

Description
WIRELINE DRILLING SYSTEM AND METHOD

Technical Field:

5 The invention relates to drilling, coring, in-situ sampling and measurement underwater on a drilling system referred to as the Rovdrill 3. The Rovdrill 3 drilling system is basically a larger version of the Rovdrill System of Perry Slingsby Systems, Inc. of Jupiter, Florida that uses conventional diamond core drilling systems and is the subject matter of co-pending U.S. Application Nos. 11/972,080
10 and 11/972,088, both filed January 10, 2008, which are incorporated herein by reference.

Land based drilling operations have used wireline drilling techniques for many years and there are several companies that produce wireline drilling tools for land operations. Land based wireline drilling operations use tools that are manually
15 operated by drilling personnel. A manual approach cannot be used for drilling on the bottom of the ocean because drillers cannot physically be at the drilling site subsea due to environmental conditions. Robotic systems are therefore used in subsea drilling operations.

The oil and gas industries also use a form of wireline deployment, although
20 their application is used to monitor pre-existing petroleum wells and to increase production flow from the wells. Those methods are called logging and workover.

Disclosure of the Invention:

It is accordingly an object of the invention to provide a wireline drilling
25 system and method, which overcome the hereinafore-mentioned disadvantages of the heretofore-known devices and methods of this general type. More specifically, it is an object of the invention to provide an improved method and apparatus for seabed and water bottom wireline drilling, core-sampling and measuring applications using the Rovdrill 3, where:

30 The cores are recovered from a drill string using a wireline winch and overshot/toggle – in the case of rotary or push sample coring.

The in-situ measuring device, including but not limited to cone, ball and T-bar penetrometer devices, is deployed down the drill string and recovered up the drill string using a wireline winch and overshot/toggle assembly.

35 This form of drilling, sampling or measuring is faster than conventional methods because the drill string does not have to be disassembled to recover the core barrel or measuring device from the bottom of the drill string and reassembled again when each core or data measurement is retrieved. The wireline method also does not have the hole collapse issues that can frequently occur in some soil conditions
40 because the drill string can stay in the hole during the operations. Hole collapse is potentially damaging to core quality and is common in conventional drilling operations.

With the foregoing and other objects in view there is provided, in accordance with the invention, a device for seabed and water bottom drilling, core sampling and
45 measuring. The device comprises a vertically movable and horizontally fixed cross beam, a winch fixed to the cross beam and having a rope wound thereon, a drill head disposed on the cross beam, a spindle having a bore formed therein and being driven by the drill head and an overshot having one end connected to the rope and another end passing through the bore in the spindle for attachment to and
50 detachment from a drilling tool of a drillstring. The spindle, the rope and the

drillstring together defining a common centerline during attachment and detachment of the overshot to and from a drilling tool and during drilling.

With the objects of the invention in view, there is also provided a method for seabed and water bottom drilling, core sampling and measuring. The method comprises unwinding a rope from a winch connected to a vertically movable and horizontally fixed cross beam, lowering the rope from the winch through a bore in a spindle to an overshot, attaching the overshot to and detaching the overshot from a drilling tool of a drillstring, rotating the drilling tool with a drill head connected to the cross beam and defining a common centerline of the spindle, the rope and the drillstring during attachment and detachment of the overshot to and from a drilling tool and during drilling.

The invention permits drilling tools to be exchanged without moving the cross beam laterally, without disassembling the drill string to recover a core barrel or measuring device from the bottom of the drill string, without reassembling the drill string again when each core or data measurement is retrieved and without the hole collapse problems of the prior art.

In accordance with another feature of the invention, a swivel is connected between the rope and the overshot. The overshot and the swivel are configured to be pulled up into the bore in the spindle by the winch, to permit tool exchange.

In accordance with a further feature of the invention, a lift rod is connected between the rope and the overshot. The lift rod is configured to be pulled into the bore in the spindle prior to commencing rotary drilling for sealing the top of the bore. When the lifting rod is in the uppermost position, water flows downwards through the spindle bore and the drill string only. Therefore, water can then be pumped down the spindle bore and drill string and into the hole, lubricating the drill cutting process and flushing cuttings from the hole. Since the top of the spindle is sealed, the water cannot flow out the top of the spindle and must only go down the hole as desired.

In accordance with an added feature of the invention, grabber and alignment arms deliver a drilling tool from a removable tool rack to a position along the common centerline for the drillstring. A foot clamp cooperates with the grabber and alignment arms for exchanging a drilling tool. A tensioner maintains tension in the rope and prevents rope slack when the rope is deployed out.

In accordance with an additional feature of the invention, the overshot has a latch for mating with a spear on a drilling tool.

In accordance with yet another feature of the invention, the device has at least one ROV/diver intervention panel. In particular, each of the drill module and the foundation module may have an ROV/diver intervention panel which are independent of each other and are used for different functions/purposes.

