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(54) **Gas lift kickover system**

(57) The present invention relates to a valve changing system for retrieving and installing a valve in a well, comprising a retrieving tool for taking out the valve, comprising a housing and an arm pivotably connected with the housing, said arm having a connector for connection to the valve, an installation tool for installing another valve connected with the retrieving tool forming a tool string, the installation tool comprising a housing and an arm which is pivotably connected with the housing and has a connector for connection to another valve, a driving tool connected with the installation tool and the retrieving tool for providing an axial movement in order to install or retrieve the valve, and a fibre optical cable sensor for detecting temperature and/or acoustic variations, the fibre optical cable sensor being arranged in one end of the tool string. Furthermore invention relates to a valve changing method.

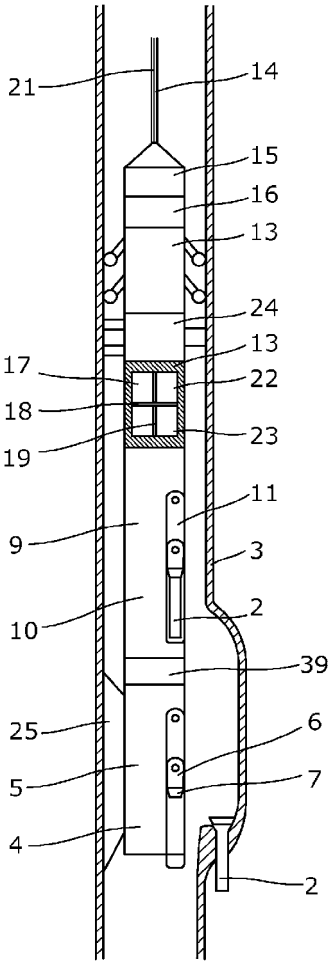

Fig. 5

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Description

Field of the Invention

[0001] The present invention relates to a valve changing system for retrieving and installing a valve in a well. Furthermore, the invention relates to a valve changing method.

Background Art

[0002] Gas lift kickover tools are used to take out a gas lift valve in a side pocket in a well and, in a next run, to put in a new gas lift valve. Gas lift valves are arranged in a side pocket in the production casing for letting gas into the casing from the annulus surrounding the casing which is filled with gas. The gas lift valves are, together with the casing, part of the primary barrier in a well and it is therefore extremely important that a gas lift valve is not leaking as pressure is then built up in the annulus. If pressure builds up in the annulus due to a leaking valve or if the production decreases, the valve is changed. After having changed a gas lift valve, a new valve is installed in a next run and the well is tested by taking off the pressure in the annulus to verify that the valve is mounted correctly and functions as intended. If the pressure in the annulus does not increase, the valve does not leak and the primary barrier is maintained. The process of taking off the pressure and pressurising the annulus again lasts around three days in which the well is not producing. Thus, the changing of a gas lift valve is performed in two runs if the operation is successful on the first attempt and subsequently, the well is out of production for at least three days to be tested. When intervening a well to change a gas lift, the well is not producing, and the sooner the operation is completed, the sooner production can be resumed.

Summary of the Invention

[0003] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved system for changing gas lift valves which is capable of changing a gas lift valve and verify the valves in less time than the known systems.

[0004] The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a valve changing system for retrieving and installing a valve in a well, comprising:

- a retrieving tool for taking out the valve, comprising a housing and an arm pivotably connected with the housing, said arm having a connector for connection to the valve,
- an installation tool for installing another valve connected with the retrieving tool forming a tool string, the installation tool comprising a housing and an arm which is pivotably connected with the housing and has a connector for connection to another valve,
- a driving tool connected with the installation tool and the retrieving tool for providing an axial movement in order to install or retrieve the valve, and
- a fibre optical cable sensor for detecting temperature and/or acoustic variations, the fibre optical cable sensor being arranged in one end of the tool string.

[0005] By having a system comprising both a retrieval and installation tool, replacing of a valve can be performed in one run. Furthermore, by having a fibre optical cable sensor, testing of the well can be made in the same run by submerging the system into the well so that the fibre optical cable sensor is arranged outside the valves and all the valves can be tested without having to decrease the pressure in the annulus. A replacement operation can then be performed in half a day instead of in three days.

[0006] When having a fibre optical cable sensor to test the valves, also horizontal wells having valves can easily be tested.

[0007] The valve changing system according to the present invention may further comprise a tool connection for connecting the retrieving tool with the installation tool.

[0008] In one embodiment, the driving tool may be a stroking tool comprising a motor and a pump driven by the motor, the pump pumping fluid into a piston chamber in the stroking tool moving a piston connected with a piston shaft, said shaft being connected with the retrieving tool or installation tool for transferring the axial movement.

[0009] Moreover, the driving tool may be a downhole tractor, said driving tool also being capable of driving the system forward in the well.

