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(54) Title: RELEASABLE WIRELINE CABLEHEAD

(57) Abstract: A apparatus for releasably connecting a wireline to a downhole tool comprises a connector having a first member adapted for connection to the downhole tool and a second member adapted for connection to the wireline. A plurality of locking elements are constrained to engage the first and second members by a moveable release member, where the plurality of locking elements maintain the first and second members in a connected position when the moveable release member is in a first locked position. An electromechanical actuator moves the moveable release member to a second released position, releasing the plurality of locking elements from engagement with the first and second members. This allows the first and second members to release the wireline from the tool.

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RELEASABLE WIRELINE CABLEHEAD

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Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application No. 60/426,897, filed November 15, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to wireline operations in a well and more particularly to a cable head system for remotely releasing a wireline from a downhole tool.

2. Description of the Related Art

Wireline operations are carried out in oil and gas wells for conveying tools downhole in the well. A wide variety of downhole tools may be supported on a wireline including tools to perform logging, perforating, and setting and retrieving operations. The tools typically comprise a combination of different tubular members threaded together to form a working unit which is manipulated and controlled from the surface via the wireline. Although tools may be conveyed downhole on a tubing string which can withstand substantially higher extraction forces than a wireline, oftentimes a wireline is preferred because it saves substantial rig time in conveying tools downhole and positioning them within the well. A cable head, which connects the tools to the wireline, is typically provided with a release
mechanism to permit the wireline to be disconnected from the tools, such as when the tools become stuck downhole.

The commonly accepted safe operational pull of the wireline is a pull which does not exceed one-half the breaking strength of the wireline. When a tension is placed on the wireline which is over 50% of its break point, then problems begin to occur with the electrical conductors in the wireline. Also, there is the danger of breaking the wireline.

A typical wireline release utilizes a mechanical weak point in the connection between the wireline and the cable head. Typically this is a metal member which is designed to break upon a predetermined pull on the wireline. The correct conventional mechanical weak point must be calculated and installed prior to running the cable head and tools into the borehole on the wireline.

There are two limitations in using the typical mechanical weak point release, one is the strength of the wireline itself and the other is the strength of the mechanical weak point. For example, when the tool is stuck, the operator will fish for the tool with the wireline still attached to the tool in the hole. The operator lowers a grapple on a separate line, such as a slick line, which grabs the top of the cable head or the tool body. Once the tools are grabbed, the operator wants to release the wireline from the tool and remove it from the hole. Removing the wireline makes it easier to pull the tools and pipe out of the well. In order to effect the release, the operator places a large tension on the wireline to activate the typical mechanical release. If the cable head and tools are in a deviated hole, the effects of friction on the wireline may prevent the mechanical link at the cable head from receiving sufficient tension to break the link. In fact, the wireline may break at some uphole location before the
mechanical link breaks. The presence of the broken wireline substantially impairs the fishing operation for the stuck tool.

Various other apparatus and methods have been provided for releasing the wireline from the cable head and tools. One common method of releasing the wireline includes the use of a spring set at a particular tension. Once the force on the spring is exceeded, the wireline is released. This release still requires that the amount of load required to release the wireline be predetermined prior to lowering the cable head into the well. If the spring tension is exceeded, there can be a premature release of the cable head.

Another typical release relies primarily on shear pins or shear screws. Problems are encountered with shear screws having a low failure point because they are exposed to various cyclical forces which tend to affect their ultimate shear rating. The shear screws are exposed to fluids in the well which over time can affect the inherent strength of the shear screws or pins making them susceptible to failure at stresses below their rated failure point. Unexpected release can significantly delay operations, causing additional operating expense. An unexpected release can also result in the loss of downhole tools and in extreme cases can cause severe damage to the wellbore requiring substantial time and money to repair.

Major problems occur if the cable head and tools get stuck in the well and the wireline breaks upon pulling on the wireline with too much tension. Breaking the wireline and dropping the wireline in the well greatly complicates the fishing operation to retrieve the tools.

