EQUIPMENT FOR WIRE-LINING OPERATIONS IN SUBMARINE WELL DRILLINGS

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Filed Dec. 2, 1966, Ser. No. 598,813
Claims priority, application France, Dec. 11, 1965, 41,881; Nov. 8, 1966, 82,844
18 Claims. (Cl. 166—6)

The present invention has general reference to the equipment and the making of former, or subaqueous oil field and related more particularly to the equipment as used for the so-called wire-lining in submarine oil wells.

It is well known in order to ensure the maintenance of an oil well, to guarantee proper safety for the staff and devices and to follow the physical evolution of an oil field by adequate measures to employ a technique known as "wire-lining" comprising a permanent or temporary insertion in the line contained in the well of measuring, supervising or cleaning instruments which are lowered at the end of a steel wire-line through the medium of a so-called "lubricator." Devices used therefor are relatively light, and the steel wire-lines whose diameter is relatively small are wound upon a drum associated with a motor and with the necessary gear.

When drilling through land ground, the assembly is fitted upon skis or skids or a specially adapted trailer or truck, and the steel wire-line is guided between the winch and the input stuffing box into the well by means of jockey pulleys. When operating on a small boat or an equivalent craft, the plant used for such wire-lining operations could then be identical with the above-mentioned plant for producing oil from land wells. However, this technical solution is only applicable to limited water depths because, beyond a depth ranging from 200 to 330 feet by way of example, the technique using emerging heads and platforms as aforesaid is far too expensive. Consequently attempts were recently made to provide plants having submerged heads and including remote control systems.

In that case, however, the means commonly used in land installations must be so modified as to permit them to be used with plants having a submerged head, and the primary object of the invention is to provide a new or improved equipment for wire-lining operations applicable to submarine well borings.

Another object of the invention is to provide an equipment of the aforesaid type adaptable to a submerged well head for permitting wire-lining to be achieved, said equipment including an assembly tightly connectable to the submerged well head and comprising a tight housing and a so-called lubricator rigid with said housing and tightly connected to the well head through said housing, this lubricator being closed at its upper end, a winch drum having a vertical axis mounted inside the housing, a wire-line wound upon said drum and tightly engaged with the lubricator, said line carrying the conventional tools, one or several motors mounted inside the housing for actuating the winch, means for guiding and holding said assembly in the required position from a ship or another craft floating on the water surface, and operating and control cables or similar means connecting the elements contained in the housing with a remote control station arranged on the water surface level or in a movable submerged enclosure.

According to a constructional form of this improved equipment, where the lubricator is closed at its upper end by a stuffing box or an equivalent element, the wire-line tightly emerges from the housing and is engaged into the lubricator through this box after passing over jockey pulleys or the like.

The winch drum having a vertical axis is preferably mounted concentrically or parallel to the lubricator, guiding means (for example a pulley) being provided for properly regulating the winding of the wire-line on said drum. The regulating action may be achieved, if needed, by the measuring pulley which permits the position of the tools in the well to be conveniently set.

The upper end of the lubricator which carries a stuffing box is preferably associated with a jockey pulley over which the wire-line passes, the latter advantageously extending upwardly from the tight housing and being then bent by 180° so as to penetrate into the lubricator through the stuffing box.

The lubricator is connected with the well head by a blow-out preventer and a joint. According to a particular feature of the invention, this blow-out preventer is advantageously of the hydraulic control type. The joint is preferably of the hydraulic connector type i.e. it is made of a joint of known type which when concentrically presented to a preset outline can be anchored upon this outline and disengaged therefrom by a hydraulic impulse. According to another particular feature the invention, a nonsymmetrical flange is provided between the aforesaid preventer and collector for permitting selective adaptation upon either the one or the other of a pair of tubings provided in the well head.

A further objective of the invention is to provide an equipment as hereinafter wherein guiding is achieved from an accompanying craft or other support floating on the water surface by means of steel cables extending between said craft and the well head, guiding means provided on the tight housing and/or the cooperating lubricator being operatively associated with said cables.