In accordance with a concomitant feature of the invention, a caisson rests on, engages with or penetrates into the surface of the seabed or water bottom, and a stinger is disposed on the caisson for receiving a sampling tool, such as a push core sampler to be preinstalled before setting the foundation prior to performing drilling, coring or sampling tasks. This serves the purpose of obtaining water bottom or seabed surface and shallow penetration depth samples during the initial penetration of the foundation.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in a wireline drilling system and method, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of the specific embodiment when read in connection with the accompanying drawings.

Brief Description of the Drawings:

Figs. 1A, 1B, 1C and 1D are diagrammatic, perspective views of a wireline assembly, a caisson assembly thereof, a foundation assembly thereof and a stinger of the caisson assembly, according to the invention;

Fig. 2 is a perspective view of a cross beam assembly of the wireline assembly;

Fig. 3 is a perspective view of a winch assembly of the wireline assembly;

Fig. 4 is a perspective view of an alignment and grabber assembly of the wireline assembly;

Fig. 5 is a perspective view of a foot clamp assembly of the wireline assembly;

Fig. 6 is a perspective view of a spear, latch and core barrel assembly of the wireline assembly;

Fig. 7 is a perspective view of a spear, latch and tool assembly of the wireline assembly;

Fig. 8 is a fragmentary, longitudinal-sectional view of a drilling spindle with an overshot of the wireline assembly;

Fig. 9 is an enlarged, fragmentary, longitudinal-sectional view of the drilling spindle and overshot of Fig. 8;

Fig. 10 is a side-elevational view of the cross beam assembly of the wireline assembly shown in Fig. 2;

Fig. 11 is an enlarged, fragmentary, longitudinal-sectional view of a portion XI of Fig. 10;

Fig. 12 is an enlarged, perspective view of a lift rod assembly of Fig. 10; and

Figs. 13-52 are highly diagrammatic, side-elevational views of the winch, drilling spindle, overshot, grabber and alignment and foot clamp assemblies, in addition to a tool rack assembly, with drill pipes and tools and a bottom hole assembly, with which the sequence of method steps according the invention will be described.

Best Mode for Carrying out the Invention:

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1A thereof, there is seen an improved wireline assembly according to the invention, including an underwater foundation assembly 1 which rests on, engages with or penetrates into the surface of the seabed or water bottom. This structure may be, but is not limited to, a prior art gravity base, suction caisson, skirted mud mat or multi-legged jack up foundation, with legs being adjustable in length and may be single stage or multi-stage telescopic in nature, and may include foot pads of varying geometry and function, including rigidly or compliant, connected flat, convex or concave bearing plate assemblies, helical augers or expanding mechanical anchor assemblies. The illustrated foundation assembly 1 is a caisson

which is also shown detached from the remainder of the wireline assembly in Fig. 1B. A jack up assembly 2 having pins 3 that align with a caisson attachment point is shown in Fig. 1C.

Such mechanisms for extending and retracting these legs or driving the expanding anchors and auger assemblies may include, but are not limited to hydraulically or electrically driven linear or rotary actuators, mechanical gear mechanisms including rack and pinion, worm and wheel and threaded shafting and floating nut, re-circulating ball drives.

Further improvements to a prior art suction caisson, skirted mud mat or multi-legged jack up foundation assembly include a prior art hollow stinger pipe 11 shown in Fig. 1D, which is mounted vertically through the uppermost base plate of the caisson or mat and extends downwards to some initial dimension less than the total height of the caisson or mat vertical wall(s). This prior art stinger pipe 11 is improved by the inclusion of a latching interface within the bore which can allow a sampling tool such as a push core sampler to be preinstalled before setting the foundation prior to performing drilling, coring or sampling tasks, for the purpose of obtaining water bottom or seabed surface and shallow penetration depth samples during the initial penetration of the foundation. Such an interface will also allow the installation of removable casing tubes to enhance the subsequent drilling, coring or sampling operations, and prevent borehole collapse.

Further improvements to the prior art hollow stinger pipe 11 include a mechanical connection interface at the lower free end of the pipe, to allow the addition of further stinger pipes or tools and casing tubes of various quantity, diameters, function and length. Such a connection interface may include, but is not limited to threaded connection, mechanical interlock and friction interference fit.

The Rovdrill 3 subsea assembly shown in Fig. 1A is formed of two major subassemblies:

The drill module 5; and

The foundation module 1.