[0010] Also, the driving tool may comprise wheels arranged on a wheel arm and may have an electrical motor driving a pump which drives the wheel to moving the system forward in the well.

[0011] Further, the driving tool may comprise an electrical power device to power the tools.

[0012] The valve changing system as described above may further comprise a wireline for powering the tools.

[0013] Additionally, the fibre optical cable sensor may be part of a wireline, an e-line or a slickline connected to the tool string in order to retrieve the tool string.

[0014] Furthermore, the fibre optical cable sensor may be a distribution temperature sensor and/or a distribution acoustic sensor.

[0015] In one embodiment, the piston may divide the piston chamber of the stroking tool into a first chamber part and a second chamber part, and the pump may pump fluid into the first chamber part and suck fluid out of the second chamber part.

[0016] Also, the stroking tool may comprise several pistons, each piston being arranged in a piston chamber.

[0017] The valve changing system according to the present invention may further comprise an anchoring section.

[0018] Said valve changing system may comprise sensors arranged to detect if the arm is in its retracted or extending position.

[0019] Furthermore, the present invention relates to a valve changing method comprising the steps of:

- entering the valve changing system according to the present invention,
- moving the valve changing system to a position in which the retrieving tool is opposite at least one valve in the well,
- retrieving the valve by means of the retrieving tool,
- moving the valve changing system so that the installation tool is in the position,
- installing another valve by means of the installation tool,
- moving the valve changing system so that the fibre optical cable sensor passes the installed valve,
- detecting temperature and/or acoustic variations opposite the at least one valve by means of the fibre optical cable sensor.

[0020] Also, the present invention relates to a valve changing method for changing a valve in a well, comprising the steps of:

- entering the valve changing system according to the present invention,
- moving the valve changing system so that the fibre optical cable sensor passes a plurality of valves in order to detect which valve is defect,
- moving the valve changing system to a position so that the retrieving tool is opposite the defect valve,
- retrieving the defect valve by means of the retrieving tool,
- moving the valve changing system so that the installation tool is in the position,
- installing another valve by means of the installation tool,
- moving the valve changing system so that the fibre optical cable sensor passes the installed valve,
- detecting temperature and/or acoustic variations opposite the at least one valve by means of the fibre optical cable sensor.

[0021] In addition, the valve changing method as described above may further comprise the step of adjusting the installed valve to be more open or closed.

[0022] Moreover, the valve changing method as described above may further comprise the step of closing the well while conducting an acoustic detection by means of the fibre optical cable sensor.

Brief Description of the Drawings

[0023] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a valve changing system in a casing in a well,

Fig. 2 shows another valve changing system in a casing in a well,

Figs. 3A-D show a retrieving tool retrieving a valve,

Figs. 3E-H show an installation tool installing another valve,

Fig. 4 shows a cross-sectional view of a wireline comprising a fibre optical cable sensor, and

Fig. 5 shows another embodiment of the valve changing system.

[0024] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0025] Fig. 1 shows a valve changing system 1 for retrieving a valve 2 in a well 3 and installing another valve. The valve changing system 1 comprises a retrieving tool 4 for taking out the valve and an installation tool 9 for installing another valve. The installation tool 9 is connected with the retrieving tool forming a tool string 8. The tool string 8 is connected with a driving tool 13 for providing an axial movement in order to install or retrieve the valve. The valve changing system 1 further comprises a fibre optical cable sensor 14 for detecting temperature and/or acoustic variations. The fibre optical cable sensor is arranged in one end of the tool string closest to the top of the well so that when the tools are moved forward in the well, the fibre optical cable sensor can test the valves in the well. This end of the tool string comprises an electrical power device 20 powering a motor 15 which drives a pump 16. The pump 16 is part of the driving tool 13 providing the axial movement of the retrieving tool and the installation tool.

[0026] The retrieving tool comprises a housing 5 and an arm 6 pivotably connected with the housing. The arm has a connector 7 for connecting to the valve to be retrieved. The installation tool 9 also comprises a housing 10 and an arm 11 pivotably connected with the housing, and the arm has a connector 12 for connection to the new valve. The arms comprises two arm parts pivotably

connected so that the first arm part is connected to the housing 10 and the second arm part is connected to the valve 2. Both the retrieving tool and the installation tool are a kind of kickover tool. The installation tool has a tool connection 39 arranged in an end opposite the driving tool transferring the axial movement of the driving tool to the retrieving tool so that only one driving tool is needed. If the retrieving tool is arranged closest to the driving tool, the retrieving tool has a tool connection arranged in an end opposite the driving tool transferring the axial movement of the driving tool to the installation tool.

[0027] The tool connection 39 comprises a cylindrical tube having an internal thread corresponding to external threads of the retrieving and installation tools, or the tool connection 39 comprises latches hooking onto a corresponding groove or corresponding grooves in the retrieving and installation tools.