The hoisting cable associated with the assembly comprising the housing and lubricator is preferably hooked up to a suitable member provided at the upper end of the lubricator and extending right up to the water surface.

The housing may also contain electric converting devices adapted to convert obtained information for their transmission to the water surface along one or more conductors. Thus the accompanying craft simply carries the power generator and the devices for remote control and for receiving transmitted information.

Yet a further feature of the invention is to provide an equipment as aforesaid wherein the housing contains a hydraulic prime mover forming two hydraulic circuits capable of being fed by two groups of pumps arranged in parallel. The main circuit feeds a hydraulic motor which actuates the winch. This motor also drives through a reversing gear (for example such a gear having disengageable couplings) a member for driving the guiding pulley associated with the winch drum.

The auxiliary circuit serves all the hydraulically operated ancillary device, of the assembly feeds a hydraulic motor which actuates the winch.

A still further objective of the invention is to provide an equipment as aforesaid comprising a jarring ram or an equivalent device mounted inside the housing and including a pulley on which the wire-line passes so as to impart
a reciprocatory motion to this wire-line for controlling the jarring action imparted to the set of tools when the winch drum is at rest.

A line-extracting device is preferably provided in the wire-line running out of the housing so as to overcome the resistance exerted by the stuffing box associated with the housing.

It will be understood that there is thus provided a unitary assembly lending itself to a particularly easy and convenient use for wire-lining operations for drilling submarine bores.

For a better understanding of the invention, reference will now be had hereafter to the accompanying diagrammatic drawings wherein are shown suitable constructional forms of the new or improved equipment according to the invention.

FIGURES 1 and 2 represent when arranged in superimposed relation an equipment according to the invention for wire-lining operations in submarine or subaqueous drilling.

FIGURES 3 and 4 which are respectively similar to FIGS. 1 and 2 show another embodiment of the equipment according to the invention for wire-lining operations under the same conditions.

FIGURE 5 is a more detailed view of the equipment housing and the members and devices fitted upon said housing. As shown, 1 designates the submarine surface, e.g., the bottom of a sea gulf or lake, and 2 the well head. The equipment according to the invention comprises a tight housing 3 rigid with a so-called lubricator 4 extending axially through said housing. The latter contains a winch drum 5 arranged concentrically or parallel with the lubricator 4 and adapted to receive a wire-line 6 wound upon it. Adjustment or regulation of the winding of said wire-line 6 is achieved owing to a relative motion of the winch drum with respect to a pulley shown at 7. This pulley can be a measuring pulley of known type.

The lubricator 4 carries at its upper end a stuffing box 8 and a frame 9 by means of which it is hinged up to a hoisting cable 10 which serves as a carrier for a jockey pulley 11. The wire-line 6 protrudes outside the tight housing 3 through a stuffing box 12 and extends right up to the jockey pulley 11 by means of which it is deviated by 180° before penetrating into the lubricator 4 through the stuffing box 8. There is shown diagrammatically 13 the set of tools suspended from the wire-line and adapted to be introduced into the well for being used in wire-lining operations in the known manner.

In the position of use as shown in the drawings, the assembly made up of the housing 3 and lubricator 4 is fitted upon the well head 2 by means of a joint 14 which is preferably associated with a blow-out preventer 15.

The housing 3 also contains the motor or motors 16 for driving the winch drum 5 also means (not shown) capable of converting the information supplied by the measuring pulley or derived from the well in view of their transmission to the water surface through one or several electric conductors 18 that are held against the lubricator 4 and hoisting cable 10, for example by means of collars 19, 20.

For positioning and withdrawing purposes, guiding steel cables 21 anchored at 22 on the well head 2 are provided and are arranged co-operatingly with the accompanying cable and are tensioned by appropriate means. A table 23 arranged adjacent the upper end of the lubricator 4 carries eyelets 24 cooperating with the guiding cables 21 and an eyelet 25 for guiding the wire-line 6. Other eyelets 26 provided on the housing 3 also cooperate with guiding cables when releasing or casting off the equipment as described hereafter.