Therefore, there is a demonstrated need for a remotely actuated cable release system
that does not primarily rely on pulling a tension on the wireline to break a mechanical link.
SUMMARY OF THE INVENTION

The present invention addresses the above-noted and other deficiencies of conventional release mechanisms and provides a releasable wireline cable head.

In one embodiment of the present invention, a system for use in a wellbore, comprises a wireline extending from a surface location to a predetermined location in the wellbore. A tool string has at least one tool adapted to perform at least one downhole operation. A cable head releasably connects the wireline to the tool string.

In one aspect of the present invention, an apparatus for releasably connecting a wireline to a downhole tool comprises a first member adapted for connection to the downhole tool and a second member adapted for connection to the wireline. A plurality of locking elements are constrained to engage the first member and the second member by a moveable release member, where the plurality of locking elements maintain the first member and the second member in a connected position when the moveable release member is in a first position. An actuator moves the moveable release member to a second position, releasing the plurality of locking elements from engagement with the first member and the second member. This allows the first member and the second member to release the wireline from the tool.

In another aspect of the present invention, a method of releasably connecting a wireline to a downhole tool comprises locking a first member to a second member by using a release member to constrain a plurality of locking members to engage the first member and the second member, when the release member is in a first position. This maintains the first and second in a locked position. The release member is moved from the first position to a second position, thereby releasing the plurality of locking members from engagement with the first member and the second member. This releases the first member from the second member and allows the wireline to be released from the downhole tool.
Examples of the more important features of the invention thus have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto.
BRIEF DESCRIPTION OF THE DRAWINGS

For detailed understanding of the present invention, references should be made to the following detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals, wherein:

Figure 1 shows an elevation view of a well logging instrument being deployed in a wellbore;

Figure 2 shows a cross section of a cable head according to one embodiment of the present invention;

Figure 3A shows a cross section of a latching mechanism in the locked position according to one embodiment of the present invention;

Figure 3B shows a cross section of a latching mechanism in the released position according to one embodiment of the present invention; and

Figure 4 shows a cross section of a latching mechanism according to another preferred embodiment of the present invention.
DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 1, there is shown a cable head 10 supported by a wireline 12 from a rig 14 at the surface 16. The releasable cable head 10 supports a tool string 18 disposed adjacent a production zone 22 located, as for example, near the bottom 24 of borehole 20, also called a wellbore. The wireline 12 is deployed from the reel 29 on the wireline vehicle 28 around one or more sheave wheels 26 down the borehole 20. The wireline vehicle 28 has instrumentation, well known in the art, for communication and control of the cable head 10 and the tool string 18. Such instrumentation may include a surface controller for remotely operating the cable head 10.

The wireline 12, sometimes referred to as a cable, typically includes a plurality of electrical conductors extending from the wireline vehicle 28 to the cable head 10, all well known in the art. One such type of multi-conductor wireline 12 includes an inner core of seven electrical conductors covered by an insulating wrap. An inner and outer steel armor sheath is then wrapped in a helix in opposite directions around the conductors. The electrical conductors are used for communicating power and telemetry between the wireline vehicle 28 and the tool string 18. Alternatively, the wireline cable may contain a combination of electrical conductors and optical fibers. A single electrical conductor cable may also be used.

The tool string 18 may include logging tools, perforating guns, packers, and/or any other device suitable for running on a wireline and performing downhole operations.

Figures 2 and, 3A,B show one preferred embodiment of the releasable cable head 10. The cable 12 is inserted in the releasable cable head 10 through an elastomeric cap 13. The cap 13 extends inside the housing 15. Commonly, the cap 13 is sized to be compressed around the cable 12 as the cap 13 is inserted in the housing 15 thereby acting as a seal against the entry of wellbore fluid into the housing 15. The housing 15 is commonly filled, after
assembly, with a non-conductive grease 41 through the fill port 40. Alternatively, a non-conductive oil may be used. The end of wireline cable 12 is terminated and captured with a conventional full-armor cone 52 and a basket 50 assembly. Alternatively, any suitable cable termination known in the art may be used. The basket is threadedly connected to the release sleeve 51. The release sleeve 51 is connected to the latching assembly 17 and is releasable under remote electrical control from the surface.