[0028] In Fig. 1, the driving tool is a downhole tractor which is also capable of driving the system forward in the well. Hereby, the valves in a horizontal part of the well can be tested in the same runs as the valves in the vertical part of the well. The driving tool comprises wheels arranged on a wheel arm and has an electrical motor 15 driving a pump 16 which drives the wheel to moving the system forward in the well. The wheels thus provide the axial movement needed for retrieving or installing a valve. The arm of the retrieving and installation tool is extending when a latch of the tool hooks onto a trail 25 or groove in the vicinity of the valve and is thus pulled back again by means of the trail 25.

[0029] In Fig. 2, the driving tool is a stroking tool which comprises a motor 15 and a pump 16 driven by the motor. The pump pumps fluid into a piston chamber 17 in the stroking tool moving a piston 18 connected with a piston shaft 19, the shaft being connected with the retrieving tool or installation tool for transferring the axial movement. In order to transfer the axial movement to the retrieving or installation tool, the valve changing system 1 comprises an anchoring section 24 which is activated by the pump before providing the stroking movement.

[0030] The piston 18 divides the piston chamber of the stroking tool into a first chamber part 22 and a second chamber part 23, and the pump pumps fluid into the first chamber part and sucks fluid out of the second chamber part. In another embodiment, the stroking tool comprises several pistons, each piston being arranged in a piston chamber 17 providing greater axial force than one piston as the pump pumps fluid into every first chamber parts to apply pressure on the piston from one side and to pull from the other side by pumping fluid out of the second chamber part. In order to pull the retrieving or installation tool back, the pump pumps fluid into the second chamber parts and pumps fluid out of the first chamber parts.

[0031] The fibre optical cable sensor is a distribution temperature sensor and/or a distribution acoustic sensor. The valve changing system is moved back and forth in the well so that the fibre optical cable sensor is located opposite each of the valves in order to detect which valve is leaking or stuck.

[0032] In Fig. 4, the fibre optical cable sensor is part of a wireline, e-line or slickline connected to the tool string 8 in order to retrieve the tool string. The wires 26 are arranged on the outside and the optical fibre 14 on the inside. The wireline may also comprise electrical cables 27 as illustrated in Fig. 4.

[0033] In Fig. 5, the valve changing system 1 has the retrieving tool 4, the installation tool 9, the fibre optical cable sensor 14 and two driving tools 13 in the form of a stroking tool and a downhole tractor. The stroking tool provides the axial force to replace the valve and the downhole tractor drives the valve changing system 1 back and forth in the well so as to move the valve changing system 1 into a specific position to perform a certain operation.

[0034] The valve changing system 1 is thus used to determine if a valve needs to be replaced or which valve needs to be replaced, to replace the valve and verify that the valve has been correctly installed and functions as intended.

[0035] If the well only has one gas lift valve and the production is not running, the valve changing system is entered into the well and the valve changing system is moved to a position in which the retrieving tool is opposite at least one valve in the well. Subsequently, the valve is retrieved by means of the retrieving tool, and the valve changing system is moved so that the installation tool is in the position outside the opening in which the valve is to be installed and the installation tool installs another valve by means of the installation tool, and then the valve changing system is moved backwards so that the fibre optical cable sensor passes the installed valve and detects the temperature and/or acoustic variations opposite the at least one valve by means of the fibre optical cable sensor. If the valve is functioning perfectly, the valve changing system is pulled out of the well.

[0036] If e.g. a dummy valve is leaking and the well has been closed, the fibre optical cable sensor is able to detect the flow around the valve by means of acoustic sensing. When the gas lift valve is functioning, the fibre optical cable sensor is able to detect the gas flowing in by means of acoustic sensing. Temperature sensing is another way of detecting flow as the temperature will change locally. When having several valves in the well, the defect valve needs to be located. After lowering the system into the well, the valve changing system is moved so that the fibre optical cable sensor passes a plurality of valves in order to detect which valve is defect, and then the valve changing system is moved to a position so that the retrieving tool is opposite the defect valve, the defect valve is retrieved by means of the retrieving tool, and then the valve changing system is moved again so that the installation tool is in the position, and another valve is installed by means of the installation tool. Subsequently, the valve changing system is moved back and forth so that the fibre optical cable sensor passes the installed valve and detects any temperature and/or

acoustic variations opposite the at least one valve by means of the fibre optical cable sensor. By having such system, the detection of which valve to replace, the replacement operation and the verification step can be performed in one run instead of in many runs as is the case when using prior art tools.