The way of utilizing this improved equipment during drilling will be easily understood from an examination of the drawings without any further detailed description being necessary. Actually the equipment according to the invention constitutes an autonomous assembly including all the necessary parts for wire-lining operations which can be effected in a conventional manner, said parts being remotely controlled from the accompanying craft which floats on the water surface and which merely carries the power source.

The method of releasing or casting off and positioning the improved equipment according to the invention is described hereafter: Interconnection of the housing 3 and lubricator 4 should be done before the release, and the tools 13 should be hooked up to the wire-line 6. The guiding cables 21 are then unwound from the accompanying craft (for example by means of small winches) and are hooked up by divers to the well head 2, as shown at 22. A hoisting apparatus carried by the accompanying craft is then used for lifting the aforesaid assembly and for immersing the same progressively while guiding it by means of the cables 21. The hoisting cable 10 serves for controlling the immersion speed. Such manipulations are facilitated by the fact that the assembly axis remains vertical.

At the end of the covered stroke, the assembly occupies owing to its guidance by the cables 21 a sufficiently accurate position to permit the same to be secured to the well head 2 through the joint 14. Once fixing has been done as hereinbefore stated, the wire-lining operations can be started.

Dismantling is effected by a reverse sequence of steps. It should be noted however that such operations may be eventually ended out by adjusting the buoyancy of the assembly owning to coffer-dams.

The blow-out preventer diagrammatically shown in FIGS. 4 and 5 is of the hydraulically controlled type. It is operatively connected both to the lubricator 4 of which it forms an extension and to the housing 3 for which it behaves as a lower supporting base. Hydraulic control of the preventer is effected from the hydraulic power station contained in the housing 3 as described hereafter with reference to FIG. 5.

In order to perform this control, there is provided inside the housing 3 an electric distributor 28 belonging to an ancillary hydraulic circuit and controlled by a duct 29 with the preventer 15. If necessary, the position of the distributor 28 may be displayed on the control desk provided in the surface equipment, for example by means of a telltale lamp, the indication being transmitted through multiple conductors 19.

A by-pass or shunt 30 is associated with the blow-out preventer 15 for accommodating its opening play or clearance. This by-pass 30 is connected by ducts 31, 32 to points situated on the opposite sides of said preventer. An additional duct 33 gives the possibility, if desired, to establish a communication between the inside of the lubricator 4 with the outer atmosphere. Control of the by-pass 30 is done from the surface by suitable conductors that are clustered with those of the multi-core cable 18.

A hand operated pump 34 is provided in the present construction form so as to permit an eventual manual control of the blow-out preventer 15.

The joint 14 which is clearly visible in FIGS. 4 and 5 is constituted in this construction by a hydraulic connector of known type. This connector may be controlled from an electric distributor or valve 35 (FIG. 5) mounted in the housing 3 through the medium of a duct 36. Control of the electric distributor 35 is also done here from the water surface. The connector 14 is adaptable to the well head 2 along the axis of this head.

It is known to use immersed well heads permitting drilling operations to be supervised when a pair of tubings are provided. It will be understood that in such a case, none of these two tubings is located along the axis of the well head. To take the advantage of this arrangement, there is provided in the present construction between the connector 14 through which two extensions of said tubings as shown at 37 (FIG. 5) are engaged and the hous-
ing a non-symmetrical flange 38 adapted to compensate for the offsetting of these tubings with respect to the axis of the well head and permitting a selective adaptation of the lubricator upon either of them. In the construction shown and described in FIGS. 4, 5, and 6, the flange 38 carries guiding arms 39 of the sliding flanges 40 having central bosses 41 and pivot end against the tubings 42 to facilitate their movement. The top of said flange 38 permits the lubricator 4 to be adapted upon either of the tubings 45. The method of positioning the assembly made up of the lubricator 4 and housing 3 is in accordance with the foregoing statement. However the anchorage and separation are effected automatically.