Each of the above-mentioned subassemblies has an ROV/diver intervention panel which are independent of each other and are used for different functions/purposes:

The remotely operated vehicle (ROV) or diver intervention interface or panel 4 mounted to the drill module assembly 5, as seen in Fig. 1A, includes two electrical wet mate connectors and two hot stab receptacles across the top row, as well as two ROV mechanical docking receptacles in the bottom row. Such a non-illustrated ROV is the Perry Slingsby Triton XLS 150HP ROV manufactured by Perry Slingsby Systems, Inc. of Jupiter, Florida as well as that shown in co-pending U.S. Application Nos. 11/972,080 and 11/972,088, both filed January 10, 2008, which are incorporated herein by reference. However, the wireline system need not use any particular ROV from a preferred manufacturer. On the contrary, it is an advantage of the invention that the wireline system can be powered by any workclass ROV of opportunity. This interface 1 includes, but is not limited to ROV mechanical docking interface(s), hydraulic (including water and oil) and electrical hot-stab interface(s), diver and ROV operable override control mechanisms for foundation leg operations, suction caisson or skirted mud mat vent valve override operation and wireline housing structure engagement/disengagement from the mechanism of the foundation structure 1.

More specifically, the drill module intervention panel 4 in Fig 1A, includes the ROV mechanical docking receptacles, which are components available from Perry

Slingsby Systems, Inc. and also hydraulic and electrical hot stab receptacles/couplings which are again components available from Perry Slingsby Systems, Inc. (hydraulic stab receptacles) and commercially available off the shelf (COTS) electrical couplers, e.g. Nautilus wet-mate electrical connectors from Ocean Design Inc. (ODI). It is by making connections with these interfaces via the ROV that all hydraulic and electrical power and control signals/telemetry is transferred to the Rovdrill drill module to drive and control all the mechanisms that Rovdrill uses to execute the drilling, sampling and measuring processes.

b) The foundation assembly 1 in Figs. 1A and 1B also has an ROV/diver intervention panel 46 which includes a water hot stab receptacle 47, the purpose of which is to allow a connection between the ROV mounted suction pump and the caisson. In the event that greater penetration of the caisson into the seabed is required for Rovdrill stability, a high flow water hot stab can be inserted into the receptacle 47 being connected to the ROV mounted suction pump via a hose and a pump run in such a way that water is pumped out of the caisson thus creating a vacuum effect within the caisson drawing it into the seabed/water bottom. Therefore, hydraulic or electrical hot stab interfaces may be provided on the foundation panel 46.

A wireline underwater subassembly and component housing structure, including a drill module assembly 5, a tool rack or carousel 6, a cross beam assembly 7, grabber arm and alignment assemblies 30 having a grabber arm 8 and an alignment arm 9, as well as the ROV intervention interface or panel 4, is laterally and vertically fixed to the foundation structure 1 by a remotely operable and manually override-able latching system or docking mechanism 10, as seen in Fig. 1D.

This structure further includes a deployment and recovery line termination interface with detachable rigging including ROV or diver operable lifting shackle and flotation module.

The remotely operated vehicle (ROV) or diver intervention interface or panel 4 is integrated on the external members of wireline underwater subassembly and component housing structure. This interface 4 includes, but is not limited to ROV mechanical docking interface(s), hydraulic (including water and oil) and electrical hot-stab interface(s), diver and ROV operable override control mechanisms for primary wireline functions.

The primary components and assemblies of the wireline system are:
a wireline winch shown in Fig. 3;
a wireline winch rope shown in Fig. 3;
an overshot/toggle shown in Figs. 2, 8 and 9;
a drilling spindle shown in Figs. 2, 8 and 9;
a wireline core barrel, tool, spear and latch shown in Figs. 6 and 7; and
a tool handling and storage assembly shown in Fig. 1A and in the co-pending applications mentioned above.

The Wire line Winch

The function of the wireline winch 12 shown in Fig. 3 is to deliver the wireline core barrel 20 shown in Fig. 6, or the push sample tool or in-situ testing tooling 25 shown in Fig. 7 into the drill string and to retrieve the same from the drill string. The winch 12 includes a drum 13 powered by hydraulic motor 14. An electrical motor can be used instead of the hydraulic motor depending on the desired applications.

The wireline winch drum 13 (such as the TX 0114-3A20-00) includes a cylinder (drum core) with flanges 15 attached on either end. An opening in the drum core or flanges allows the winch rope to be installed and terminated to the drum. The drum motor 14 (such as the MOT-X 40518) powers the drum 13 through a stainless steel chain 16 and sprockets 17, one on the drive motor 14 and one attached to the shaft of the drum 13. The sprocket ratio is selected to develop the required torque and speed of the drum.

The angle where the winch rope departs at the drum is called the fleet angle. Winches require small fleet angles (commonly 0.5 to 2 degrees) to spool rope properly. To compensate for and minimize fleet angles, the winch includes a levelwind assembly (such as that manufactured by Cellula Robotics Ltd., Vancouver, Canada) which ensures that a wireline or rope 18 is spooled on and off the drum 13 in such a manner that the rope wraps onto the drum core and aligns properly with lower rope layers as the spooling operation progresses.

