieving the frame structure 25 and the associated cable connector 34 for service and maintenance.

In Figure 6, each guide post 26 is provided with a locking recess 76 located in spaced relation to the top end of guide post 26. Each guide sleeve 36 is provided with a throughbore 78 having a downwardly facing annular shoulder 79 against which may be seated an internal annular member 80 secured by screw bolts 81 extending through the side wall of sleeve 36 into the annular member 80. The top surface of member 80 provides a seat for a compression spring 82 having its top end seated at 83 against a lock sleeve member 84 having an outer circumference slidably received within the upper internal portion 85 of bore 78. The lock sleeve 84 includes an enlarged chamber 86 defining sleeve walls of relatively thin section which terminate in a radially inwardly thickened end edge wall portion 87 having internal cam surfaces 88 for cammed engagement with enlarged lock heads 89 on a plurality of latch members 90 carried by annular member 80. Latch members 90 include relatively thin section tail portions 91 which are received between the exterior surface of guide post 26 and the spring 82. It will be apparent from Figure 6 that frame structure 25 is locked on guide post 26 when assembled therewith and lock sleeve member 84 is biased by spring 82 to its upper position. In such position, the upper end of lock member 84 extends above sleeve 36 for contact with a running or landing tool 100 now described.

Landing or running tool 100 is shown in Figures 4 and 5 and includes a pair of spaced guide and locking cylindrical members 101 interconnected by a crossbar 102. Each cylindrical member 101 has an axial opening 103 for passage therethrough of guide line 27. Midway between guide cylinder members 101, crossbar 102 is provided with an upstanding mandrel 104 adapted to be releasably connected to a service connector means 105 carried by the lower end of drill string 24. Service connector 105 is provided with mechanically actuated latches 106 spaced 180° apart and which move into latched engagement with the mandrel as the service connector 105 is lowered thereover. A pressure fluid conducting tube 107 supplies hydraulic actuating fluid to release latches 106 in the event it is desired to separate running tool 100 from drill string 24 at the subsea station.

Each guide and locking cylindrical member 101 is adapted to be releasably connected to guide sleeves 36 on the frame structure 25. When connected with guide sleeves 36, running tool 100 through pipe string 24 may lower frame structure 25 to the subsea station or may retrieve frame structure 25 from the subsea station by actuating the latch means between the sleeve 36 and guide post 26 to a release position.

Figure 5 shows running tool 100 engaged with the frame structure 25 and with the guide sleeve 36 in release position with respect to guide post 26. Guide and locking cylinder member 101 comprises a hollow cylindrical body 110 having a top cap 111 secured thereto by internal threaded engagement as at 112. Top cap 111 provides an intumed annular flange 113, which defines opening 103. The lower end of body 110 is provided with an internal annular portion 115 having a downwardly and outwardly flared conical surface 116 for seating as at 117 on a conical shoulder 118 provided on guide sleeve 36 to limit downward movement of running tool 100 with respect to frame structure 25. Internal annular member 115 is also provided with a conical seating surface 120 for engagement with a complementary conical surface 121 on each of a plurality of latch fingers 122 carried by and depending from an annular follower member 123.

Follower member 123 includes an intumed flange 124 defining an opening 125 for reception of the upper portion of guide post 26. Flange 124 provides a seat as at 126 for the lower end of a compression spring 127 which has an upper end seated as at 128 against the internal surfaces of intumed flange 113 of cap 111. Intumed flange 124 extends over the top edge of sleeve 36 and also over the top edge of lock sleeve 84 of the latching mechanism on the guide sleeve 36. In the position shown in Figure 5, abutting contact at 130 of flange 124 with lock sleeve 84 illustrates the holding of lock sleeve member 84 in retracted position with spring 82 compressed and with the latches

89 in position for release from guide post 36 or for reception thereof.

Means for releasing running tool 100 from frame structure 25 and guide sleeves 36 includes a pressure fluid line 132 which may be carried along pipe string 24 and which may be extended through fluid conducting lines 133 to the latch release means provided at each lock cylinder member 101 on running tool 100. In Figure 5, fluid pressure line 133 may be connected to the latch release means which comprise a cylinder 134 having a piston rod 135 therein pivotally connected at its upper and exposed end to a lug 136 secured by suitable means to a downwardly extending cylindrical wall 137 of follower member 124. Lugs 136 are provided at diametrically opposite positions on the follower 128 and each of the cylinder and piston means 134, 135 is provided with pressure fluid.