In FIG. 5 are shown in a more detailed way the several members housed in the housing 3. However the ducts of the hydraulic circuits have not been shown for the sake of clearness of the drawing.

The housing 3 contains the hydraulic power station of the plant which is incorporated into a pair of separate hydraulic circuits each one of which is fed by pumps 41 immersed in a tank 42 and driven by electric motors 43. One of the pumps 41 drives the hydraulic motor 44 which serves in turn for driving the winch 5 through a train of gears 46. A safety brake 45 provided for the winch is mounted directly upon the shaft of the motor 44. This brake is normally applied by springs and may be released by a hydraulic pressure supplied by an electric distributor 47 which permits the hydraulic motor to be short-circuited when the brake is applied. It will be understood that all the electric devices contained in the housing 3 are controlled from the water surface as indicated in the foregoing by the aforesaid multi-core conductors 18 which are engaged into the housing 3 by passing through a tight junction box 47. The hydraulic motor 44 also drives through a bevel gear 48 a shaft 49 associated with disengagable electromagnetic couplings 50 and driving through another bevel gear 51 a lead screw 52 carrying the pulley 7 for guiding the wire-line 6 as it is being wound on the winch drum 7 or unwound from it. Inversion of the direction of rotation of the lead screw 52 which also causes a reverse of the direction of motion of the pulley 7 takes place when said screw reaches the end of its stroke due to the electromagnetic couplings 50 which are operated by contacts located at the end of the stroke.

It is known, when performing wire-lining operations for producing oil from an oil field to take advantage of a particular technique known as “jarring” which consists in causing sudden reciprocatory motions of the wire-line.

The reciprocatory motion can be obtained by multiple inversions of the direction of rotation of the drum but, in the present construction, there is provided an additional jarring means consisting of a jarring ram 53 whose piston rod controls a pulley 54 on which the wire-line is engaged. During continuous lowering and raising motions of the set of tools and while conventional jarring action occurs from the winch drum, the ram 53 is at rest but in order to do the jarring, it is set into motion by a controlling action triggered from the water surface craft.

A dynamometer 55 permitting the tension imparted to the cable to be detected is associated with the jarring ram 53 and supplies an electrical information which is transmitted to the water surface by the multi-core conductors 18.

As above-stated, the wire-line 6 passes out of the casing 3 through a stuffing box 12. This box is preferably adapted to perform a hydraulic clamping action on the linings and a self-lubrication of the wire-line with a view to lessening the frictional stress exerted by said wire-line on the linings.

In order to impart the wire-line a sufficient tension inside the housing 3 and to overcome the resistance offered to its motion through the stuffing box 12, there is provided near said box a line withdrawing device 56 preferably comprising a hydraulic motor directly coupled up to a pulley on which the wire-line is wound to form a dead turn. The device 56 thus positively withdraws the wire-line 6 from the housing 3. In order to be able to detect eventual slackness of the wire-line 6 between the device 56 and the input position of the wire-line into the lubricator 4 (see FIG. 2) it is advantageously provided a slack-detector 57 interposed in the wire-line 7 as shown by FIG. 5. It will be understood that where the wire-line run in question remains under tension, the downward motion of the tool into the lubricator 4 and tubing takes place in correct fashion.

In the present construction, there is provided adjacent the stuffing box 12 inside the housing 3 a proximity detector 58 which permits the instant to be detected when, during the raising motion, the set of tools 13 reaches the neighborhood of the lubricator 4. This detector 58 may for example comprise a receiving spool cooperating with magnetic points provided on the steel wire-line 6.

When the set of tools is raised during their return motion, the detector 58 completes those indications that were normally furnished by a depth indicator shown diagrammatically at 59 and associated with the guiding pulley 7 which ensures regulation of the winding action. This indicator may be constituted by a pulse transmitter cooperating with a receiving set arranged on the surface craft. Here again the information is transmitted by the multi-core conductors 18.

Electric valves 60 of known type contained in the housing 3 permit the maximum tension of the wire-line to be permanently controlled so as to stave off the risk of an accident. Such valves are triggered into operation when the wire-line tension exceeds a threshold value which is displayed on the surface craft.