[0037] In Fig. 3A, the retrieving tool 4 is arranged opposite the valve 2 to be replaced. In Fig. 3B, the arm 6 of the retrieving tool 4 is in its extended position, ready to be subjected to an axial movement from the driving tool 13 to engage the valve 2 by the connector of the arm 6. In Fig. 3C, the retrieving tool 4 has been subjected to the axial movement and the arm 6 is connected to the valve 2, ready for retrieval. In Fig. 3D, the retrieving tool 4 is retrieving the valve 2 and the retrieving tool 4 is moved further down the well so that the installation tool 9 is arranged in the position opposite the opening 40 in which the valve is to be installed. In Fig. 3E, the arm 11 of the installation tool 9 is extended and the valve is arranged outside the opening 40 into which the valve is to be inserted. In Fig. 3G, the valve is in its inserted position and in Fig. 3H, the installation tool 9 is pulled back in order to retract the arm 11. Subsequently, the tool string 8 is moved forward in the well so that the fibre optic cable sensor is arranged outside the valves to verify that the valve has been installed correctly and is working as intended and that it was in fact that valve that needed to be changed in order to solve the problem.

[0038] The system may further comprise an adjustment device for adjusting the installed valve to be more open or closed. In order determine if the valve is leaking, the well may be closed while conducting an acoustic detection by means of the fibre optical cable sensor.

[0039] By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid, etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

[0040] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0041] In the event that the tool is not submergible all the way into the casing, a downhole tractor can be used to push the tool all the way into position in the well. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0042] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. A valve changing system (1) for retrieving and installing a valve (2) in a well (3), comprising:

   - a retrieving tool (4) for taking out the valve, comprising a housing (5) and an arm (6) pivotably connected with the housing, said arm having a connector (7) for connection to the valve,
   - an installation tool (9) for installing another valve connected with the retrieving tool forming a tool string (8), the installation tool comprising a housing (10) and an arm (11) which is pivotably connected with the housing and has a connector (12) for connection to another valve,
   - a driving tool (13) connected with the installation tool and the retrieving tool for providing an axial movement in order to install or retrieve the valve, and
   - a fibre optical cable sensor (14) for detecting temperature and/or acoustic variations, the fibre optical cable sensor being arranged in one end of the tool string.

2. A valve changing system according to claim 1, wherein the driving tool is a stroking tool comprising a motor (15) and a pump (16) driven by the motor, the pump pumping fluid into a piston chamber (17) in the stroking tool moving a piston (18) connected with a piston shaft (19), said shaft being connected with the retrieving tool or installation tool for transferring the axial movement.

3. A valve changing system according to claim 1 or 2, wherein the driving tool is a downhole tractor, said driving tool also being capable of driving the system forward in the well.

4. A valve changing system according to claim 3, wherein the driving tool comprises wheels arranged on a wheel arm and has an electrical motor (15) driving a pump (16) which drives the wheel to moving the system forward in the well.

5. A valve changing system according to any of the proceeding claims, wherein the driving tool comprises an electrical power device (20) to power the tools.

6. A valve changing system according to any of claims 1-4, further comprising a wireline (21) for powering the tools.

7. A valve changing system according to any of the preceding claims, wherein the fibre optical cable sensor is part of a wireline, an e-line or a slickline connected to the tool string in order to retrieve the tool string.

8. A valve changing system according to claim 7, wherein the fibre optical cable sensor is a distribution temperature sensor and/or a distribution acoustic sensor.

9. A valve changing system according to any of the preceding claims, wherein the piston divides the piston chamber of the stroking tool into a first chamber part (22) and a second chamber part (23), and the pump pumps fluid into the first chamber part and sucks fluid out of the second chamber part.

10. A valve changing system according to any of the preceding claims, wherein the stroking tool comprises several pistons, each piston being arranged in a piston chamber.

11. A valve changing system according to any of the preceding claims, further comprising an anchoring section (24).

12. A valve changing method comprising the steps of:

- entering the valve changing system according to any of claims 1-11,
- moving the valve changing system to a position in which the retrieving tool is opposite at least one valve in the well,
- retrieving the valve by means of the retrieving tool,
- moving the valve changing system so that the installation tool is in the position,
- installing another valve by means of the installation tool,
- moving the valve changing system so that the fibre optical cable sensor passes the installed valve,
- detecting temperature and/or acoustic variations opposite the at least one valve by means of the fibre optical cable sensor.

13. A valve changing method for changing a valve in a well, comprising the steps of:

- entering the valve changing system according to any of claims 1-11,
- moving the valve changing system so that the fibre optical cable sensor passes a plurality of valves in order to detect which valve is defect,
- moving the valve changing system to a position so that the retrieving tool is opposite the defect valve,
- retrieving the defect valve by means of the retrieving tool,
- moving the valve changing system so that the installation tool is in the position,
- installing another valve by means of the installation tool,
- moving the valve changing system so that the fibre optical cable sensor passes the installed valve,
- detecting temperature and/or acoustic variations opposite the at least one valve by means of the fibre optical cable sensor.

14. A valve changing method according to claim 12 or 13, further comprising the step of adjusting the installed valve to be more open or closed.