The latching assembly 17 (see Fig. 3A,3B) comprises a restraining sleeve 54 fixedly attached in the housing 15. The sleeve 54 transfers wireline tension loading to the housing through the shoulder 57. The sleeve 54 has an annular groove 60 (see Fig. 3B) on an inner surface. The release sleeve 51 has a plurality of radial through holes 58 arranged around a circumference such that the holes 58 are juxtaposed with the annular groove 60 when the release sleeve 51 is inserted in the restraining sleeve 54. Both the holes 58 and the annular groove 60 are sized to accept the ball locking elements 53. In the locked position (see Fig. 3A), the balls 53 are captured between the restraining sleeve 54 and the release sleeve 51 by the locking sleeve 70. The number, size, and material of the balls 53 are determined, using techniques known in the art, such that the shear strength of the balls substantially exceeds the tensile strength of the cable 12. Alternatively, the locking elements may be axially aligned rollers with appropriately shaped holes in the release sleeve.

The locking sleeve 70 is forced into the locked position by the spring 55 that extends around a reduced diameter portion of locking sleeve 70. The reduced portion of the locking sleeve 70 extends through an annular solenoid coil 56 disposed in the housing sleeve 54. When energized (see Fig. 3B), the solenoid 56 magnetically interacts with the locking sleeve 70 to retract the locking sleeve 70, compressing the spring 55 and allowing the balls 53 to move inwardly. This action releases the cable 12 from latching the assembly 17, and allows the cable to be retrieved to the surface. The solenoid 56 may be potted using a suitable
material such as an epoxy or elastomeric potting compound to protect the solenoid from contaminants. The electrical conductors 80 are routed through the passage 71 and connected to the connectors 72 at the pressure sealed bulkhead 73 (see Fig. 2) for connection and operation of at least one downhole tool. Power to actuate the solenoid 56 is provided by an electronics controller (not shown) through the connector 42. The connectors 72 and 42 are pressure sealed against intrusion of downhole fluids by use of o-rings and elastomeric boots known in the art. Such connectors are well known in the art and are commercially available. The electronics controller may be located in an atmospheric pressure sealed chamber 35 in the cable head 10. Alternatively, the electronics may be located in a separate module (not shown) connected between the cable head 10 and the tool string 18. Electrical power and communications signals are fed through the conductors 80 and passed through the electronics controller to operate the tools in the tool string 18.

In another preferred embodiment, see Figure 4, a cable 112 is terminated in the termination 150. Electrical conductors 152 carried in cable 112 are connected to connectors 153 for transmitting power and/or signals to a controller (not shown) similar to that described previously. The termination 150 is mechanically connected through the tensile link 151 to the release anchor 120 that has an annular groove 123 and a flange 122. Multiple locking fingers 121 are hinged at the hinge pins 124 and arranged to engage the anchor head 122. The fingers 121 are forced to remain engaged with the anchor head 122 by the locking sleeve 154 that is held in position by the spring 125. When the solenoid coil 156 is actuated, the locking sleeve 154 is retracted, compressing the spring 125 and releasing the restraint around the fingers 121. The fingers 121 are allowed to pivot outward, releasing the anchor 120 and allowing the cable 112 to be retrieved to the surface. Alternatively, the locking fingers 121 may be flexible, non-hinged collet-type fingers (not shown) of a type common in the art.

A tensile link 151 is used as a fail-safe device in case of failure of the electrically
operated release. Such a fail-safe link may be incorporated in any of the preferred embodiments described herein.

In the preferred embodiments described above, a solenoid has been used to retract a sleeve to release a cable. Alternatively, an electric motor (not shown) may be used through a suitable mechanical drive, such as a ball-screw mechanism (not shown), to retract the release sleeve in the preferred embodiments.

The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope of the invention. It is intended that the following claims be interpreted to embrace all such modifications and changes.
WHAT IS CLAIMED IS:

1. A system for use in a wellbore, comprising:
   a. a wireline extending from a surface location to a predetermined location in the
      wellbore;
   b. a tool string having at least one tool adapted to perform at least one downhole
      operation; and
   c. a cable head for releasably connecting said wireline to said tool string.

