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(54) DEVICE AND METHOD FOR ISOLATING A SECTION OF A WELLBORE

VORRICHTUNG UND VERFAHREN ZUM ISOLIEREN EINES ABSCHNITTS EINES BOHRLOCHS
DISPOSITIF ET PROCÉDÉ POUR ISOLER UNE SECTION D'UN FORAGE

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Description

[0001] This invention regards a device and a method for installation, setting and/or operation of a tool string in a well. In particular, the present invention regards a device and a method for isolating a section of a wellbore, the device including a straddle packer and associated systems for selectively setting of at least one upper packer element, at least one lower packer element and at least one anchoring device of the straddle packer.

Background

[0002] Straddle packers are commonly used for zone isolation in wells related to the production of hydrocarbons. Typically, straddle packers are utilised to shut off unwanted production, such as water or in some cases gas, that originates from reservoir zones in an upper or middle section of the wells producing interval, so that fluids, such as oil, from lower lying intervals still can be produced. Straddle packers as long as 50-100 meters and more have in some cases been required to shut off unwanted production.

[0003] Publication US 6,883,610 discloses straddle packer systems and methods of using them for downhole isolation of zones for fracturing treatment, the system including upper and lower seal systems having resiliently flexible sealing elements hydraulically and operatively connected to one another which are responsive to an increase in hydraulic pressure for setting the sealing elements at a first hydraulic pressure threshold.

[0004] Prior art subsea well service operations (Riserless Well Intervention - RLWI) applies tailor made well service vessels and equipment, such as subsea lubricators, in order to service subsea wells in an increasingly more cost effective manner. However, due to a lack of proper technology, such methods for subsea well service still suffer from distinctive restrictions related to types of operations that can be performed. In particular, this applies for operations involving long and bulky well intervention tool strings. As a consequence, the task of getting long straddle packers into a subsea well by means of a RLWI operation is a major challenge.

[0005] Norwegian patent application NO 20051257, owned by the applicant of the present application, discloses a method for intervening subsea wells with very long toolstrings in conjunction with RLWI operations, and is included herein by reference.

[0006] In relation to the invention according to the present application, the invention disclosed in NO 20051257 would in some cases of straddle packer installation be insufficient due to the following:

[0007] In general, regarding straddle packers, it is for the very most desirable to have a large outer diameter (OD).

- This may relate to production issues;

○ It is desirable to have as big an inner diameter (ID) of the straddle packer as possible in order to avoid choking of the production fluids that are going to be produced through the straddle packer subsequent to installation. To obtain a big ID, the OD must be accordingly large.

- It may relate to requirements for subsequent operations/service;

○ If the inner diameter (ID) of the straddle packer becomes too small, subsequent intervention could become problematic, as tools with a certain size and shape might not be able to be intervened through the straddle packer.

- It may be related to technical issues with respect to the actual performance of the straddle packer after installation;

○ If the OD of the straddle packer can be made sufficiently large, this entails that the required radial expansion of the packer elements (to form a seal towards the wellbore) will be reduced compared to a smaller OD straddle packer. This is beneficial for many reasons. First, the pressure rating will be higher for these "low expansion" packers as little "free packer element" is exposed in the annulus between the straddle packer metal body and the inner diameter of the wellbore (tubing/liner/ casing) that the straddle packer is installed in. Secondly, low expansion systems are less expensive and more reliable than high expansion systems. Finally, high expansion systems entail a smaller ID of the straddle packer, as increased wall thickness is required to provide required radial metallic support for the high expansion packer element and/or anchors.

[0008] As a conclusion of the above bullet point list, large OD straddle packers are generally preferred over smaller OD, high expansion straddle packer systems.

[0009] One main challenge with the above seen in relation to application NO 20051257 is that the requirements for a straddle packer with a large outer diameter could conflict with the requirements for a "flush pipe" of the application NO 20051257. As the flush pipe would have to be made with an OD smaller than the ID of the tubing in the well below the wellhead, the ID of the flush pipe would be accordingly smaller than the ID of the tubing. Hence, should a flush pipe be utilised for deploying a long straddle packer into a subsea well, this could entail requirements to the packer elements being of a small OD, high-expansion type, which is undesirable according to the argumentation above.

[0010] In order to overcome this specific challenge, it is described in application NO 20051257 that the outer

body of the straddle packer itself could fulfil the same function as the flush pipe when lubricating the tool string into the well. This would solve one problem, but raise another:

- It is known to those skilled in the art that a straddle packer is normally set by means of a setting tool, of similar length as the straddle packer itself.
- A setting tool commonly includes a top section (including the power module), a central, tube shaped steel rod running all the way from the setting tool to a point under the lowermost packer element of the straddle, and a collapsible mandrel in the bottom.
- Often, such setting tools have a resulting bulky, uneven shape that can not be deployed out through a dynamic seal without a flush tube (ref application NO 20051257).
- Hence, the issue of bringing a traditional setting tool out of the well after setting a straddle packer could represent a major challenge in relation to the invention of application NO 20051257, and the main reason is that without any flush pipe according to the general idea of the application NO 20051257, it would be impossible to lubricate an unevenly shaped tool (i.e. the setting tool in this case) out of the well.

[0011] Thus, it is an object of the present invention to provide an arrangement and a method for deploying, operating and/or installing a range of "challenging" objects, such as long objects with large outer diameter, such as a straddle packer, in a subsea well.

[0012] Further, it is an object of the present invention to provide an arrangement and a method for deploying, operating and/or installing a range of "challenging" objects, such as long objects with large outer diameter, such as a straddle packer, in wells in general.

[0013] Publication US 6,257,338 B1 discloses a device for isolating a section section of a wellbore, the device including a straddle packer and a setting tool for selectively setting of at least one upper packer element and at least one lower packer element, wherein the setting tool includes at least one setting element for setting the at least one lower packer element.

Existing methods

[0014] In cases where the rig-up height above the well-head is sufficient, as would be the case on some platforms, land wells and offshore drilling rig operations involving a riser, the entire straddle packer with setting tool could be assembled, intervened and installed in one run. Based on the relevant technique applied for assembling the straddle packer and the setting tool, assembly operations may become awkward due to a need for assembling sections of a setting tool centre rod inside equivalent

sections of the straddle packer body (i.e. assembling of threaded rod inside threaded pipe). Hence, the risk of loosening components into the well during rigging as well as the time required to assemble the straddle packer can become significant.

[0015] Further, it is known that longitudinal expansion of the centre rod during operation of the setting tool might impair the setting operation itself. Hence, longitudinal expansion of the centre rod (due to the setting force applied by the setting tool power chamber) may come in conflict with the requirement for the setting tool to provide a certain distance of compression/ stroke of the straddle packer in order to set this. In summary, there are numerous reasons why straddle packer setting tools of present, comprising a long centre rod, may impose negative aspects to the straddle packer setting operation.

[0016] In other cases, comprising wells where there are limitations in how long lengths of tool that can be intervened in one run, existing means for bringing long straddle packers into the well involve splitting the relevant straddle packer into numerous sections and installing each section in a run of its own, splicing them together downhole by means of so-called stinger subs. In particular, such methods would apply for subsea well servicing (RLWI operations) where lubricator space is limited. Such operations often become very time consuming and expensive.

[0017] For a subsea well operation, splitting a straddle packer into separate parts would entail numerous runs in the hole to install the straddle packer. This means additional time and cost related to the operation. Costs for this sort of operation could easily become substantial, possibly to the extent that such operation is deemed non-economical. Hence, important remedial work in the wells may be omitted due to the said cost considerations.

[0018] Thus, there is a need for improved setting tool designs for straddle packers and other similar well servicing tools that make them shorter and easier to assemble and operate.

[0019] In the light of this, the potential for economic savings represented by the invention is significant.