15. A valve changing method according to any of claims 12-14, further comprising the step of closing the well while conducting an acoustic detection by means of the fibre optical cable sensor.

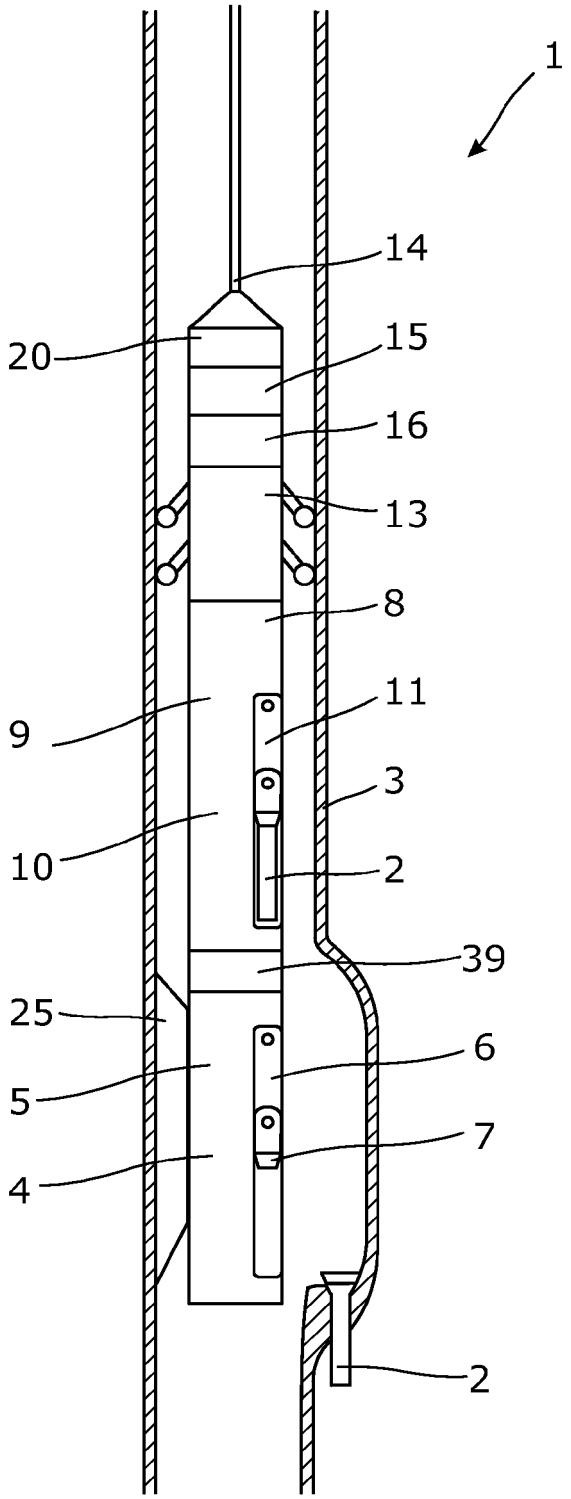

Fig. 1

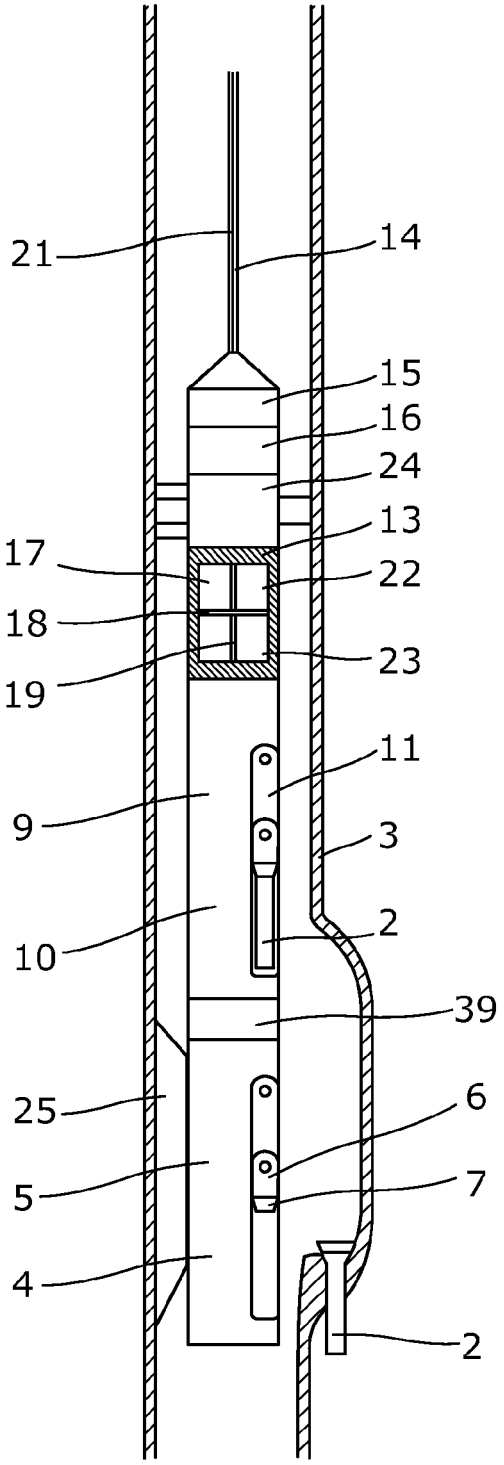

Fig. 2

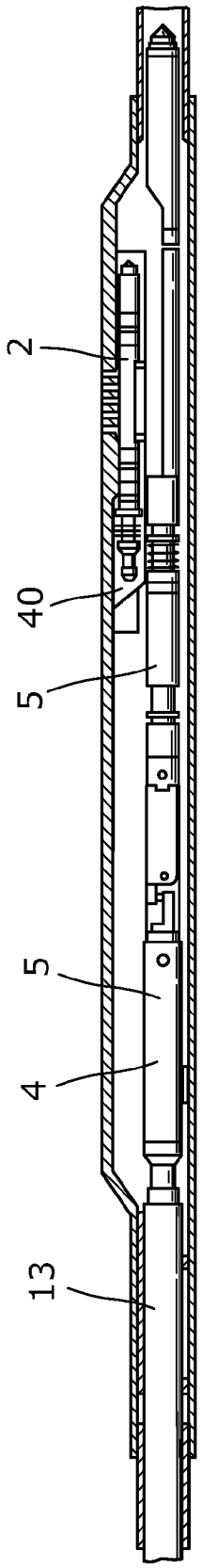

Fig. 3A

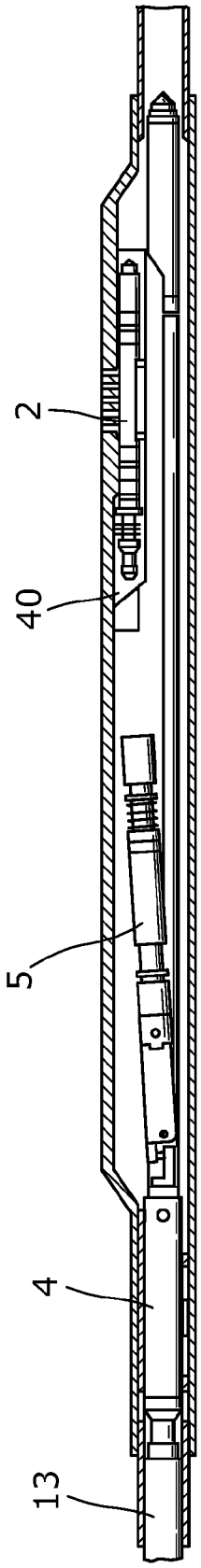

Fig. 3B

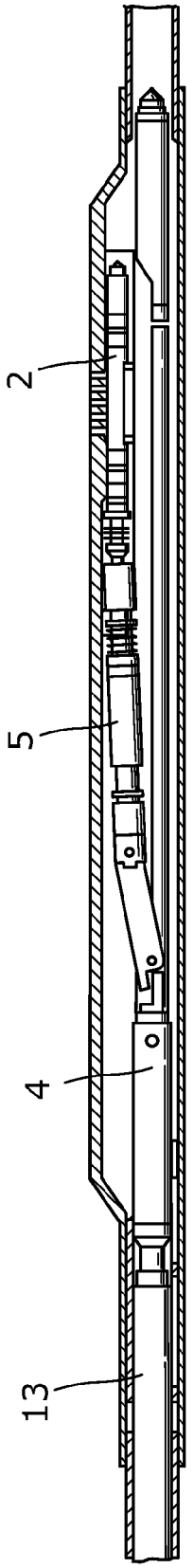