A device 41 is advantageously provided for detecting the pressure prevailing in the lubricator 4. This detecting device may be for example of the piezoelectric type and is capable of supplying electric information which is brought back to the inside of the housing through a conductor 62 in view of its transmission to the surface craft. Advantageously the housing 3 contains a box 63 containing all those electronic components that are necessary for proper operation and connected by the multi-core cable 18 to the control desk and to the power source provided on the surface craft.

It will be understood that the hydraulic circuit which controls all the ancillary devices preferably comprises an accumulator 64 adapted to compensate for fluctuations occurring when control is made.

The method of operation of all these devices will be easily understood from the foregoing by those skilled in the art.

1. An equipment for wire-lining operations by means of tools suspended from a wire-line in submarine or subaqueous well bores, adaptable to a submerged well head including an assembly comprising a tight housing, a lubricator rigid with said housing and engaged therethrough, connecting means on the lubricator for its tight connection with the submerged well head, a winch drum having a vertical axis mounted inside the housing, the winch drum being mounted on said drum, a prime mover in the housing for actuating the winch, means for guiding and upholding said assembly from the water surface, a remote control station arranged outside the housing, and conductors connecting said housing to said station.

2. An equipment for wire-lining operations in well drilling according to claim 1 comprising a first stuffing box on the tight housing for the output of the wire-line and a second stuffing box on the lubricator for the input of the wire-line into said lubricator.

3. An equipment for wire-lining operations in well drilling according to claim 1 wherein the winch drum is mounted concentrically to the lubricator.

4. An equipment for wire-lining operations in well drill-
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According to claim 1 wherein the winch drum is mounted parallel to the lubricator.

5. An equipment for wire-lining operations by means of tools suspended from a wire-line in submarine or subaqueous well drilling adaptable to a submerged well head and comprising a tightly engaging, a lubricator rigid with said housing and engaged through it, connecting means arranged in the lubricator for tightly connecting it to the submerged well head, a stuffing box on the lubricator, a winch drum having a vertical axis fitted inside the housing, the tool carrying wire-line being wound upon said drum, a jockey pulley for driving the winch, a guiding pulley movable with respect to said drum for regulating winding of the wire-line upon the drum, a stuffing box on the housing for proper wire-line output, a jockey pulley fitted outside the housing, said wire-line coming out of the housing for passing on the pulley and entering the lubricator, means for guiding and holding the housing and lubricator from the water surface, a control station outside the housing, and conductors connecting the housing with said station.

6. An equipment for wire-lining operations in well drilling according to claim 5 controlled from a ship floating on the water surface wherein the means for guiding and holding the housing and lubricator include cables extending between said ship and the submerged well head and guiding eyelets on the housing and lubricator and engaged on said cables, the control station being provided on the ship and including a hoisting cable connected with the lubricator and controlled from the ship.

7. An equipment for wire-lining operations by means of tools suspended from a wire-line in submarine or subaqueous well drilling adaptable to a submerged well head comprising a tightly engaging, a lubricator rigid with said housing and extending from the latter, a hydraulically controlled blow-out preventer at the lower end of the lubricator, a joint interconnecting the lubricator and submerged well head, a stuffing box at the upper end of the lubricator, a winch drum having a vertical axis arranged inside the housing, the tool-carrying wire-line being wound upon said drum, a motor in the housing for actuating the drum, a guiding pulley movable with respect to the drum for regulating winding of the wire-line on the drum, a stuffing box on the housing for proper output of the wire-line, a jockey pulley outside the housing, said wire-line being transferred by said jockey pulley from the housing to the lubricator, means for guiding and holding the housing and lubricator from the water surface, a control station outside the housing, and conductors interconnecting the housing and control station.

8. An equipment for wire-lining operations in well drilling according to claim 7 utilizing a well head engaged by a pair of tubings, comprising a nonsymmetric flange between said blow-out preventer and said joint for compensation for eccentricity of said tubings with respect to the well head.