The wireline or rope 18 is spooled onto and off of the wireline winch drum 13 during operations by a combination of clockwise or counterclockwise drum rotation and lateral movement of a follower block in the levelwind assembly. A reversing screw (such as the TX 0114-3A00-28) aids in this movement. The winch drum 13 can rotate bi-directionally about its own axis, as described, but cannot move laterally under any circumstances and can only move in the vertical plane when the crossbeam 7 to which it is statically mounted is moved in that direction by an elevator mechanism 39.

Fig. 10 is a side view of the cross beam assembly 7 of Fig. 2 and Fig. 11 is an enlarged portion XI of the cross beam assembly 7 of Fig. 10. The sectional view of Fig. 11 is taken through a sealing interface of a lifting rod 60 and a spindle bore 61. The circle in the center of Fig. 11 represents a lifting rod sealing area. When the lifting rod 60 is in the uppermost position as shown, water flow downwards through the spindle bore 61 and the drill string only. The lifting rod 60 is shown in an exploded view in Fig. 12, from which a shear pin 26, a water sealing collar 62 and twin O-ring seals 63 can be seen.

One end of the lift rod 60 having the shear pin 26 is connected to the wireline or rope 18 and the other end thereof is connected to the overshot 21. The top of the spindle bore may be sealed off by pulling the lift rod 60 all the way up into the top of the spindle 24 prior to commencing rotary drilling. The advantage of this is that water can then be pumped down the spindle bore and connected drill string and into the hole, lubricating the drill cutting process and flushing the cuttings from the hole and because the top of the spindle 24 is sealed then the water cannot flow out the top of the spindle 24 and must only go down the hole as desired.

The levelwind assembly is basically a rope fleet angle guide mechanism and may include:

A drive shaft or mechanism coupled either mechanically or electronically to the drum drive mechanism such that the movement of the levelwind is timed to the motion of the drum. This mechanism may include but is not limited to;

- a diamond shaft;
- a leadscrew;
- a re-circulating ball drive screw assembly;
- an electrically or hydraulically operated linear slideway;
- a rack and pinion drive; and
- a worm and wheel geared drive.

The levelwind drive mechanism is constructed to move a follower block assembly along the drum axis by a fixed amount, which is dependent on the diameter of the rope such that consecutive wraps are laid properly without gaps.

If a diamond screw is used for the levelwind drive mechanism, the direction of the follower block can be changed automatically without rotating the screw in an opposite direction of rotation. This automatic change in direction maintains the proper fleet angle and permits the installation of more than one layer of rope on the drum.

The follower block assembly mounted to the drive shaft or mechanism described in 1. above. This follower block traverses longitudinally and parallel to the horizontal axis of the winch drum 13, the follower block incorporates a rope guide mechanism which may include a pair of vertically oriented free rotating rollers set at some nominal distance apart axially, and between which the wireline or rope 18 is guided between the drum 13 and the tensioner wheel, or may include a rotating and horizontally swiveling sheave assembly, performing the same function.

The result is a narrow winch drum 13 that can hold the required quantity of wireline or rope 18 for the drilling application with no lateral movement of the winch assembly 12 itself. The assembly 12 has a compact construction well suited for installation on the spindle base structure referred to as the cross beam 7 of an underwater drill. Installation of the wireline winch 12 on the cross beam 7 has several advantages over one that is installed on a static structure, as follows:

The length of the wireline or rope 18 does not require adjustment, in or out, when the cross beam 7 is moving up and down during normal operations;

The pull of the winch 12 can be limited because the cross beam elevator system 39 can be used to pull on the wireline or rope 18 should added line force be required, with the result being a more compact winch 12;

The wireline or rope 18 can be parted if the inner core barrel 20 is stuck by using a winch brake and shearing a pin at the top of a swivel of an overshot 21 shown in Fig. 8;

The cross beam 7 does not need to be moved clear of the drill string centerline, either laterally or vertically, to allow the introduction of the wireline to the drill string/spindle centerline, since with this system the spindle, wireline and drillstring centerlines are common at all times.

Wireline Winch Rope

Ropes 18 used for the wireline winch 12 can be a variety of types including but not limited to synthetic, wire and wire with internal conductors that are used for monitoring sensors downhole. Instrumented wires would require the installation of a slip ring on one side of the winch 12.

Termination to the drum 13 and the overshot 21 may incorporate conventional methods, depending on the type of wireline or rope 18 used and termination efficiency required.

The wireline or rope 18 contemplated for use in the wireline system according to the invention is ¼" diameter high performance synthetic Amsteel rope.

Winch Rope Tensioner

Wireline or rope 18 is installed on the drum 13 under tension to assure that the wraps on the drum are spooled on correctly and that the wraps on the succeeding layers do not cut into those of the layers below. If the wireline or rope 18 becomes slack on the winch drum 13, the rope will unwind and potentially

crossover onto an adjacent wrap and prevent proper spooling of rope on the drum. A rope tensioner 23, which is a proprietary assembly designed and manufactured by Perry Slingsby Systems Inc., Jupiter, Florida, prevents rope slack from occurring on the drum during operations. When the winch wireline or rope 18 is deployed
5 out, the tensioner 23 provides the rope tension required, preventing rope slack between the winch drum 13 and tensioner 23 at all times. This is made possible by using a hydraulic motor drive and a hydraulic circuit. When rope is deployed in by the winch 12, the tensioner 23 supplies back tension to again prevent slack.