In Figure 5, actuation of pistons 135 by introduction of pressure fluid into the lower portions of cylinders 134 will drive follower member 124 upwardly against the compression spring 127, lugs 136 being movable in longitudinal slots 138 provided in cylindrical body 110. As follower member 124 moves upwardly, the enlarged heads 140 of the latch fingers 122 are cammed radially outwardly into the space provided therefor by the thin wall section of the body member 110 so that the latch heads 140 may slide along the exterior surface of guide sleeves 36 for releasing the running tool from its interlocked engagement with the frame structure 25.

When the follower 124 has reached the uppermost position of its vertical travel in slots 138, it will be apparent that compression springs 82 within sleeve 36 have urged the lock sleeve member 84 into an upper position similar to that shown in Figure 6 wherein the latch members 89 are retained in locked engagement with guide post 26. The running tool 100 may be thus retrieved and separated from the frame structure 25.

When it is desired to retrieve frame structure 25, running tool 100 may be lowered along the guide lines at 27 and will be guided over the guide post 26 by the outwardly flared surfaces 141 and the conical surfaces 116 of body member 110 which slidably contact the tapered or beveled edges on lock sleeve member 84 and on sleeve 36. As the follower member contacts the top edge portions of lock sleeve member 84, it will drive sleeve member 84 downwardly to compress spring 82 and to unlatch latches 89 from guide post 26. During the same downward movement, the spring 127 drives the follower downwardly so that the latch fingers 122 are moved into latched engagement with the annular recess 143 provided in the exterior surface of sleeve 36. When such latched engagement has been made with the sleeve 36, the frame structure 25 may be moved upwardly off guide posts 26 and retrieved for service of the electrical connector receptacle 34 and other

equipment associated with frame structure 25. In connection with the above description of retrieval of frame structure 25, it will be understood that the container 72, reel drum 73 associated plug assembly 70 will have been withdrawn by connection of a cable to cleat 144 provided on the top of container 72.

After cable connecting frame structure 25, carrying electrical connector 34, has been locked on guide posts 26 and thereby secured and fixed to the subsea station, the cable supply vessel 30 may move in the direction of the path along which the cable is to be laid on the sea floor. As cable 32 is paid out from the storage reel 31 and subjected to tension because of the cable laying operation, the socket container will be rotated to vertical position and dropped into locked relation with the cable connecting frame structure 25 as above described. The assembly of the plug means 70 and the weight container 72 with the socket container is readily accomplished by lowering the plug means and weight container by a running tool guided along guide lines 27. The plug means 70 is guided into aligned relation with the receptacle connector means 34 by its contact with the funnel 54 and engagement of key 71 in the longitudinal slot 47.

The interlocking and latching of the cable connecting frame structure 25 with guide posts 26 and also with running tool 100 during landing or retrieval of cable connecting structure 25 provides a remotely controlled assembly and disassembly of an electrical connector receptacle means with a subsea station.

It is important to note that the cable connecting assembly comprising the guide frame structure 25 and the pivotally mounted socket container thereon with its connection to one end of a flexible cable may be permanently fixed to the subsea station and yet may be readily released therefrom for repair, service or replacement. Retrieval of such a cable connector frame structure 25 is readily accomplished by the construction of the landing or running tool which is releasably attached to the frame structure 25 and also provides means for assuring that the frame structure 25 will be latched to the guide posts on the subsea station.

From the foregoing, it will be seen that there is provided an apparatus for attaching a flexible line, such as a multiconductor electric cable for power and control circuits, a single flexible hose, or conventional flexible cables to a subsea station by remotely controlled means and without the assistance of divers or diver capsules or submarines. The apparatus includes a cable connecting frame structure upon which is pivotally mounted a socket-like container means which receives a receptacle means connected at one end of a flexible power cable or line. The frame structure is adapted to be releasably attached to the subsea station. A plug assembly is receivable by the socket-like container for electrical engagement with the receptacle means,

and lock means holds the socket-like container in a selected position with respect to the subsea station. There is also described a method of connecting a flexible line to a subsea station in which a cable connecting frame structure carrying a socket-like container receiving a receptacle means provided at one end the power line is lowered to the subsea station by a running tool which has latched engagement with the frame structure and holds latch members on the frame structure in release position for reception of guide posts on the subsea station. Release of the running tool from its latched engagement with the frame structure provides latching of the frame structure to the guide posts so that the running tool may be retrieved. With the described method, the running tool may also be used for retrieving the frame structure for service of the electrical receptacle means carried by the frame structure.