The object of the invention

[0020] The object of the invention is to provide a novel and alternative system and method for installing and operating long and bulky well servicing tools such as straddle packers in subsea wells as well as other relevant well cases.

[0021] One main feature of the invention, related to straddle packers, is the removal of the need for a setting tool of similar length as the straddle packer. The proposed way to achieve this is to provide for an autonomous setting of one or multiple components, such as the lower packer element and anchor. In a preferred embodiment, such autonomous setting is operator controlled by means of a wireless signal sent to activate the actual components at the determined time for installation.

[0022] Despite this text mainly describes inventive features that mostly relates to straddle packers, it is obvious to a person skilled in the art that a similar system and method philosophy could be applied for other cases where autonomous equipment/component control and operation in a wellbore would provide improvements.

The invention

[0023] In a first aspect the present invention regards a device for isolating a section of a wellbore, the device including a straddle packer and associated systems for selectively setting of at least one upper packer element, at least one lower packer element and at least one anchoring device of the straddle packer, the at least one setting element of the straddle packer is operated independent from other setting elements.

[0024] As mentioned, common, known prior art setting tools for straddle packers involve components such as a top section (where the power module normally is located), a centre rod and a bottom collapsible mandrel initially being held expanded and in place by means of a shear pin arrangement. When setting a straddle packer by means of prior art setting tools, the top section and the bottom mandrel are forced towards each other by means of the centre rod, powered by a pyrotechnical charge, an electric pump, wellbore pressure, pressurised gas chambers or similar. Once the required force is applied in order to set anchor(s) and packer elements, the shear pin arrangement of the bottom mandrel shears, whereupon the mandrel collapses and becomes retrievable through the straddle packer body. Because of this arrangement with the mandrel and feed-trough/centre rod, the setting tool has to be made of similar length as the straddle packer itself.

[0025] Due to the novel setting device/system and method according to a preferred embodiment of the present invention utilizing communication means, the need for setting tool parts such as a feed-trough rod and collapsible mandrel are at least partly eliminated from the straddle packer setting tool.

[0026] In a preferred embodiment the communication means includes means for transmitting and receiving wireless signals for controlling the setting element of the straddle packer. In one embodiment the wireless communications means includes at least one transmitter and at least one receiver and/or at least one transceiver.

[0027] In alternative embodiments of the invention, the communication means associated with the activation of straddle packer element(s) and/or anchor(s) could be direct means such as electrical, fiberoptic or hydraulic connections. Further, said means for activation could also comprise sensors monitoring changes or desired set-values of wellbore parameters. The latter could as an example be a pressure or temperature sensor, associated with a timer device that trigger element/anchor activation at a predetermined time after a sensor reading a defined set-value.

[0028] One of the most typical applications would be the installation of straddle packers in subsea wells, but could also be the case of setting straddle packers, or other tools, in other types of wells, in order to save cost, time, overcome rigging constraints and similar.

[0029] In one embodiment of the invention, pulling tools intended for the retrieval of a straddle packer could be provided with similar transmitter systems as the setting tool described above, and straddle packers provided with a second receiver and activation system to facilitate retrieval of the packer in a similar fashion and philosophy as for the setting process.

[0030] In one embodiment the axial length of the setting tool is less than the axial length of the straddle packer. The axial length of the setting tool is in one embodiment less than three quarter of the axial length of the straddle packer. In another embodiment the axial length of the setting tool is less than one half of the axial length of the straddle packer. In still another embodiment the axial length of the setting tool is less than one quarter of the axial length of the straddle packer.

[0031] In one embodiment at least one separate setting element is integrated in a portion of a tubular body of the straddle packer.

[0032] In a second aspect of the present invention there is provided a method for isolating a section of a wellbore, the method including setting a straddle packer using a system for selectively setting of at least one upper packer element, at least one lower packer element and at least one anchoring device of the straddle packer, wherein the method comprising operating at least one setting element of the setting tool independent from other setting elements.

[0033] The invention will now be described in more detail by means of the attached figures. Do note that despite the fact that the figures illustrate one particular application and technique in order to deploy, intervene and install a long straddle packer in a subsea well by means of RLWI techniques (subsea wireline from a vessel without riser to the surface), this does not indicate any restrictions to the invention. A person skilled in the art would be able to identify variable ways of performing steps of the operation described in the figures as well as transfer the system and method principles to other applications of similar nature.

[0034] It is also imaginable a device for operating elements such as valves, barrier elements and actuators related to wellbore tooling, the device including systems for selectively operating at least one of said valves, barrier elements and/or actuators, wherein at least one system element can be operated independent from other system elements.

[0035] It is further imaginable a method for operating elements such as valves, barrier element and actuators related to wellbore tooling, the device including systems for selectively operating at least one of said valves, barrier elements and/or actuators, wherein at least one system element being operated independent from other sys-

tem elements.

[0036] Hereinafter, non-limiting examples of preferred embodiments are described and visualized in the accompanying drawings, in which:

- Figure 1a illustrates schematically a portion of a prior art straddle packer.
- Figure 1b illustrates schematically a portion of a straddle packer according to a preferred embodiment of the invention.
- Figure 2 illustrates schematically and in a larger scale a bottom setting element of the straddle packer according to one embodiment of the present invention.
- Figure 3a and 3b illustrates each, in a smaller scale, a system module utilized in a preferred embodiment for intervening a long straddle packer in a subsea well.
- Figure 4 illustrates in a smaller scale an initial stage of an intervention process, when lowering a long straddle packer through the open sea.
- Figure 5 illustrates in substantially the same scale as in figures 3a and 3b, a first step of system deployment, i.e. bringing the straddle packer from the marine environment into the pressurised well environment.
- Figure 6 illustrates a second step of system deployment
- Figure 7 illustrates a third step of system deployment.
- Figure 8a and 8b illustrates system installation in the downhole part of the well.
- Figure 9 illustrates an installed straddle packer in a producing well.
- Figure 10 illustrates retrieving the main part of the setting tool for a preferred embodiment of the invention from the well.

[0037] In the figures the same or similar components are designated with the same reference numerals.

[0038] Figure 1a and 1b illustrate in a schematic manner an overall system according to prior art and according

to a preferred embodiment of the invention, respectively, in order to facilitate the description of innovative aspects. Both figures 1a and 1b describes a straddle packer 1 (reference numeral 1' for the prior art straddle packer), provided with a top packer element 2, a bottom packer element 3 and an anchor 4. Other elements known to be associated with straddle packers, such as additional anchoring modules and/or expansion joints are not shown in Figures 1a and 1b, but a person skilled in the art would easily recognise that such modules as well as other system modules as *per se* could be included in a preferred embodiment of the invention. The straddle packers 1 and 1' in Figures 1a and 1b are both prepared for setting.

[0039] In the embodiment of the novel art straddle packer 1 in figure 1b, an as *per se* setting tool 100 comprises the top section 5, a collapsible mandrel 9, and a limited length feed-through rod 8. The cable head 6 and cable 7 are also illustrated to outline the complete well service tool string. An important feature of the invention is that for this preferred embodiment, the setting tool system for the straddle packer comprises more than one setting unit/element, and that said setting elements can be operated independent of each other. For the embodiment described in figure 1b, the as *per se* setting tool top section 5 is anchored to the upper sections of the straddle packer 1 by means of a collapsible mandrel 9, through the limited length feed-through rod 8. Unlike prior art straddle packer 1' that utilises a long feed-through rod 8' being substantially coextensive with the length of the straddle packer 1, the feed-through rod 8 for the straddle packer 1 according to the present invention runs through the top section only of the straddle packer 1. The feature of axial length L1 of the as *per se* setting tool 100 being significantly shorter than the axial length L2 of the straddle packer 1 is one essential characteristic for the present invention.

[0040] Preferably, for this embodiment of straddle packer 1 of the invention, the axial length L1 of the as *per se* setting tool 100 is less than three quarter of the axial length L2 of the straddle packer 1.