2. The system of claim 1, wherein the cable head includes:
   i. a first member adapted for connection to the downhole tool and a second
      member adapted for connection to the wireline;
   ii. a plurality of locking elements constrained to engage said first member and said
      second member by a moveable locking sleeve, said plurality of locking elements
      maintaining said first member and said second member in a connected position
      when said moveable locking sleeve is in a first position; and
   iii. an actuator adapted to move said moveable locking sleeve to a second position
        releasing said plurality of locking elements from engagement with said first
        member and said second member allowing said first member and said second
        member to release said wireline from said tool.

3. The system of claim 2 wherein the plurality of locking elements are balls.

4. The system of claim 2 wherein the actuator includes a solenoid.

5. The system of claim 2 wherein the actuator includes a motor drive.
6. The system of claim 2 further comprising a breakable tensile link.

7. The system of claim 2 wherein the plurality of locking elements includes locking fingers.

8. The system of claim 7 wherein the locking fingers pivot about a hinge.

9. The system of claim 7 wherein the locking fingers comprise collet type elements.

10. The system of claim 2, wherein the plurality of locking elements move inwardly when said moveable locking sleeve is moved to the second position.

11. The system of claim 1, wherein the wireline is a multi-conductor wireline.

12. The system of claim 1, wherein the at least one tool is a logging tool.

13. The system of claim 1, wherein the cable head is remotely operated by a surface controller.

14. An apparatus for releasably connecting a wireline to a downhole tool, comprising:

   a. a cable head having a first member adapted for connection to the downhole tool and a second member adapted for connection to the wireline;

   b. a plurality of locking elements constrained to engage said first member and said second member by a moveable locking sleeve, said plurality of locking elements maintaining said first member and said second member in a connected position when said moveable locking sleeve is in a first position; and

   c. an actuator adapted to move said moveable locking sleeve to a second position releasing said plurality of locking elements from engagement with said first member and said second member allowing said first member and said second member to release said wireline from said tool.
15. The apparatus of claim 14 wherein the plurality of locking elements are balls.

16. The apparatus of claim 14 wherein the actuator includes a solenoid.

17. The apparatus of claim 14 wherein the electromechanical actuator includes a motor drive.

18. The apparatus of claim 14 further comprising a breakable tensile link.

19. The apparatus of claim 14 wherein the plurality of locking elements includes locking fingers.

20. The apparatus of claim 19 wherein the locking fingers pivot about a hinge.

21. The apparatus of claim 19 wherein the locking fingers comprise collet type elements.

22. The apparatus of claim 14, wherein the plurality of locking elements move inwardly when said moveable locking sleeve is moved to the second position.

23. The apparatus of claim 14, wherein the wireline includes multiple conductors.

24. The apparatus of claim 14, wherein the wireline includes at least one optical fiber.

25. A method of releasably connecting a wireline to a downhole tool, comprising:

a. locking a first member coupled to the wireline to a second member coupled to the downhole tool by using a locking sleeve to constrain a plurality of locking elements to engage said first member and said second member when said locking sleeve is in a first position; and

b. using an actuator to move said locking sleeve from said first position to a second position releasing said plurality of locking elements from engagement with said first member and said second member for releasing said first member from said second member and releasing said wireline from said downhole tool.
26. The apparatus of claim 25 wherein the plurality of locking elements are balls.

27. The apparatus of claim 25 wherein the actuator includes a solenoid.

28. The apparatus of claim 25 wherein the actuator includes a motor drive.

29. The apparatus of claim 25 further comprising a breakable tensile link.

30. The apparatus of claim 25 wherein the plurality of locking elements includes locking fingers.

31. The apparatus of claim 30 wherein the locking fingers pivot about a hinge.

32. The apparatus of claim 30 wherein the locking fingers comprise collet type elements.

33. The apparatus of claim 25, wherein the plurality of locking elements move inwardly when said moveable locking sleeve is moved to the second position.

34. The apparatus of claim 25, wherein the wireline includes at least one optical fiber.
A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B17/02 E21B17/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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