WHAT WE CLAIM IS:—

1. Apparatus for connecting a flexible line carried by a first vessel and having an end connector on one end thereof to a subsea station having guide posts connected by guide lines to a second vessel positioned above said subsea station, the apparatus comprising a guide frame including guide sleeves slidable cooperable with said guide lines and releasably engageable with said guide posts, whereby said guide frame is adapted to be guided by said guide lines for movement between said second vessel and said subsea station:

said guide frame including a socket having a longitudinal axis, arranged to receive said end connector in the direction of said axis while said guide frame is at the surface and to retain said end connector in said socket with said flexible line extending from the end connector in the socket laterally with respect to said longitudinal axis;

mounting means on said guide frame for said socket for allowing pivotal movement of said socket in selected angular relation relative to said guide frame during lowering of the guide frame and for allowing vertical displacement of said socket when said longitudinal axis of said socket is parallel to the longitudinal axes of said guide sleeves; and locking means arranged in the latter position of said mounting means to lock said socket in that position, thereby enabling said socket and said end connector to receive a further connector-lowered thereto along said guide lines in longitudinal alignment with the longitudinal axis of the socket.

2. Apparatus in accordance with claim 1 wherein said socket includes a longitudinally extending slot for guiding and aligning said end connector and for guiding and aligning said connecting means for connection to said end connector on said line.

3. Apparatus in accordance with claim 1 or 2 and including a running tool having releasable connecting means thereby said running tool may be releasably connected to said guide



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equipment associated with frame structure 25. In connection with the above description of retrieval of frame structure 25, it will be understood that the container 72, reel drum 73 associated plug assembly 70 will have been withdrawn by connection of a cable to cleat 144 provided on the top of container 72.

After cable connecting frame structure 25, carrying electrical connector 34, has been locked on guide posts 26 and thereby secured and fixed to the subsea station, the cable supply vessel 30 may move in the direction of the path along which the cable is to be laid on the sea floor. As cable 32 is paid out from the storage reel 31 and subjected to tension because of the cable laying operation, the socket container will be rotated to vertical position and dropped into locked relation with the cable connecting frame structure 25 as above described. The assembly of the plug means 70 and the weight container 72 with the socket container is readily accomplished by lowering the plug means and weight container by a running tool guided along guide lines 27. The plug means 70 is guided into aligned relation with the receptacle connector means 34 by its contact with the funnel 54 and engagement of key 71 in the longitudinal slot 47.

The interlocking and latching of the cable connecting frame structure 25 with guide posts 26 and also with running tool 100 during landing or retrieval of cable connecting structure 25 provides a remotely controlled assembly and disassembly of an electrical connector receptacle means with a subsea station.

It is important to note that the cable connecting assembly comprising the guide frame structure 25 and the pivotally mounted socket container thereon with its connection to one end of a flexible cable may be permanently fixed to the subsea station and yet may be readily released therefrom for repair, service or replacement. Retrieval of such a cable connector frame structure 25 is readily accomplished by the construction of the landing or running tool which is releasably attached to the frame structure 25 and also provides means for assuring that the frame structure 25 will be latched to the guide posts on the subsea station.

From the foregoing, it will be seen that there is provided an apparatus for attaching a flexible line, such as a multiconductor electric cable for power and control circuits, a single flexible hose, or conventional flexible cables to a subsea station by remotely controlled means and without the assistance of divers or diver capsules or submarines. The apparatus includes a cable connecting frame structure upon which is pivotally mounted a socket-like container means which receives a receptacle means connected at one end of a flexible power cable or line. The frame structure is adapted to be releasably attached to the subsea station. A plug assembly is receivable by the socket-like container for electrical engagement with the receptacle means,

and lock means holds the socket-like container in a selected position with respect to the subsea station. There is also described a method of connecting a flexible line to a subsea station in which a cable connecting frame structure carrying a socket-like container receiving a receptacle means provided at one end the power line is lowered to the subsea station by a running tool which has latched engagement with the frame structure and holds latch members on the frame structure in release position for reception of guide posts on the subsea station. Release of the running tool from its latched engagement with the frame structure provides latching of the frame structure to the guide posts so that the running tool may be retrieved. With the described method, the running tool may also be used for retrieving the frame structure for service of the electrical receptacle means carried by the frame structure. WHAT WE CLAIM IS:—

