

A SYSTEM AND METHOD FOR CONDUCTING WIRELINE
OPERATIONS IN AN UNDERWATER WELL

The present invention relates to a system and method for conducting wireline operations in an underwater well.

According to one aspect of the present invention there is provided a system for conducting wireline operations in an underwater well comprising:

- (a) lubricator means connectable on the wellhead including a remotely operable connector, at least one lubricator section and a stuffing box, said lubricator means having a wireline tool string therein and a wireline passed through said stuffing box and connected to said tool string;
- (b) a floating vessel having mounted thereon winch means for said lubricator means, winch means for said wireline, a source of pressured fluid; and
- (c) conduits for conducting fluid from said source to said remotely operable connector for remote operation thereof.

According to another aspect of the present invention there is provided a system for conducting wireline operations in an underwater well comprising:

- (a) a lower lubricator stack section connectable to the wellhead including part of an hydraulically operable connector;
- (b) an upper lubricator stack section including part of an hydraulically operable connector connectable to said lower connector part, at least one lubricator section and a stuffing box, said upper stack section

having a wireline tool string therein, a wireline connected to the tool string and passed through the stuffing box;

- (c) a floating vessel having mounted thereon winch means for the upper lubricator stack section including a line for lifting or lowering said upper lubricator stack section, winch means for the wireline, a source of pressured fluid; and
- (d) conduits for conducting pressured fluid from the vessel source to the hydraulically operable connector for operation thereof.

According to another aspect of the present invention there is provided a method for conducting wireline operations in an underwater well comprising the steps of:

- (a) placing a wireline tool string in a lubricator connectable to the wellhead, said lubricator including a remotely operable connector, at least one lubricator section and a wireline stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) lowering the lubricator with line winch means from a floating vessel to an underwater wellhead;
- (d) connecting the lubricator to the wellhead;
- (e) raising and lowering the wireline with wireline winch means from said floating vessel to perform operations in the well;
- (f) remotely operating the remotely operable connector to disconnect and reconnect said lubricator section and stuffing box from and to the lubricator to perform operations in the well;
- (g) disconnecting the lubricator from the wellhead for lifting back to the floating vessel.

According to another aspect of the present invention there is provided a method for conducting wireline operations in an underwater well comprising the steps of:

- (a) placing a wireline tool string in an upper lubricator stack section, said section including part of a remotely operable connector, at least one lubricator section and a stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) connecting the upper section to a lower lubricator stack section, which is connectable to an underwater wellhead and includes part of a remotely operable connector, by connecting said remotely operable connector parts;
- (d) lowering the connected sections with a line and line winch means from a floating vessel to an underwater wellhead;
- (e) connecting the lower section to the wellhead;
- (f) raising and lowering the wireline and tool string with wireline winch means on the floating vessel, to perform operations in the well;
- (g) remotely operating the lubricator section connector to disconnect the upper lubricator section from and reconnect said section to the lower lubricator section; and
- (h) disconnecting the connected lubricator sections from the wellhead for lifting back to the floating vessel.

Various aspects of the present invention are hereinafter described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic drawing of an ocean floor well utilizing a system according to the present invention.

Figure 2 is a sectioned drawing of a remotely operable connector for use with the present invention showing the members of the connector connected.

Figure 3 is the drawing of a fragment of a section along lines 3-3 of Figure 2.

Figure 4 is a sectioned drawing of the connector of Figure 2 showing the members disconnected and moved slightly apart.

Figure 5 is a fragment of drawing Figure 2, showing the connector lock actuated.