[0041] More preferably, for this embodiment of straddle packer 1 of the invention, the axial length L1 of the as *per se* setting tool 100 is less than one half of the axial length L2 of the straddle packer 1.

[0042] Most preferably, for this embodiment of straddle packer 1 of the invention, the axial length L1 of the as *per se* setting tool 100 is less than one quarter of the axial length L2 of the straddle packer 1.

[0043] In the embodiment shown, there is a bottom setting element 10 in the bottom section of the straddle packer 1. The bottom setting element 10 is used for setting of the bottom packer element 3. For the setting of straddle packer 1, the setting tool 5 is provided with a transmitter 11 of a wireless signal that is used to transmit an activation command 12 to the bottom setting element 10 in order to set this by means of expansion. The bottom setting element 10 is provided with a receiver and activation unit 14 that detects the received setting command 13,

translates it as known *per se* initiates the setting sequence of the bottom packer element 3.

[0044] In the embodiment shown in figure 1b, the bottom setting element 10 is a centred device, i.e. the bottom setting element 10 is substantially coaxial with the straddle packer.

[0045] The bottom setting element 10 could be designed to disappear by means of disintegration, mechanical retraction or other means as known *per se* after the bottom packer element 3 is set.

[0046] In another embodiment of the invention, shown in figure 2, the bottom setting element 10 is built into a wall of the straddle packer 1. In this embodiment, the bottom setting element 10 may be regarded as a setting tool being dependent upon the as *per se* setting tool 100 comprising communication means. Further, in other embodiments of the invention, the setting tool top section 5 could be of the same type as the bottom setting element 10, associated with similar communication and activation means. Further, anchor(s) 4 could be associated with similar type setting element 10, associated with similar communication and activation means. In a general embodiment, all elements to be operated (packer elements, anchors, valves etc) can be operated partly or totally independent from other elements to be operated, using similar type setting element 10, associated with similar communication and activation means.

[0047] In one embodiment of the invention, the bottom element 10 forms a seal against the inner wall of the straddle packer 1, so that fluids can not flow into the straddle packer 1 from below during deployment into a subsea well. This feature could be required in subsea deployment operations where pressure seals between the potentially high-pressurised wellbore and the marine environment on the outside of the wellhead might be a necessity. In yet another embodiment of the invention, such seal requirement is achieved by means of a sealing function between the setting tool 5 and the top section of the straddle packer 1. A person skilled in the art will be familiar with ways of obtaining such a seal. For this reason, sealing elements are not shown in detail in the drawing.

[0048] Figure 2 illustrates an alternative embodiment of the bottom setting element 10 of the straddle packer 1. Note that only a portion of the straddle packer 1 wall located at the right side of the straddle packer centre line CL is shown in figure 2. In this embodiment the receiver 14 reads the received setting command 13. An electronics module 21 interrogates the receiver 14 in order to interpret registrations from the sensor/receiver 14. When there is a positive detection of an activation signal, i.e. an initiating command, the electronics emit a signal/impulse to fire a detonator 22 that again ignites a pyrotechnic charge 23 that is adapted to fit inside a slot in the wall of the straddle packer 1. As the pyrotechnic charge 23 burns, it generates gas that imposes a large pressure on a piston 24. The piston 24 is forced downwards, and pushes a fluid 25, such as hydraulic oil, downwards. Then said fluid 25 forces a wedge-shaped element 26 down-

wards and forces this to set a packer element 3 against the tubing wall 27. Alternatively, the wedge shaped element 26 is replaced by means of an alternative element with similar function - i.e. to compress and support the bottom packer element 3. The receiver 14 and associated electronics module 21 is powered by means of a battery module 28.

[0049] Further to figure 2; this only illustrates one of a variety of ways of designing a system that sets (in this case) the lower packer element 3 of the straddle (or activates any element in a general application). Other possible methods that could be applied involve:

- A secondary thermal battery that operates a motor, which again applies force on the mechanic components that force the lower packer element 3 to set.
- A pilot valve or similar, exposing a "power chamber" to well fluids which again works against an atmospheric chamber to create the necessary forces to operate mechanic components that force the lower packer element 3 to set.
- A pilot valve or similar, exposing a "power chamber" to a high pressurised gas reservoir that forms part of the tool design, which again works against an atmospheric chamber to create the necessary forces to operate mechanic components that force the lower packer element 3 to set.
- Any relevant method for directly and/or indirectly generating a force on a packer element in an autonomous manner.
- Any combination of the above methods, combined with a valve or another type of barrier (as indicated by means of bottom setting element 10 in figure 1b), located in the bottom section of the straddle packer, said valve/barrier opens or "disappears" in other manners upon a finalised setting of the bottom packer element.
- A pump that inflates the lower packer element by means of pumping well fluids into the lower packer element 3, by use of a built-in reservoir.
- Any method for setting a packer element as known *per se*.
- Self-swelling packers.

[0050] Figure 3a and 3b illustrates two essential system modules of a preferred embodiment for intervening a long straddle packer 1 in a subsea well.

[0051] The apparatus shown in figure 3a is merely a preferred embodiment of the invention disclosed in NO 20051257, including the following modules and components:

- Subsea Deployment Lubricator Module (SDLM) 31, comprising a dynamic seal 32, an anti-blowout device 33 and flush lines 34a and 34 b.
- Lower Riser Package (LRP) 35, comprising test valves (gate valves) 36a and 36b, and a safety head (shear valve) 37.
- A hang-off spool 38, comprising a hang off profile 39 (not applied for this application specifically, but a perceived general component in the seabed stack for operations involving the SDLM 31).
- The wellhead 300.
- A small section of lubricator riser 301 (might not be needed neither in a preferred embodiment of this invention nor in the invention disclosed in NO 20051257).
- The LRP 35 is in this example also hooked up to a kill line 302.

[0052] Figure 3b shows the schematics of a preferred straddle packer 1 to be used in conjunction with the SDLM 31 and other seabed stack components shown in figure 3a. As also described for figure 1b, the straddle packer 1 is provided with a top packer element 2, a bottom packer element 3 and an anchor 4. The *as per se* setting tool 100 comprises a top section 5, a collapsible mandrel 9, and a limited length feed-through rod 8. The cable head 6 and cable 7 are also illustrated. In the bottom of the straddle packer 1, there is a bottom setting element 10, used for setting of the bottom packer element 3. The "as per se" setting tool 100 top setting element 5 is provided with a transmitter 11 of a wireless signal that is used to transmit a setting command 12 (see figure 1b) to the bottom setting element 10. The latter is provided with a receiver and activation unit 14 that detects the received setting command 13 (see figure 1b) translates it and initiates the setting sequence of the bottom packer element 3. In this embodiment of the invention, the bottom setting element 10 is built into the wall of straddle packer 1.

[0053] A person skilled in the art would recognise that for alternative embodiments, the transmitter 11 could be located elsewhere than on the *as per se* setting tool 100 top setting element 5, as a module of its own or as part of other system modules. This is not further described herein.

[0054] In other embodiments of the invention, the transmitter 11 and receiver 14 are replaced by transceivers. In this way, one can by means of active two-way communication and/or passive monitoring of parameters related to the activation get a positive feedback that the bottom setting element has received a setting command 12 and executed the setting process. In yet another embodiment of the invention, the transceiver located in the top setting element includes a sensor that can record any

indications that the setting process has taken place. An example of such is a quartz crystal sensor that "listens" for the sound created when detonating e.g. the detonator 22 shown in figure 2.