Fig. 3C

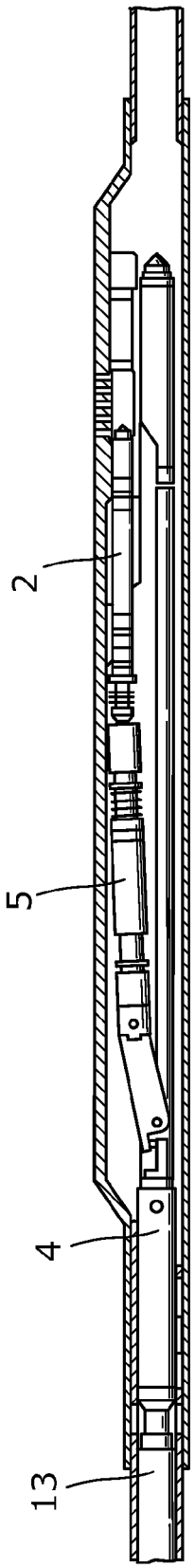

Fig. 3D

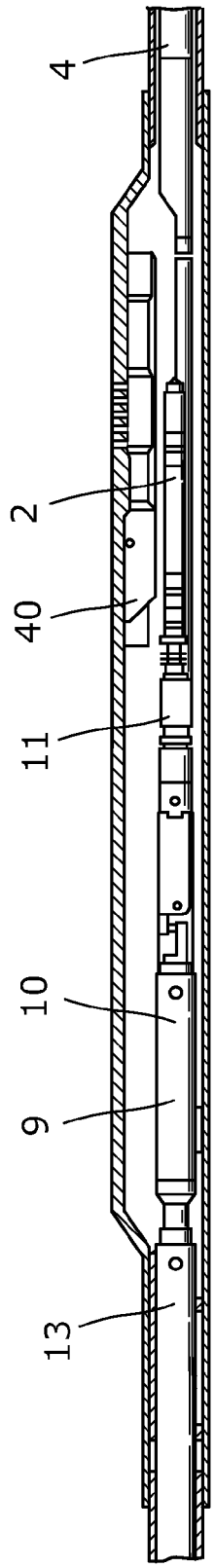

Fig. 3E

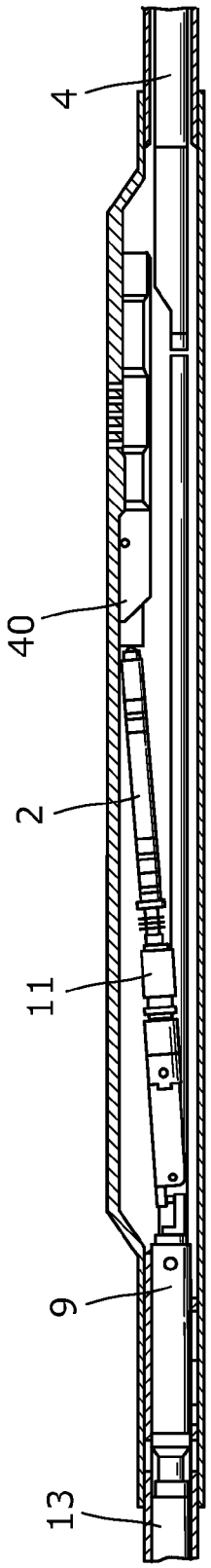

Fig. 3F

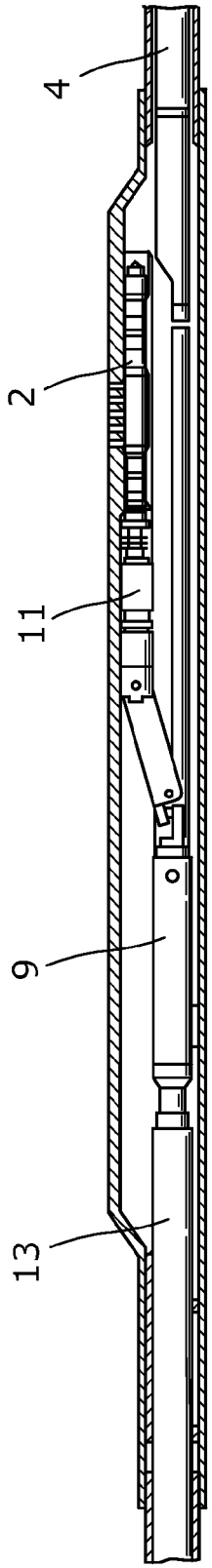

Fig. 3G

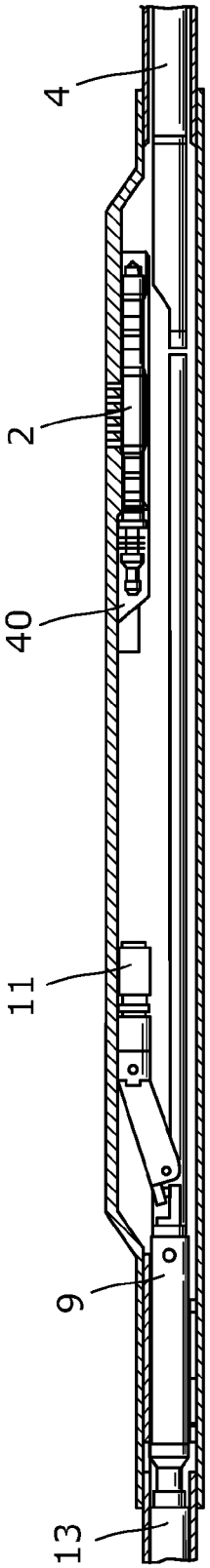

Fig. 3H

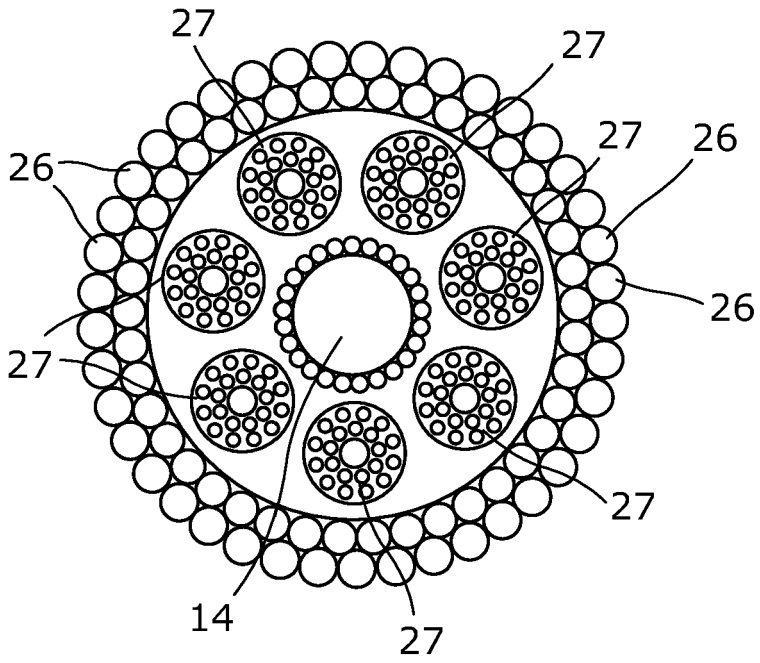

Fig. 4

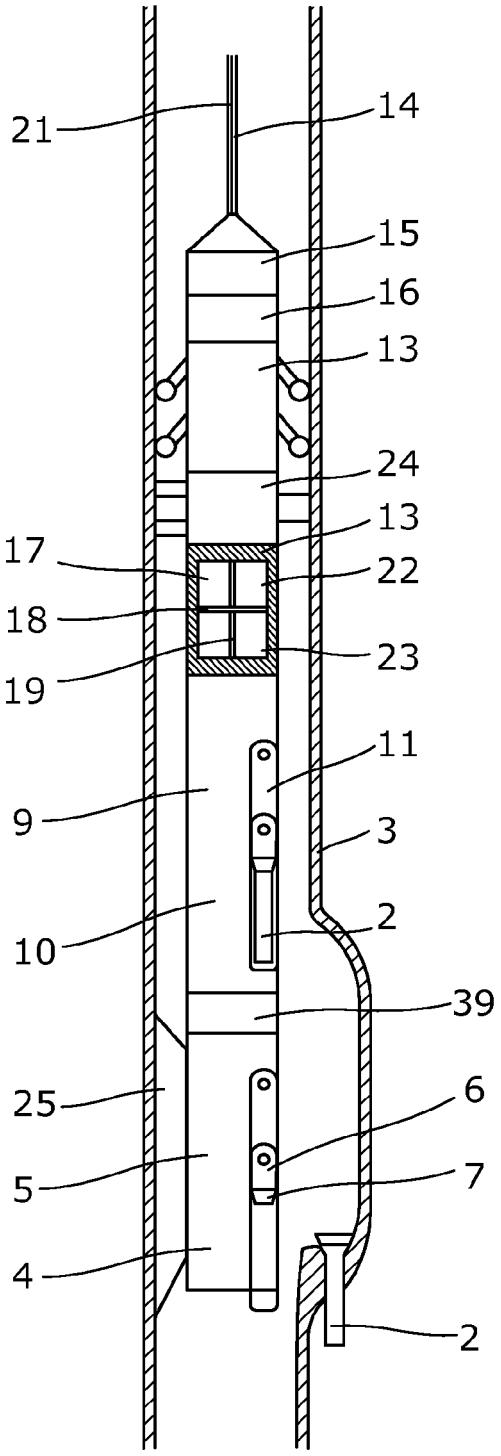

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 2157

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2011/071391 A2 (PETROLEUM TECHNOLOGY COMPANY AS [NO]; KLEPPA ERLING [NO]; PETTERSEN ST) 16 June 2011 (2011-06-16) * page 5, line 4 - line 13; claim 1 *	1-15	INV. E21B23/03 E21B43/12 E21B47/10 E21B47/12
Y	WO 2007/003445 A1 (HEAD PHILIP [GB]) 11 January 2007 (2007-01-11) * page 3, line 18 - page 4, line 2 * * page 10, line 6 - line 29; figures 6-13 *	1-15	
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A	GB 2 438 202 A (SCHLUMBERGER HOLDINGS [VG]) 21 November 2007 (2007-11-21) * page 7, line 11 - line 13 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 December 2011	Ott, Stéphane

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 17 2157

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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