Description of the Preferred Embodiment

Figure 1 shows schematically an ocean floor wellhead 10, utilizing a remotely operable connector 11 of this invention to connect a lubricator 12 to the wellhead for servicing the well. A service boat 13, on the ocean surface, has winch means for a wireline 17 in the form of a wireline reel 14 and a pressure source 15. Hoses 16 connected to the pressure source and the connector, conduct pressured fluid between the pressure source and connector. The wireline 17 is connected to the reel and passes over a sheave 18 and through a stuffing box 19 into the lubricator and well. A handling cable 20, attached to the lubricator, passes over a cable sheave 21 and is connected to winch means in the form of a cable reel 22 on the boat. After connecting a connector member to the wellhead and a connector member to the lubricator or other well servicing equipment, the lubricator may be

lowered and the connector operated remotely to connect or disconnect and raise the lubricator or other well servicing equipment as often as required during well servicing operations.

Accordingly the above arrangement can be used to conduct the following wireline operations in an underwater well, viz

- (a) placing a wireline tool string in a lubricator connectable to the wellhead, said lubricator including a remotely operable connector, at least one lubricator section and a wireline stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) lowering the lubricator with line winch means from a floating vessel to an underwater wellhead;
- (d) connecting the lubricator to the wellhead;
- (e) raising and lowering the wireline with wireline winch means from said floating vessel to perform operations in the well;
- (f) remotely operating the remotely operable connector to disconnect and reconnect said lubricator section and stuffing box from and to the lubricator to perform operations in the well;
- (g) disconnecting the lubricator from the wellhead for lifting back to the floating vessel.

In a modified arrangement, the lubricator may have upper and lower lubricator stack sections which are connectable by a hydraulically operable connector 11. The lower lubricator stack section is connected to the well head and includes a part of the connector for connection with a part of the connector on the upper stack section. The upper stack section includes at least one lubricator section and the stuffing box 19.

Accordingly the above modified arrangement can be used to conduct the following wireline operations in an underwater well, viz

- (a) placing a wireline tool string in an upper lubricator stack section, said section including part of a remotely operable connector, at least one lubricator section and a stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) connecting the upper section to a lower lubricator stack section, which is connectable to an underwater wellhead and includes part of a remotely operable connector, by connecting said remotely operable connector parts;
- (d) lowering the connected sections with a line and line winch means from a floating vessel to an underwater wellhead;
- (e) connecting the lower section to the wellhead;
- (f) raising and lowering the wireline and tool string with wireline winch means on the floating vessel, to perform operations in the well;
- (g) remotely operating the lubricator section connector to disconnect the upper lubricator section from and reconnect said section to the lower lubricator section; and
- (h) disconnecting the connected lubricator sections from the wellhead for lifting back to the floating vessel.

In both arrangements, ie where the lubricator is connected to the wellhead via the connector or where the upper lubricator stack section is connected to the lower lubricator stack section, the stuffing box is adjustable so that it may be adjusted to seal around the wireline while performing operations in the well.

The connector 11 shown in Figure 2 includes a male member 23, having an appropriate connection on its upper end for connection to well servicing equipment to be connected to the wellhead. The male member has an external groove 24, a cam surface 24a, and houses resilient seals 25 in grooves near its lower end. An external camming surface 23a is provided between the resilient seals and groove.

The female connector member 26 includes a lower body 27 which has an appropriate connection on its lower end to connect the female member to the wellhead. The upper end of the lower body is connected to body 28 with thread 29 and sealed to the body with resilient seal 30. The body has a through bore 28a, a seal bore 28b, a shoulder 28c, an external flange 31, and openings 32. A longitudinally movable sleeve 33 is mounted around the lower portion of the body and the flange and has seal bores 33a and 33b. Bore 33a is slidably sealed to the body with resilient seal 34 and bore 33b is slidably sealed to the flange with resilient seal 35. The lower end of the sleeve has a counterbore 33c which forms a shoulder 33d with bore 33a. The sleeve is fitted with an inlet 36, which is connected to a conduit, to conduct control fluid from a remote pressure source to act on the sealed annular area between resilient seals 34 and 35. Mounted around the body in sleeve bore 33b is a spring 37.