[0055] Figure 4 illustrates an initial stage of a subsea intervention process from a RLWI vessel. More specifically, figure 4 illustrates the process of lowering a long straddle packer 1 assembly through the open sea. A surface vessel 41 tailored for riserless well intervention (RLWI) is used in conjunction with a seabed stack 42, comprising a SDLM 31, LRP 35, hang-off spool 38 and, in this embodiment, a small section of lubricator riser 301 in order to deploy a long straddle packer 1 into the subsea well 43. It should be noted that, at the given stage of the deployment sequence, the downhole safety valve 44 of subsea well 43 is closed and pressure is bled off above it. Also, in order to provide the required amount of well barriers, the test valves (gate valves) 36a and 36b are closed.

[0056] Steps required for flushing, pressure testing as well as monitoring parameters are not described in detail here. However, any person skilled in the art would be able to identify the need for such actions as well as the most appropriate location of related system components and also the most relevant sequence of operation with respect to these actions. Flushing, pressure testing and monitoring systems could be located anywhere on the seabed stack, for example built into the SDLM 31, the LRP 35, the hang off spool 38 or other location or combination of locations.

[0057] Figure 5 illustrates the first step of system deployment, i.e. bringing the straddle packer 1 assembly from the marine environment into the pressurised well environment. As soon as the bottom of the straddle packer 1 assembly enter the seabed stack 42, a positioning procedure is performed in order to position the bottom packer element 3 and the bottom setting element 10 correct with respect to the test valves (gate valves) 36a and 36b and the dynamic seal 32, an anti-blowout device 33 of the SDLM 31. Said positioning is performed in a way known *per se*.

[0058] Upon having positioned the straddle packer 1 correctly, the dynamic seal 32, and an anti-blowout device 33 of the SDLM 31 is engaged to the tubing wall of the straddle packer 1. A person skilled in the art will understand that it is of importance that no mechanical engagement is made to the bottom packer element 3 and the bottom setting element 10 in order to avoid damage to these. Hence, a proper positioning procedure is performed prior to engagement. However, in other embodiments of the invention, the bottom packer element 3 and bottom setting element 10 are built robust enough or with a sufficient protection to allow for mechanical engagement onto these sections as well, reducing the requirements for a strict positioning of the straddle packer 1.

[0059] Figure 6 illustrates the second step of system deployment. Subsequent the required flushing, pressure testing and monitoring actions, the test valves (gate

valves) 36a and 36b are opened and the straddle packer 1 is lowered into the wellbore. The lowering operation is stopped prior to the anchor 4 entering the dynamic seal 32 of the SDLM 31. It is important to stop at such location as the anchor 4 might cause damage to the dynamic seal 32 if lowered into this. Also, such event could cause a breach of barrier requirements. In a preferred embodiment of the invention, positioning systems and/or mechanical or other "halt" systems are included to facilitate the correct positioning of the anchor 4 with respect to the dynamic seal 32. Upon finalising a correct positioning, the top of the cable head 6 should be fully contained inside the lubricator riser 301. In a preferred embodiment of the invention, there is no need for the lubricator riser as the full top sections of the toolstring can be contained within the seabed stack (i.e. within the top section of the SDLM 31). A grease injection head 62 is mounted on top of the lubricator riser 301. After flushing, pressure testing and monitoring are performed, a third step of system deployment as illustrated in figure 7, commences.

[0060] Figure 7 illustrates an embodiment of the invention, where the dynamic seal 32 and the anti-blowout device 33 are radially disengaged from the straddle packer 1 whereupon this is run into the wellbore in order to perform the desired operation.

[0061] Figure 8a and 8b illustrates system installation in the downhole part of the well. More specifically, figure 8a illustrates the straddle packer 1 being positioned with respect to an upper perforated section 80 by aligning the bottom packer element 3 with a non-perforated section 80' of a casing/liner 81. The non-perforated section 80' is located below said upper perforated section 80. The top packer element 2 and anchor 4 are aligned with a non-perforated section 80" of the wells casing/liner 80 above the perforated section 80. Hence, the straddle packer 1 is aligned in order to fully seal off and isolate perforation 80. Figure 8b illustrates the straddle packer 1 after setting/engagement of bottom packer element 3, top packer element 2 and anchor 4. Also, figure 8b illustrates emission of a wireless activation signal 12 from transmitter 11 of the setting tool 5. The activation signal 12 is received as signal 13 by the receiver and activation unit 14 that is located in the proximity to the bottom packer element 3. Upon receiving a correct message 13, receiver and activation unit 14 initiates and performs the process of setting bottom packer element 3, either directly or indirectly through a bottom setting element 10 as illustrated in figures 1 and 2.

[0062] As described earlier, the straddle packer 1 assembly could comprise more than one anchor 4. In particular, for a preferred embodiment, a bottom anchor 4 would enable an installation procedure where the bottom packer element 3 and a bottom anchor (not shown) is set first, whereupon a pull test by means of applying tension to the cable 7 is performed to verify a successful setting of this part of the straddle packer 1. Subsequently, the top packer element 2 and anchor 4 can be set. Further, top and bottom anchors are commonly used if an expan-

sion joint is included in the straddle packer 1. Such expansion joints could be required if expected temperature differences in the well exceed certain limits, or if the straddle packer 1 is installed across expansion joints in the well to fix leakages. A person skilled in the art would recognise all such considerations, and no further reference is given herein.

[0063] Figure 9 illustrates schematically an installed straddle packer 1 in a producing well after the as *per se* setting tool 100 with associated elements are retrieved, and production of the well is re-established. As can be seen, no fluids will now be produced from the upper perforated section 80, whereas fluids from the lower lying zone 91 are produced through straddle packer 1.

[0064] Figure 10 illustrates retrieval of the setting tool assembly from the well. Figure 10 shows the as *per se* setting tool 100 and accessories after retrieval into the top section of the seabed stack 42. Further, the figure shows the lower end of the seabed stack. After retrieval and positive indication that the entire straddle packer setting string 101 is positioned in a defined top section of the seabed stack 42, valves 36a and 36b are shut. Thereupon, appropriate flushing, pressure testing and monitoring actions are performed prior to disconnecting the grease injection head 62. Then, relevant steps described in the prior sections are reversed in order to retrieve the packer setting string 101 and seabed stack 42 to the surface and thereby finalizing the straddle packer installation operation.

Claims

1. A device for isolating a section of a wellbore, the device including a straddle packer (1) and a setting tool (100) for selectively setting of at least one upper packer element (2), at least one lower packer element (3) and at least one anchoring device (4) of the straddle packer (1), wherein the setting tool (100) includes at least one setting element (10) arranged for setting the at least one lower packer element (3), **characterised in that** the at least one lower packer element (3) is operated independent from other setting elements (2) by wireless communication means (11, 14) comprising a transmitter (11) located in the setting tool (100) and a receiver (14) located in the setting element (10).
2. The device according to claim 1, **characterised in that** the transmitter (11) and the receiver (14) includes a transceiver.
3. The device according to claim 1, **characterised in that** the axial length L1 of the setting tool (100) is less than the axial length L2 of the straddle packer (1).
4. The device according to claim 1, **characterised in**

that the axial length of the setting tool (100) is less than three quarter of the axial length of the straddle packer (1).

5. The device according to claim 1, **characterised in that** the axial length of the setting tool (100) is less than one half of the axial length of the straddle packer (1).
6. The device according to claim 1, **characterised in that** the axial length of the setting tool (100) is less than one quarter of the axial length of the straddle packer (1).
7. The device according to claim 1, **characterised in that** at least one separate setting element (10) is integrated in a portion of a tubular body (27) of the straddle packer (1).
8. A method for isolating a section of a wellbore, the method including setting a straddle packer (1) using a setting tool (100) for selectively setting of at least one upper packer element (2), at least one lower packer element (3) and at least one anchoring device (4) of the straddle packer (1), **characterised in that** the method comprising operating the at least one lower packer element (3) independent from other setting elements by means of a setting element (10) that is controlled by a wireless communication means comprising a transmitter (11) located in the setting tool (100) and a receiver (14) located in the setting element (10).
9. The method according to claim 8, **characterised in that** the setting tool (100) has an axial length that is considerably less than the axial length of the straddle packer (1).