The tensioner 23 also has sensors installed in the assembly that are used to
10 indicate the amount of rope deployed and the force applied to the rope.

The tensioner assembly 23 includes several components, as follows:

A tension wheel provides the driving force to the wireline or rope 18 to
15 prevent the rope from slipping and is used to turn the rope from the winch 12 to the vertical axis of the drill center. This is an aluminum wheel with a lining of high friction plastic material machined to the rope diameter.

An idler wheel provides a force against the tension wheel to prevent slipping
of the rope in the tension wheel. The wheel is fabricated from plastic and includes a circumferential groove cut into the wheel to match the rope. A compression
20 spring is used to apply a set tension on the rope to the tension wheel. The idler also has a sensor that is used to determine the amount of rope or cable deployed.

A hydraulic motor is mounted on the tension wheel axis and is used to drive
the tension wheel by hydraulics to pay rope out. This motor acts as a brake when the winch is paying rope in.

A load cell is mounted on the structure above the tension wheel and is used
25 to measure load on the winch wireline or rope 18.

The entire assembly is mounted in an underslung orientation to a suitable
structural member via a horizontally swiveling connection. This swiveling motion ensures that the optimum fleet angle of the rope is maintained between the
levelwind follower block rope guides and the tensioner wheel across the full range
30 of the follower block lateral travel.

Overshot/Toggle Assembly

The overshot 21 seen in Fig. 8 is part of an overshot/toggle assembly 22
seen in Fig. 2 and is a key component of the wireline drilling system described
35 herein. It is used to deploy an empty core barrel 20 into the drill string using an alignment arm 9 of an alignment/grabber assembly 30 shown in Fig. 4 and to recover full wireline core barrels 20 through the use of a release and latching mechanism. It is also used to seal off a water passage when drilling. The overshot
21 is attached to the wireline rope 18 and is housed inside a spindle 24 during
40 drilling operations. A drill head 38 is disposed atop of the spindle 24. An upper portion of the overshot 21 includes a swivel 54 seen in Fig. 9, that is used to prevent rotation of the wireline or rope 18 when the drilling spindle 24 is operated. This section also includes a shear pin that will disconnect the rope from the swivel
54 should the overshot 21 and/or core barrel 20 become stuck downhole. It is
45 important to note that the wireline or rope 18 must be removed from the drill string to allow the string to be disassembled and brought back to the surface.

The components of the overshot assembly 22 are as follows:

The swivel 54 is located at the top of the overshot 21 and prevents the
wireline or rope 18 from spinning when the spindle 24 rotates. When the rope is
50 pulled tight, the top of the swivel 54 is pulled against the spindle 24 and seals off

the spindle to allow water to be pumped through the drill string. The shear pin 26 is installed at the rope termination to allow the rope to be parted from the drill string should the overshot 21 or core barrels 20 become jammed in the drill string.

An overshot latch assembly 27 shown in Fig. 9 has fingers which latch to an inner assembly of the core barrel 20 via a separate/detachable assembly of a spear 28 and the latch assembly 27 which provides a connection interface between the core barrel 20 or tool 25 and the overshot assembly 22. Fig. 9 also shows a water seal 50, a modified top spindle cap 51, an alignment arm release collar 52 and a wave spring 53.

Drilling Spindle

The drilling spindle 24 is similar to one produced on wireline systems disclosed in co-pending U.S. Application Nos. 11/972,080 and 11/972,088, both filed January 10, 2008. The major change to this subsea drilling system is that the overshot assembly (swivel and overshot) 22 can be pulled up into the spindle 24 permitting a more compact assembly.

The wireline core barrel 20 being used is of conventional construction that includes the latch 27 at the top which latches into the outer core barrel in accordance with standard surface wireline coring system structures.

Tool Handling and Storage Assembly

A tool handling and storage assembly is mounted integrally within the wireline underwater subassembly and component housing structure. This assembly may include:

A tooling carousel, shown in Fig. 1A and described in co-pending U.S. Application 11/972,080, filed January 10, 2008.

The tooling carousel has a tooling tool rack 6, which is basically a tooling rack retaining tools and measuring devices in a vertical orientation in any number of rows or slots side by side and any number of tool holding stations per slot or row. The tool rack 6 may be movable laterally in such a way that any slot or row of tools can be positioned within the reach of tooling arms 8, 8 of an alignment/grabber assembly 30 shown in Fig. 4 for extraction or replacement of any tool into the tool rack.