Mounted around body 28 and connected to the upper end of the sleeve with threads 38 is a lock sleeve 39, which is sealed to the sleeve with resilient seal 40 and slidably sealed to the body with resilient seal 41. The lock sleeve retains spring 37 in bore 33b and has bores 39a, 39b, and 39c, which form an internal recess 39d in

the lock sleeve. A conical surface 39e, connects bores 39b and 39c and shoulder 39f extends from bore 39a to bore 39c. Sleeve 33 is fitted with another inlet 42, which is connectable to a conduit, to conduct control fluid from a remote pressure source to act on the annular area between seals 35 and 41.

Mounted for radial movement in each body opening 32, is a lug 43 having camming surfaces 43a, 43b and 43c. Connected to the upper end of the female connector body 28 with threads 44 is a frusto-conical guide 45, useful to guide the male member into the female member for connection.

Housed in a recess in the lower wall of body 28 is a connector lock 46. As shown by Figure 3, the lock includes a rod 47 with a through flow passage 47a and an external flange 47b. The rod is connected in the wall recess to body 28 with thread 48 and one end of flow passage 47a in communication with body bore 28a. The rod is sealed to the body with resilient seal 49. Mounted over the rod in a recess in sleeve stop 50 is a piston 51, slidably sealed to the rod with resilient seal 52. Any pressure in bore 28a may act through flow passage 47a on the area sealed by seal 52. The sleeve stop has through holes 50a with internal shoulders 50b. Additionally, the stop has a side surface 50c and an arcuate surface 50d. The diameter of surface 50d is very slightly less than the diameter of bore 33c. Mounted around a shoulder screw 53 in each hole is a spring 54 and each screw is connected to the bottom of the body wall recess by threads 55.

To utilize the connector 11 and connect the male and female members, as shown in Figure 2, the male member 23 is connected to the lower end of the equipment to be

connected to the wellhead and the female member 26 is connected to the wellhead. If desirable, this connector may be inverted and the male member attached to the wellhead. It should be obvious that the connector 11 is useful to connect pipes, cylindrical shapes and the like, and is operable in air or under water in any attitude. After connecting the male member, equipment with male member is lowered into guide 45. Pressure is then applied from the remote pressure source through the conduit and inlet 36 to act on the annular sealed area between seals 34 and 35. Sufficient pressure on this area will move sleeves 33 and 39 downwardly, compressing spring 37, until lock sleeve shoulder 39f contacts body shoulder 28c and recess 39d is beside dogs 43, as shown in Figure 4. As the male member is lowered further, camming surface 23a may contact surface 43a on lugs 43 and move the lugs out into lock sleeve recess 39d, clearing the way for male member seals 25 to travel down and sealingly engage body seal bore 28b, and position groove 24 inside the lugs.

Now, pressure at inlet 36 is reduced until spring 37 moves sleeves 33 and 39 upwardly until lock sleeve surface 39a contacts dog surface 43b and cams lugs 43 radially in from recess 39d and into engagement with male member groove 24. On continued upward movement of sleeve 39, bore 39b moves up over the lugs, locking then engaged in groove 24, and the male and female connector members connected. If desired, pressure may now be applied through inlet 42 to act on the sealed annular area between seals 35 and 41 to prevent any downward movement of sleeves 39 and 33 and retain the connector connected and locked connected.

To unlock and disconnect the connector 11 when there is no pressure in body bore 28a, pressure in inlet 36 is increased sufficiently to compress spring 37 and move sleeves 33 and 39 downwardly until lock sleeve recess 39d is outside lugs 43. At that time, male member 23 may be lifted disengaging seals 25 from body bore 28b, until groove cam surface 24a contacts lug surface 43c. Further upward movement of the male member will cam lugs 43 into lock recess 39d, as shown in Figure 4 and permit the male member 23 to be freely lifted and disconnected from female member 26.