1. Apparatus for connecting a flexible line carried by a first vessel and having an end connector on one end thereof to a subsea station having guide posts connected by guide lines to a second vessel positioned above said subsea station, the apparatus comprising a guide frame including guide sleeves slidable cooperable with said guide lines and releasably engageable with said guide posts, whereby said guide frame is adapted to be guided by said guide lines for movement between said second vessel and said subsea station:

said guide frame including a socket having a longitudinal axis, arranged to receive said end connector in the direction of said axis while said guide frame is at the surface and to retain said end connector in said socket with said flexible line extending from the end connector in the socket laterally with respect to said longitudinal axis;

mounting means on said guide frame for said socket for allowing pivotal movement of said socket in selected angular relation relative to said guide frame during lowering of the guide frame and for allowing vertical displacement of said socket when said longitudinal axis of said socket is parallel to the longitudinal axes of said guide sleeves; and locking means arranged in the latter position of said mounting means to lock said socket in that position, thereby enabling said socket and said end connector to receive a further connector lowered thereto along said guide lines in longitudinal alignment with the longitudinal axis of the socket.

2. Apparatus in accordance with claim 1 wherein said socket includes a longitudinally extending slot for guiding and aligning said end connector and for guiding and aligning said connecting means for connection to said end connector on said line.

3. Apparatus in accordance with claim 1 or 2 and including a running tool having releasable connecting means thereby said running tool may be releasably connected to said guide

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- frame for lowering said connector guide frame means to said subsea installation; said releasable connecting means on said running tool including latch means on said running tool arranged interlocking to engage the guide sleeves of said connector frame and there being further releasable latch means for interlocking said guide sleeves and said guide posts.
4. Apparatus in accordance with claim 3 wherein said latch means on said running tool is arranged to be mechanically actuated into a locked position.
5. Apparatus in accordance with claim 4 wherein said latch means on said running tool includes means for holding said latch means on said connector frame means in release position when said running tool means is assembled with said connector frame means.
6. Apparatus in accordance with claim 1 or 2 wherein said means for locking said socket in said one position includes a depending lock pin on said socket and a recess on said guide frame for reception of said lock pin in said preselected position of said socket.
7. Apparatus in accordance with claim 6 wherein said means for pivotal mounting of said socket includes a pivot member on said socket and a part-circular bearing means arranged to allow pivotal movement of said socket about the axis of said bearing means and downward displacement of said pivot member for engagement of said depending lock pin in said recess to lock said socket in said preselected position.
8. Apparatus in accordance with claim 7 wherein said trunnion means on said socket; said part-circular bearing means on said guide frame includes a recess extending radially downwardly of said bearing means; and said pivot member comprises trunnion means having a non-circular cross section with one dimension of the trunnion means permitting reception of a portion of the trunnion means in said recess in said predetermined position of said socket to hold said socket means against rotation.
9. A method of connecting a flexible line carried by a first vessel to a subsea station below a second vessel, which comprises providing guide lines extending between the subsea station and said second vessel, providing a guide frame including guide sleeves slidably cooperating with said guide lines and including a pivotally mounted socket having a longitudinal axis, said method including the steps of:
- placing a first connector at one end of said flexible line is said socket with said flexible line extending from the end connector in the socket laterally with respect to said longitudinal axis; lowering the guide frame along the guide lines to the subsea station while the socket pivotally adjusts to the angular position of the flexible line which extends from the first vessel during lowering of the guide frame; releasably attaching the guide frame to said subsea station; locking said socket in a selected position in which said longitudinal axis is parallel with the longitudinal axes of said guide sleeves; lowering a second connector from said second vessel along said guide lines into said socket in said selected position to establish engagement with said connector; and producing mutual engagement between said connectors within said socket.
10. A method in accordance with claim 9 and including the step of providing the guide frame with means arranged to permit rotative movement of said socket until said socket attains said selected position and thereafter to prevent said movement.
11. A method in accordance with claim 9 or 10, wherein the step of lowering said guide frame and socket to said subsea station includes releasably connecting a running tool with the guide frame carrying said socket and lowering the running tool and thereby the guide frame including said socket.
12. A method in accordance with claim 10 wherein said line is an electrical cable and including the steps of: supporting said electrical cable from said first vessel, placing an electrical connector on one end of said cable in said socket of said guide frame, lowering said guide frame with said one end of said cable along said guide line means to said subsea station while permitting relative movement between said guide frame and socket and said one end of said cable; releasably attaching said guide frame to said subsea station; and locking said socket in said selected position by relative movement of said one end of said cable with respect to said guide frame; whereby said one end of said cable and said socket are fixedly positioned in a position for making an electrical subsea connection to said cable.
13. An apparatus for and method of making a subsea electrical connection to an electric cable, substantially as hereinbefore described with reference to the accompanying drawings.
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