A mechanism or drive to allow the tool rack 6 to be movable laterally may include, but is not limited to:

- a rack and pinion;
- hydraulic or electric rotary or linear actuators;
- a chain or belt and sprocket drive;
- a diamond shaft;
- a threaded leadscrew and nut;
- a re-circulation ball and nut; and
- a geneva wheel and pin drive.

Furthermore, this tooling tool rack 6 may be completely removable from the wireline underwater subassembly and component housing structure, either remotely or manually, during underwater operations or while the unit is above the water.

The alignment/grabber assembly 30 includes a telescopic cylinder 31 (such as a CYL X 40533), gripper fingers 32 (such as a TX 0114-7200-00), first, second and third stages 33, 34, and 35 as well as a base or fourth stage 35, as is seen in Fig. 4.

A foot clamp assembly 40 shown in Fig. 5 includes a rotation cylinder 41 (such as a CYL-X 39259), a ring bearing support 42 (such as a TX 0114-4100-00), lower and upper clamps 43, 44 and tool guides 45 (such as TX 0114-4000-25).

Description of the Operational Sequence of the improved wireline Operation:

The following description relates specifically to the wireline drilling method and operational sequence of the steps thereof. The method may be applied to operations using push sample tooling and measuring devices, with the differences being predominantly in the tooling type. The method of deployment and recovery with the wireline winch and overshot tool is basically the same.

Referring initially to Fig. 13, drilling is started with the drilling system at the seafloor or water bottom. All of the tools are installed in the tool carousel or tool rack 6 in a specific order before deploying the drill underwater. These tools may include conventional and wireline core barrels 20, tools 25, a bottom hole assembly 29, rods and bits. The cross beam 7 that carries the drilling spindle 24 as well as the wireline winch 12, the rope tensioner, the overshot 21 of the toggle/overshot assembly 22 and a saver sub 37, is deployed to its uppermost parked position. The arms 8, 9 of the grabber arm and alignment arm assemblies 30 are retracted in a parked position and the foot clamp assembly 40 is open.

The method will be described below by using the following method steps:

With reference to Fig. 13, if an upper sediment or shallow penetration sampler has been installed in the foundation stinger 11, it must first be removed and placed into the carousel or tool rack 6 using the overshot 21 to capture and retrieve the tool from the stinger 11. Otherwise, the method skips to step 2.

The overshot 21 is pulled up into the spindle 24 using the wireline winch 12. A brake on the winch 12 holds the overshot/toggle assembly 22 in the spindle 24.

The carousel or tool rack 6 is positioned to the correct location that will allow access to the first tool to be deployed. This will be the bottom hole assembly (BHA) 29.

As is seen in Fig. 14, the tool rack 6 is aligned such that the BHA 29 is opposite the grabber and alignment arms 8, 9 and both arms deploy or extend to the location of the carousel or tool rack 6 and grab on to the BHA 29.

Fig. 15 shows that both grabber and alignment arms 8, 9 pull or retract the BHA 29 through retaining fingers in the carousel or tool rack 6 and locate it at the hole centerline in line with and below the spindle 24 and saver sub 37.

According to Fig. 16, the cross beam 7 is lowered until the saver sub 37 male thread enters a female thread on the end of the BHA 29.

As is further indicated in Fig. 16, the spindle 24 screws into the BHA 29 using resistance from the upper grabber arm 8 to provide the torque to make up the joint between the saver sub 37 and the BHA 29.

Fig. 17 indicates that the grabber arms 8 are retracted into a stowage area and according to Fig. 18 the cross beam 7 lowers the BHA 29 while the spindle 24 rotates or remains static, drilling or pushing (or a combination of both motions, dependent on prevailing soil strengths) the BHA 29 into the soil to make a first hole.

In Fig. 18, drilling/coring is then continued with the BHA 29 until the maximum penetration is reached, i.e. the BHA/Spindle joint reaches a 'joint make' position just above the foot clamp 40.

Fig. 19 shows that after drilling, the BHA 29 is broken out from the spindle 24 at the saver sub 37 by holding the BHA static in the foot clamp 40 and rotating the spindle 24 to break out the joint.

As is indicated in Fig. 19, the cross beam 7 is then raised to the upper park position and the tool rack 6 is positioned to align the first core barrel 20 or tool 25 with the grabber and alignment arms 8, 9.

5 The tool rack 7 or carousel seen in Fig. 20 is positioned in such a way that an empty core barrel 20 or measuring tool 25 is positioned opposite the grabber and alignment arms 8, 9.

According to Fig. 20, the alignment and grabber arms 8, 9 select an empty wireline inner barrel 20 or tool 25 from the tool rack or carousel 6, withdraw it from the rack and position it on the centerline of the drill string above the borehole.