When there is about 100 psi (7.03 kg per sq cm) or more pressure in body bore 28a, the connector cannot be unlocked and disconnected even if pressure is increased in inlet 36 to move sleeves 33 and 39 downward to unlock the connector. Pressure in bore 28a acts through flow passage 47a on the area sealed by seal 52 and urges piston 51 and sleeve stop 50 to move out of the body wall recess and compress springs 54. A pressure of about 100 psi or more in bore 28a is sufficient to move the sleeve stop outwardly until stop surface 50d contacts sleeve bore 33c, as shown in Figure 5. After sleeve shoulder 33d contacts stop surface 50c, no further downward movement of sleeves 33 and 39 may occur even if pressure is applied in inlet 36 and the connector cannot be unlocked and disconnected until pressure in bore 28a is reduced to below about 100 psi, and springs 54 move piston 51 and stop 50 back into the body wall recess, disengaging shoulder 33d and surface 50, and allowing sleeve bore 33a to be moved downwardly over sleeve stop 50.

Reference is hereby made to our UK Patent Specification 2165908 from which the present specification has been divided. UK patent specification

2165908 describes and claims a remotely operable connector suitable for use in the system and method of the present invention.

**CLAIMS**

1. A system for conducting wireline operations in an underwater well comprising:

- (a) lubricator means connectable on the wellhead including a remotely operable connector, at least one lubricator section and a stuffing box, said lubricator means having a wireline tool string therein and a wireline passed through said stuffing box and connected to said tool string;
- (b) a floating vessel having mounted thereon winch means for said lubricator means, winch means for said wireline, a source of pressured fluid; and
- (c) conduits for conducting fluid from said source to said remotely operable connector for remote operation thereof.

2. A system for conducting wireline operations in an underwater well comprising:

- (a) a lower lubricator stack section connectable to the wellhead including part of an hydraulically operable connector;
- (b) an upper lubricator stack section including part of an hydraulically operable connector connectable to said lower connector part, at least one lubricator section and a stuffing box, said upper stack section having a wireline tool string therein, a wireline connected to the tool string and passed through the stuffing box;
- (c) a floating vessel having mounted thereon winch means for the upper lubricator stack section including a line for lifting or lowering said upper lubricator stack section, winch means for the wireline, a source of pressured fluid; and
- (d) conduits for conducting pressured fluid from the vessel source to the hydraulically operable connector for operation thereof.



3. A method for conducting wireline operations in an underwater well comprising the steps of:

- (a) placing a wireline tool string in a lubricator connectable to the wellhead, said lubricator including a remotely operable connector, at least one lubricator section and a wireline stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) lowering the lubricator with line winch means from a floating vessel to an underwater wellhead;
- (d) connecting the lubricator to the wellhead;
- (e) raising and lowering the wireline with wireline winch means from said floating vessel to perform operations in the well;
- (f) remotely operating the remotely operable connector to disconnect and reconnect said lubricator section and stuffing box from and to the lubricator to perform operations in the well;
- (g) disconnecting the lubricator from the wellhead for lifting back to the floating vessel.

4. The method of Claim 3, further including adjusting the stuffing box to seal around the wireline while performing operations in the well.

5. A method for conducting wireline operations in an underwater well comprising the steps of:

- (a) placing a wireline tool string in an upper lubricator stack section, said section including part of a remotely operable connector, at least one lubricator section and a stuffing box;
- (b) passing a wireline through said stuffing box and connecting said wireline to said tool string;
- (c) connecting the upper section to a lower lubricator stack section, which is connectable to an underwater wellhead and includes part of a remotely operable connector, by connecting said remotely operable connector parts;



- (d) lowering the connected sections with a line and line winch means from a floating vessel to an underwater wellhead;
 - (e) connecting the lower section to the wellhead;
 - (f) raising and lowering the wireline and tool string with wireline winch means on the floating vessel, to perform operations in the well;
 - (g) remotely operating the lubricator section connector to disconnect the upper lubricator section from and reconnect said section to the lower lubricator section; and
 - (h) disconnecting the connected lubricator sections from the wellhead for lifting back to the floating vessel.
6. The method of Claim 5 further including adjusting the stuffing box to seal around the wireline while performing operations in the well.
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