Patentansprüche

1. Vorrichtung zum Isolieren eines Abschnittes eines Bohrloches, wobei die Vorrichtung umfasst: einen Überbrückungs-Packer (1); und ein Einstellwerkzeug (100) für das selektive Einstellen von mindestens einem oberen Packerelement (2), mindestens einem unteren Packerelement (3) und mindestens einer Verankerungsvorrichtung (4) des Überbrückungs-Packers (1), wobei das Einstellwerkzeug (100) mindestens ein Einstellelement (10) umfasst, das für das Einstellen des mindestens einen unteren Packerelementes (3) angeordnet ist, **dadurch gekennzeichnet, dass** das mindestens eine untere Packerelement (3) unabhängig von den anderen Einstellelementen (2) mittels eines drahtlosen Kommunikationsmittels (11, 14) betätigt wird, das einen Sender (11), der im Einstellwerkzeug (100) angeordnet ist, und einen Empfänger (14) aufweist, der

im Einstellelement (10) angeordnet ist.

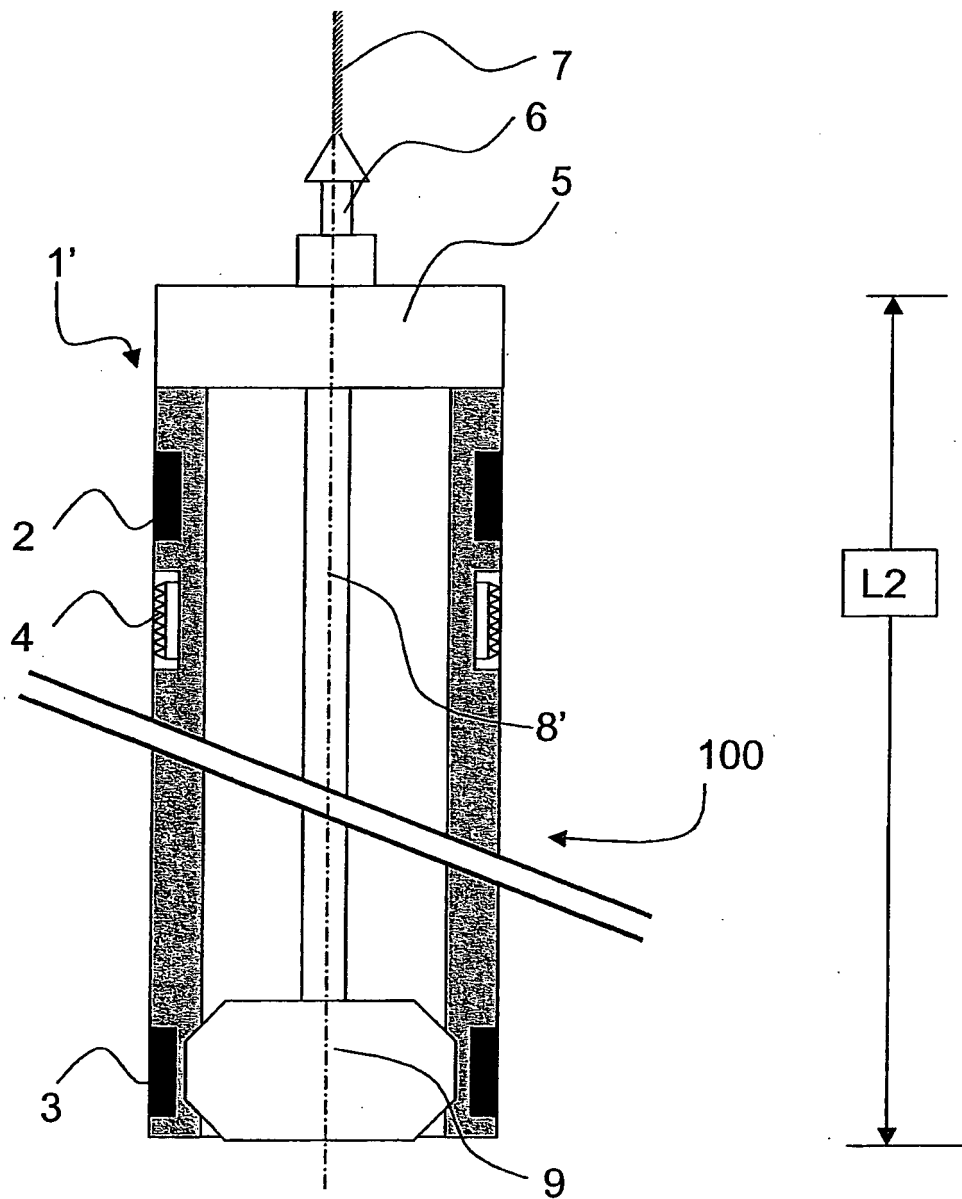
2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der Sender (11) und der Empfänger (14) ein Sende/Empfangsgerät umfasst.
3. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die axiale Länge L1 des Einstellwerkzeuges (100) kleiner ist als die axiale Länge L2 des Überbrückungs-Packers (1).
4. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die axiale Länge des Einstellwerkzeuges (100) kleiner ist als drei Viertel der axialen Länge des Überbrückungs-Packers (1).
5. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die axiale Länge des Einstellwerkzeuges (100) kleiner ist als eine Hälfte der axialen Länge des Überbrückungs-Packers (1).
6. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die axiale Länge des Einstellwerkzeuges (100) kleiner ist als ein Viertel der axialen Länge des Überbrückungs-Packers (1).
7. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** mindestens ein separates Einstellelement (10) in einem Abschnitt eines rohrförmigen Körpers (27) des Überbrückungs-Packers (1) integriert ist.
8. Verfahren zum Isolieren eines Abschnittes eines Bohrloches, wobei das Verfahren den Schritt des Einstellens eines Überbrückungs-Packers (1) bei Benutzung eines Einstellwerkzeuges (100) für das selektive Einstellen von mindestens einem oberen Packerelement (2), mindestens einem unteren Packerelement (3) und mindestens einer Verankerungsvorrichtung (4) des Überbrückungs-Packers (1) umfasst, **dadurch gekennzeichnet, dass** das Verfahren den Schritt des Betätigens des mindestens einen unteren Packerelementes (3) unabhängig von den anderen Einstellelementen mittels eines Einstellelementes (10) aufweist, das mittels eines drahtlosen Kommunikationsmittels gesteuert wird, das einen Sender (11), der im Einstellwerkzeug (100) angeordnet ist, und einen Empfänger (14) aufweist, der im Einstellelement (10) angeordnet ist.
9. Verfahren nach Anspruch 8, **dadurch gekennzeichnet, dass** das Einstellwerkzeug (100) eine axiale Länge aufweist, die beträchtlich kleiner ist als die axiale Länge des Überbrückungs-Packers (1).