10 Fig. 22 shows that the overshot/toggle assembly 22 is lowered downward, by paying out wireline or rope 18 from the wireline winch 12, from the park position inside the drill spindle 24 at the top until it lands out and locates on the spear 28 on the top end of the inner barrel 20, or tool 25, with the cross beam 7 remaining static.

15 Fig. 23 shows that the winch 12 continues to lower the overshot/toggle until the overshot/toggle mechanism 22 closes and the spear assembly 28 on top of the core barrel 20, or tool 25 is latched. The cross beam 7 remains static.

20 As is seen in Fig. 24, the core barrel 20, or tool 25 is now latched via the spear 28 into the overshot 21, which is in turn connected to the wireline via the swivel 54. The winch 12 pays in to take tension on the wireline and extend the overshot/toggle mechanism 22, with the cross beam 7 remaining static.

In Fig. 25, the arms 8, 9 of the grabber and alignment assemblies 30 are now released from the core barrel 20, or tool 25 and retracted to their park positions.

25 According to Fig. 26, the core barrel 20, or tool 25 is lowered downwards via the wireline winch 12 until the lower end of the core barrel, or tool enters the bore of the BHA 29 sitting in the borehole below.

As is seen in Fig. 27, the wireline winch 12 continues to pay out wireline or rope 18 lowering the core barrel 20, or tool 25 further downwards into the BHA 29.

30 Fig. 27 also shows that as the core barrel 20, or tool 25 fully lands out in the BHA 29, the overshot/toggle assembly or mechanism 22 closes and releases the core barrel, or tool spear 28 from the overshot/toggle assembly. The core barrel, or tool is now latched into the BHA and de-latched from the overshot/toggle.

35 According to Figs. 28, 29 and 30, the wireline winch then pays in, takes wireline tension, extends the overshot/toggle assembly 22 to delatch from the spear 28 of the core barrel 20, or tool 25 and the overshot/toggle assembly is raised out of the BHA 29, hauling the overshot/toggle assembly 22 up into the upper park position in the spindle.

40 As is seen in Figs. 31-35, the tool rack 6 moves to align the drill pipe nesting opposite the arms 8, 9 of the alignment and grabber assemblies 30, the arms advance forward and select and grasp a drill pipe from the carousel or tool rack 6, position it on the hole centerline and it is mated to the top of the BHA 29 and the spindle saver sub 37 in the previously described manner by lowering the cross beam 7 and using the rotation of the spindle 24 and foot clamp 40 to make a joint
45 between the drill pipe and the saver sub. The arms 8, 9 of the alignment and grabber assemblies 30 release the drill pipe and return to the park position.

Fig. 36 shows that the first wireline rotary coring, or push sampling can now commence and the cross beam 7 is advanced downwards with the spindle 24 static or rotating until the first drill pipe 25 is stroked out, for instance at 3 m.

According to Figs. 36 and 37, drilling, coring or measurement is ceased and the overshot/toggle 22 is then deployed downwards from its upper parked position in the spindle 24 down the bore of the drill pipe 25 until it latches with the spear 28 on the upper part of the wireline core barrel inner tube or tool located in the BHA 29 and unlatches the core barrel or tool from the BHA, with the cross beam remaining static.

Fig. 38 shows that the wireline winch 12 then pays in and the core barrel 20, or tool 25 is raised and extracted from the BHA 29 and into the drill pipe, with the cross beam 7 remaining static.

As is seen in Fig. 39, the spindle is then broken out from the drill pipe at the saver sub 37 by clamping the drill pipe in the foot clamp 40 and rotating the spindle 24 to break the joint.

Fig. 39 additionally shows that the cross beam 7 is raised to the upper park position withdrawing the core barrel 20 or tool 25 from the drill string.

According to Figs. 40 and 41, the arms 8, 9 of the alignment and grabber assemblies 30 are deployed from the park position to grip the core barrel 20 or tool 25 on the hole centerline and the wireline winch 12 is operated briefly to pay out and lower the overshot/toggle mechanism 22 in such a way that the overshot closes, disengaging the overshot/toggle from the core barrel, or tool spear, with the cross beam 7 remaining static.

As is seen in Figs. 42 and 43, the winch 12 pays in so that the overshot 21 is raised to its upper park position inside the top of the drill spindle 24, with the spear 28 of the core barrel 20 or tool 25 now being fully detached from the overshot/toggle, while the cross beam 7 remains static.

In Fig. 44, the core barrel 20 or tool 25 can be placed back into the carousel or tool rack 6 by advancing the arms 8, 9 of the alignment and grabber assemblies 30. In Fig. 45, the arms of the alignment and grabber assemblies 30 release the core barrel 20 or tool 25 and return to the park position.

An empty wireline core barrel 20 or tool 25 can now be placed into the BHA assembly 29 by repeating steps 2-8 above following which an additional drill pipe may be added as per step 9 above.

The borehole is progressed in the manner described above until the target borehole depth is reached or refusal, or all drill pipes, core barrels 20 and tools 25 are used.