9. An equipment for wire-lining operations in well drilling according to claim 7 wherein the winch drum is mounted concentrically to the lubricator.

10. An equipment for wire-lining operations according to claim 7 wherein the winch drum is parallel to the lubricator.

11. An equipment for wire-lining operations in well drilling according to claim 7 wherein the guiding pulley movable with respect to the winch drum comprises a measuring pulley used in known fashion during said operations for setting proper position of the tools in the well.

12. An equipment for wire-lining operations by means of tools suspended from a wire-line in submarine or subaqueous well drilling adaptable to a submerged well head comprising a tightly engaging, a lubricator rigid with said housing and engaged therewith, connecting means on the lubricator for tightly uniting it to the submerged well head, a winch drum having a vertical axis fitted inside the housing, the tool-carrying wire-line being wound upon said drum, means for tightly transferring said wire-line in said lubricator, a guiding pulley movable with respect to said drum for regulating winding of the wire-line on the drum, a hydraulic power station inside the housing, said station including two separate hydraulic circuits, two pump groups mounted in parallel and feeding said circuits, a winch drum driving hydraulic motor operated from one of said pump groups, ducts connecting the other pump group with said connecting means, means for guiding and holding the housing and lubricator from the water surface, a remote control station inside the housing, and conductors connecting said housing with said station.

13. An equipment for wire-lining operations in well drilling according to claim 12 comprising means for shifting the movable guiding pulley, and a reversing gear interconnecting said hydraulic motor and said shifting means.

14. An equipment for wire-lining operations according to claim 12 comprising a stuffing box carried by the housing, a jockey pulley carried by said ram, the wire-line being engaged over said pulley, and means connecting said ram with one of said hydraulic circuits of the hydraulic power station contained in the housing.

15. An equipment for wire-lining operations according to claim 12 comprising a first stuffing box carried by the lubricator, a second stuffing box supported by the lubricator, the wire-line emerging from the housing through said first stuffing box and penetrating into said lubricator through said second stuffing box, a jockey pulley for directing said wire-line outside the housing and lubricator, a withdrawing device interposed in the cable adjacent to said first stuffing box for overcoming resistance to passing of said wire-line by said first stuffing box, and means for controlling said withdrawing device.

16. An equipment for wire-lining operations in well drilling according to claim 12 comprising a first stuffing box carried by the housing for proper output of the wire-line out of said housing, a second stuffing box on the lubricator for proper engagement of the wire-line into the lubricator, and a proximity detector in the housing between the first stuffing box and the guiding pulley movable with respect to the winch drum for detecting the time when the tools reach the neighborhood of the lubricator during the lifting cycle.

17. An equipment for wire-lining operations in well drilling according to claim 12 comprising a first stuffing box carried by the housing for proper output of the wire-line from it, a second stuffing box for right engagement of the wire-line into it, and a wire-line slackness detector arranged between said first and second stuffing boxes.

18. An equipment for wire-lining operations by means of tools suspended from a wire-line in submarine or subaqueous well drillings adaptable to a submerged well head and controlled from a supporting craft on the water surface, comprising a tightly engaging, a lubricator rigid with said housing and engaged through it, means for tightly connecting said lubricator with the submerged well head, a winch drum having a vertical axis fitted inside the housing, the tool-carrying wire-line being wound upon said drum, means for tightly transferring said wire-line from the housing to the lubricator, a guiding pulley movable with respect to the drum for regulating winding of the wire-line on the drum, a hydraulic station inside the housing, said station including two separate hydraulic circuits, two pump groups mounted in parallel and feeding said circuits, a hydraulic motor for driving the winch drum controlled by one of said pump groups, electric distributors in the hydraulic circuit connected with the other pump groups, electric connecting means inside the housing, a control station on the supporting craft on the water surface, multiple core conductors con-
necting said transformer means with said station, guiding and holding cables connected with said housing and lubricator and with said surface craft and a hoisting cable secured to the lubricator and extending from the surface craft.

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U.S. Cl. X.R.