Revendications

1. Dispositif pour isoler une section d'un puits de forage, le dispositif englobant une garniture d'étanchéité double (1) et un outil de pose (100) pour la mise en place sélective d'au moins un élément supérieur de la garniture d'étanchéité (2), d'au moins un élément inférieur de la garniture d'étanchéité (3) et d'au moins un dispositif d'ancrage (4) de la garniture d'étanchéité double (1), l'outil de pose (100) englobant au moins un élément de pose (10) destiné à la mise en place du au moins un élément inférieur de la garniture d'étanchéité (3), **caractérisé en ce que** le au moins un élément inférieur de la garniture d'étanchéité (3) est actionné indépendamment des autres éléments de pose (2) par un moyen de communication sans fil (11, 14), comprenant un émetteur (11), agencé dans l'outil de pose (100), et un récepteur (14) agencé dans l'élément de pose (10). 5
2. Dispositif selon la revendication 1, **caractérisé en ce que** l'émetteur (11) et le récepteur (14) englobent un émetteur-récepteur. 10
3. Dispositif selon la revendication 1, **caractérisé en ce que** la longueur axiale L1 de l'outil de pose (100) est inférieure à la longueur axiale L2 de la garniture d'étanchéité double (1). 15
4. Dispositif selon la revendication 1, **caractérisé en ce que** la longueur axiale de l'outil de pose (100) représente moins des trois quarts de la longueur axiale de la garniture d'étanchéité double (1). 20
5. Dispositif selon la revendication 1, **caractérisé en ce que** la longueur axiale de l'outil de pose (100) représente moins de la moitié de la longueur axiale de la garniture d'étanchéité double (1). 25
6. Dispositif selon la revendication 1, **caractérisé en ce que** la longueur axiale de l'outil de pose (100) représente moins d'un quart de la longueur axiale de la garniture d'étanchéité double (1). 30
7. Dispositif selon la revendication 1, **caractérisé en ce qu'**au moins un élément de pose séparé (1) est intégré dans une partie d'un corps tubulaire (27) de la garniture d'étanchéité double (1). 35
8. Procédé d'isolation d'une section d'un puits de forage, le procédé englobant l'étape de pose d'une garniture d'étanchéité double (1) par l'intermédiaire d'un outil de pose (100) pour la mise en place sélective d'au moins un élément supérieur de la garniture d'étanchéité double (2), d'au moins un élément inférieur de la garniture d'étanchéité (3) et d'au moins un dispositif d'ancrage (4) de la garniture d'étanchéité double (1), **caractérisé en ce que** le procédé com- 40

prend l'étape d'actionnement du au moins un élément inférieur de la garniture d'étanchéité double (3) indépendamment des autres éléments de pose par l'intermédiaire d'un élément de pose (10) contrôlé par un moyen de communication sans fil, comprenant un émetteur (11), agencé dans l'outil de pose (100), et un récepteur (14), agencé dans l'élément de pose (10). 45

9. Procédé selon la revendication 8, **caractérisé en ce que** l'outil de pose (100) a une longueur axiale considérablement inférieure à la longueur axiale de la garniture d'étanchéité double (1). 50



(Prior art)