When the final core barrel 20 or tool 25 has been retrieved from the bottom hole assembly 29, the entire drill string can be broken down and placed back in the carousel or tool rack 6.

More specifically, with regard to steps 31-33, in Fig. 46, the cross beam 7 is lowered such that the saver sub 37 enters the drill pipe and the spindle 24 is rotated to make a joint between the saver sub and the drill pipe.

According to Fig. 47, the cross beam 7 is raised such that the joint between the drill pipe and the BHA 29 is midway in the foot clamps 40, in the joint break position, but the drill pipe is not separated from the BHA.

As is seen in Fig. 48, the cross beam 7 is raised such that the joint between the drill pipe and the BHA 29 is above the foot clamp 40 in the joint make position.

Fig. 49 shows that the cross beam 7 is raised to the height of the rack 7 while rotating the spindle 24 to fully separate the drill pipe from the BHA 29.

In Fig. 50, the arms 8, 9 of the alignment and grabber assemblies 30 are advanced to grasp a drill pipe.

Fig. 51 shows that the spindle 24 is rotated and the cross beam 7 is raised to the upper park position to fully separate the drill pipe from the saver sub 37.

Finally, according to Fig. 52, the arms 8, 9 of the alignment and grabber assemblies 30 are extended to place the drill pipe back in the rack 6.

Claims

1. A device for seabed and water bottom drilling, core sampling and measuring, the device comprising:
 - a vertically movable and horizontally fixed cross beam;
 - a winch fixed to said cross beam, said winch having a rope wound thereon;
 - a drill head disposed on said cross beam;
 - a spindle having a bore formed therein, said spindle being driven by said drill head; and
 - an overshot having one end connected to said rope and another end passing through said bore in said spindle for attachment to and detachment from a drilling tool of a drillstring;
 - said spindle, said rope and the drillstring together defining a common centerline during attachment and detachment of said overshot to and from a drilling tool and during drilling.
2. The device according to claim 1, which further comprises a swivel connected between said rope and said overshot, said overshot and said swivel configured to be pulled up into said bore in said spindle by said winch.
3. The device according to claim 1, which further comprises a lift rod connected between said rope and said overshot, said lift rod configured to be pulled into said bore in said spindle prior to commencing rotary drilling for sealing the top of said bore.
4. The device according to claim 1, which further comprises a removable tool rack, and grabber and alignment arms for delivering a drilling tool from said tool rack to a position along said common centerline for the drillstring.
5. The device according to claim 1, wherein said overshot has a latch for mating with a spear on a drilling tool.
6. The device according to claim 1, which further comprises at least one ROV/diver intervention panel.
7. The device according to claim 1, which further comprises a caisson resting on, engaging with or penetrating into the surface of the seabed or water bottom, and a stinger disposed on said caisson for receiving a sampling tool.
8. The device according to claim 4, which further comprises a foot clamp cooperating with said grabber and alignment arms for exchanging a drilling tool.
9. The device according to claim 4, which further comprises a tensioner for maintaining tension in said rope and preventing rope slack when said rope is deployed out.
10. A method for seabed and water bottom drilling, core sampling and measuring, the method comprising the following steps:
 - unwinding a rope from a winch connected to a vertically movable and horizontally fixed cross beam;
 - lowering the rope from the winch through a bore in a spindle to an overshot;

attaching the overshot to and detaching the overshot from a drilling tool of a drillstring;

rotating the drilling tool with a drill head connected to the cross beam; and
defining a common centerline of the spindle, the rope and the drillstring during attachment and detachment of the overshot to and from a drilling tool and during drilling.

11. The method according to claim 10, which further comprises connecting a swivel between the rope and the overshot, and pulling the overshot and the swivel up into the bore in the spindle with the winch for attachment and detachment of a drilling tool.

12. The method according to claim 10, which further comprises connecting a lift rod between the rope and the overshot, and pulling the lift rod into the bore in the spindle prior to commencing rotary drilling for sealing the top of the bore.

13. The method according to claim 10, which further comprises storing drilling tools in a removable tool rack, and delivering a drilling tool from the tool rack to a position along the common centerline for the drillstring with grabber and alignment arms.

14. The method according to claim 10, which further comprises mating a spear on a drilling tool with a latch on the overshot.

15. The method according to claim 10, which further comprises interfacing a remotely operated vehicle or a diver with at least one intervention panel.

16. The method according to claim 10, which further comprises placing a sampling tool into a stinger disposed on a caisson, and resting the caisson on, engaging the caisson with or penetrating the caisson into the surface of the seabed or water bottom.

17. The method according to claim 13, which further comprises exchanging a drilling tool using a foot clamp cooperating with the grabber and alignment arms.

18. The method according to claim 13, which further comprises maintaining tension in the rope and preventing rope slack when the rope is deployed out, with a tensioner cooperating with the winch.