Fig. 1a

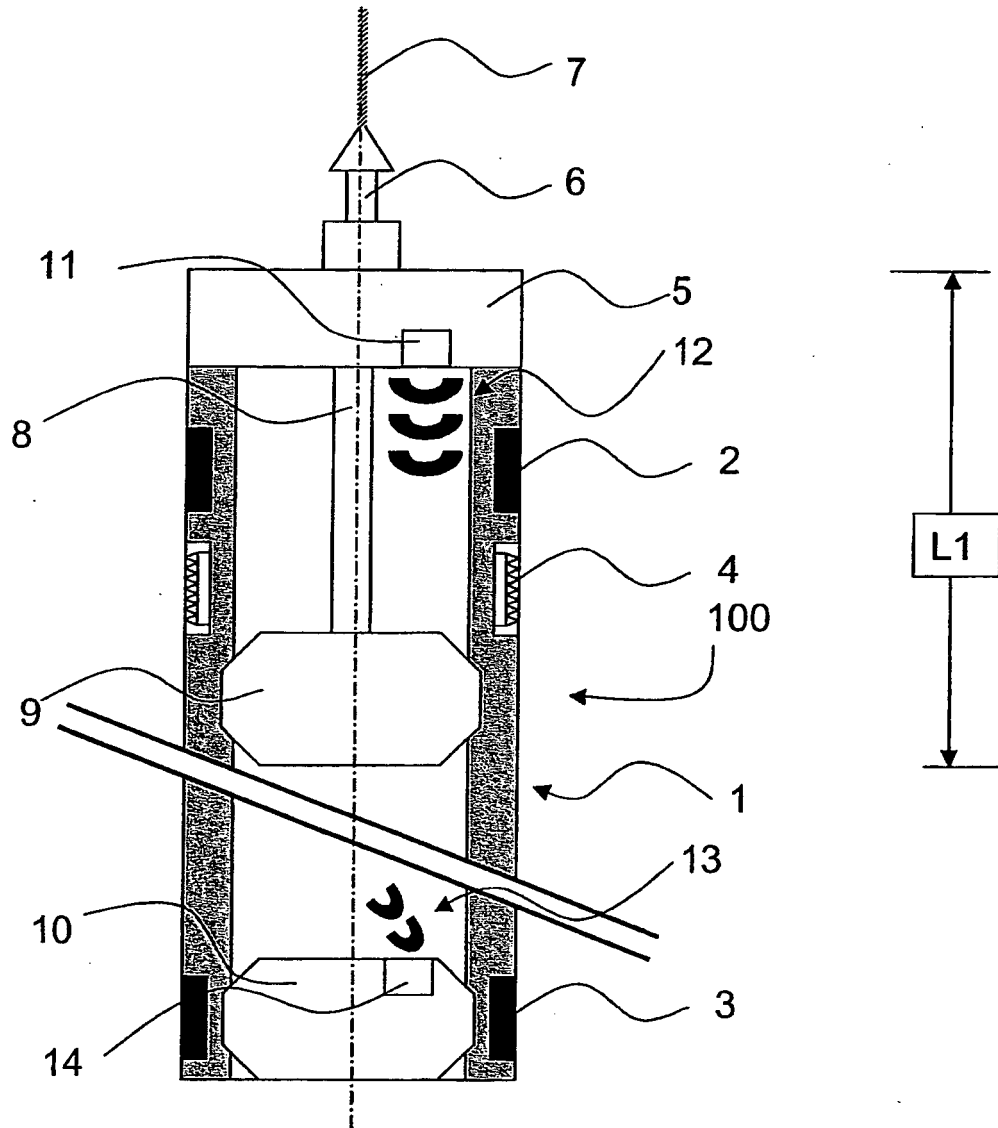


Fig. 1b

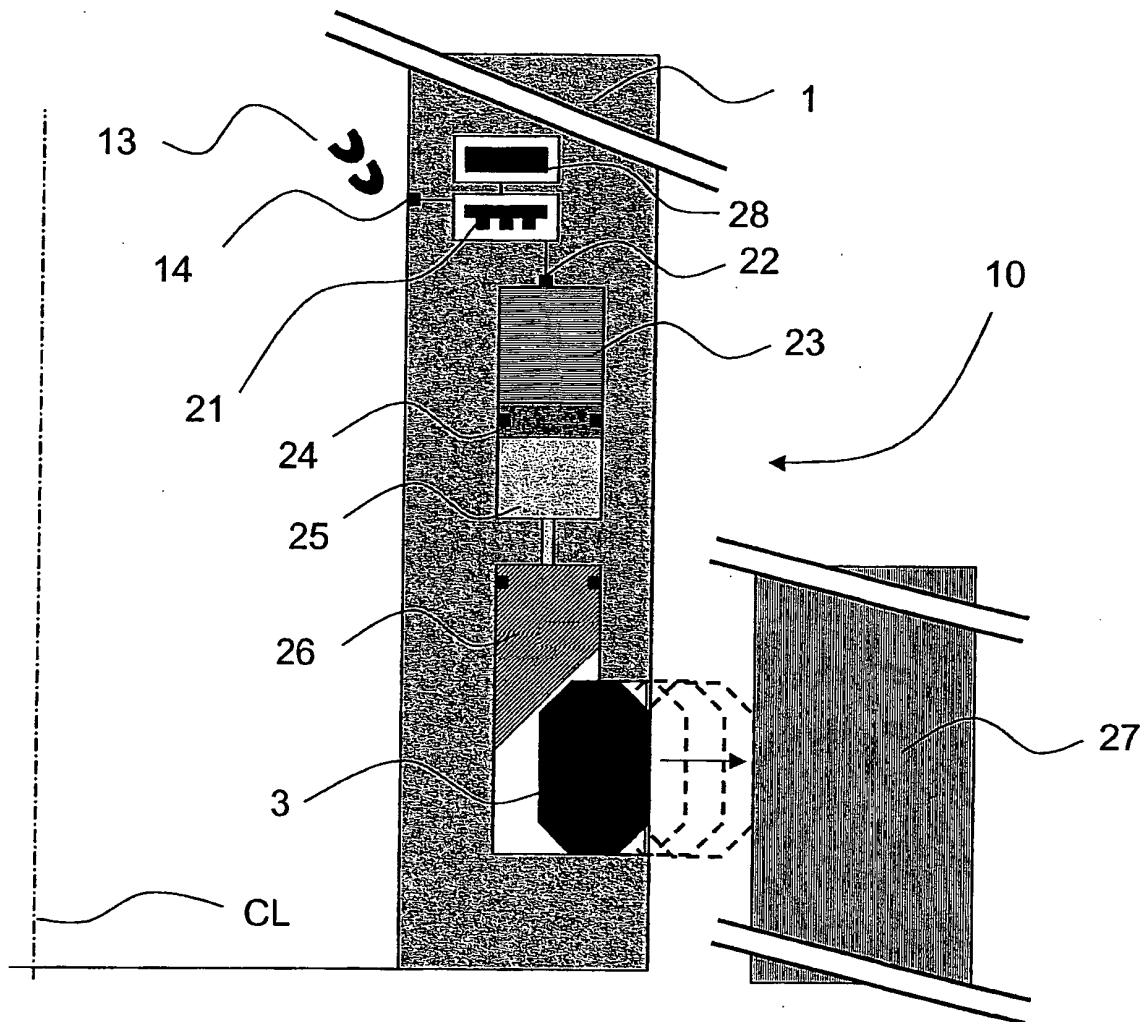


Fig. 2

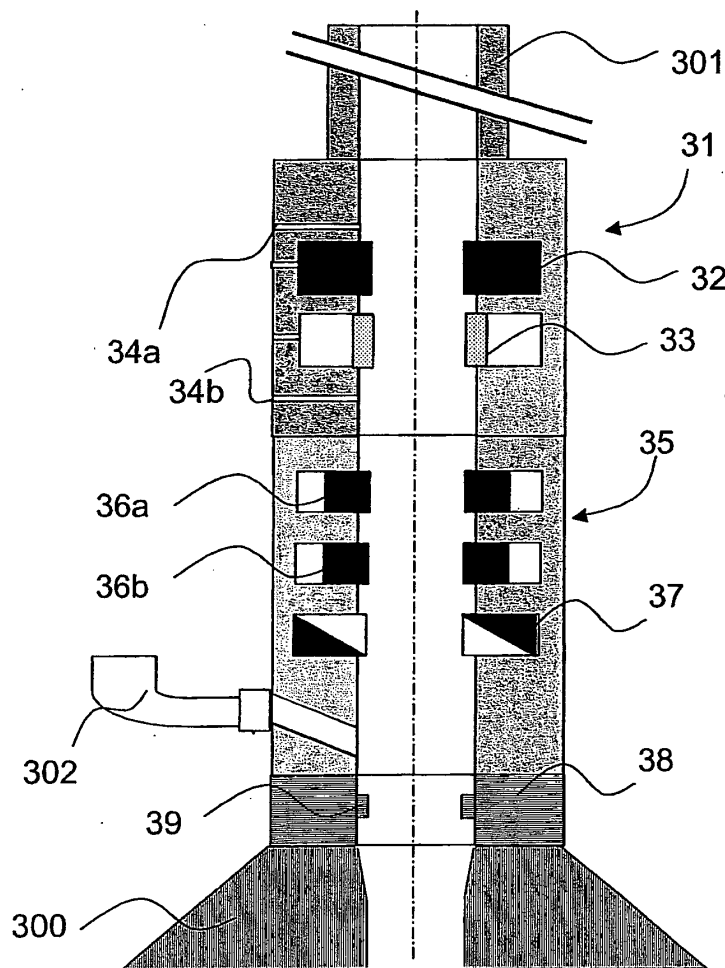


Fig. 3a

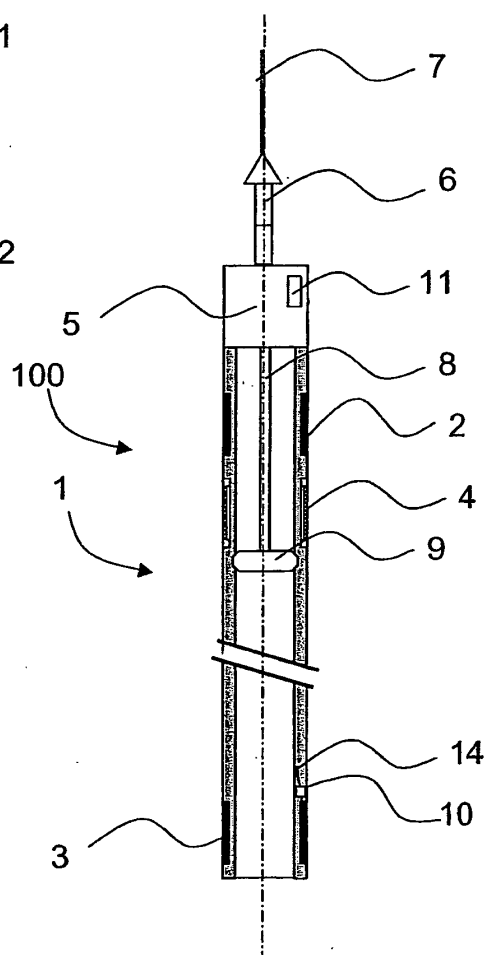


Fig. 3b

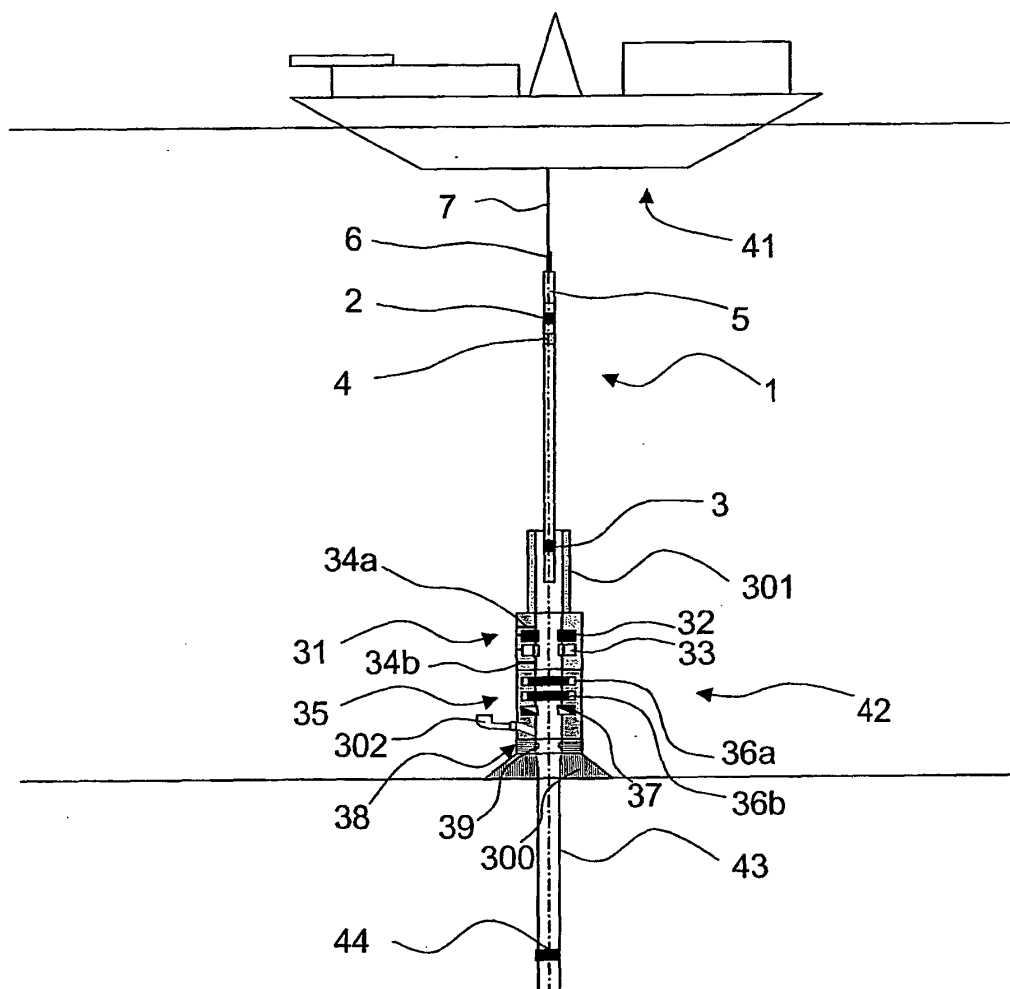


Fig. 4

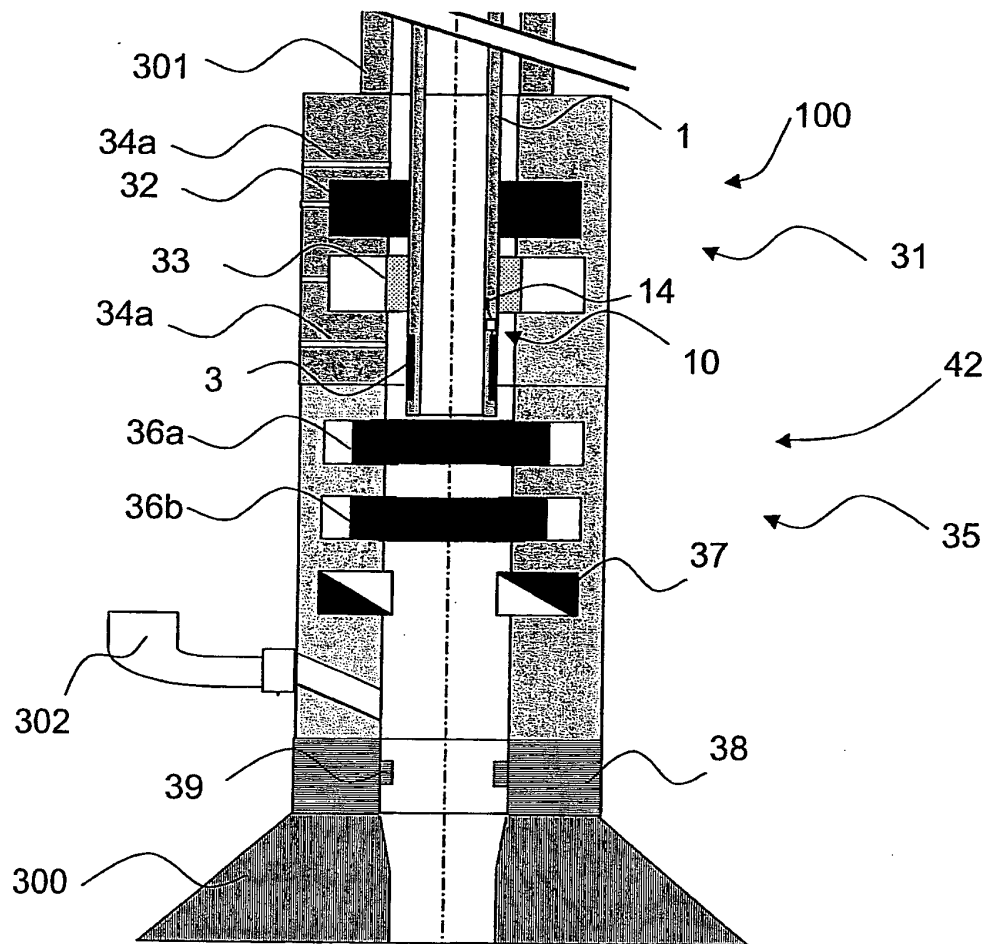


Fig. 5

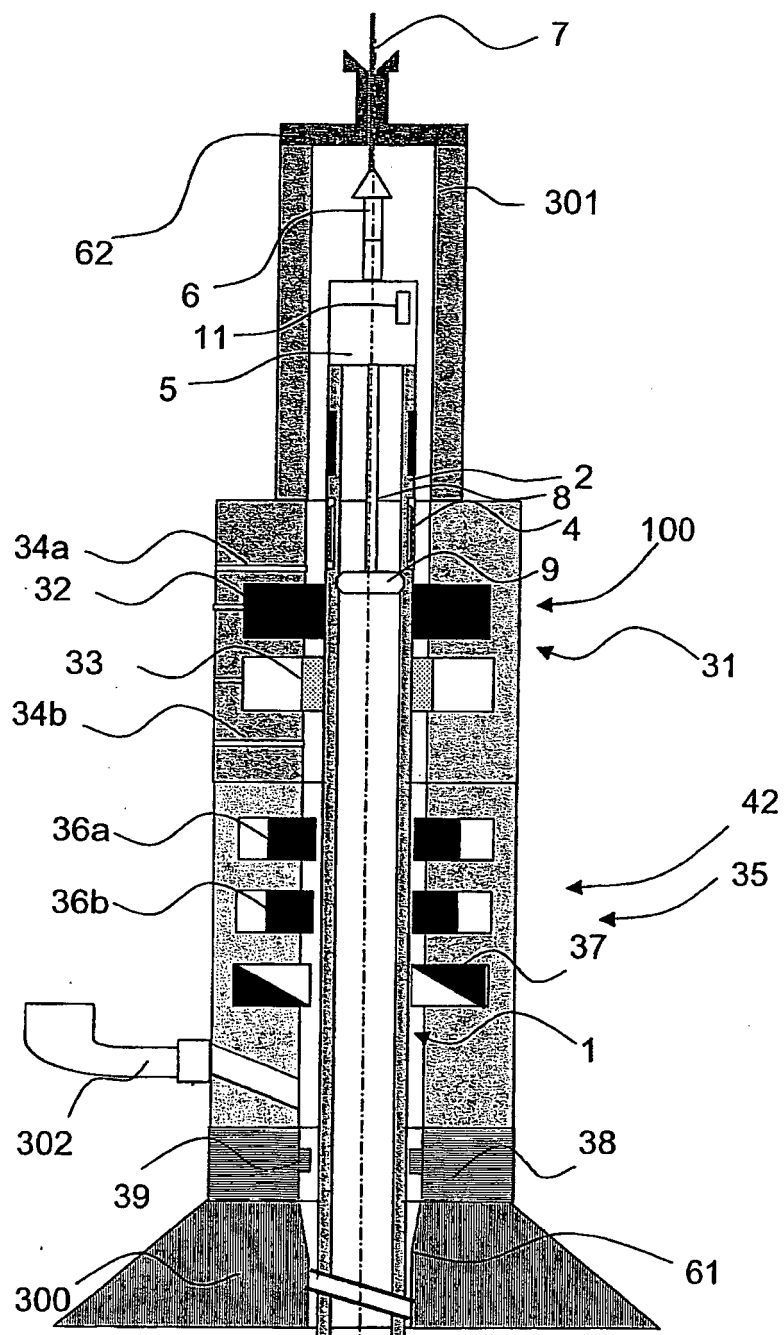


Fig. 6

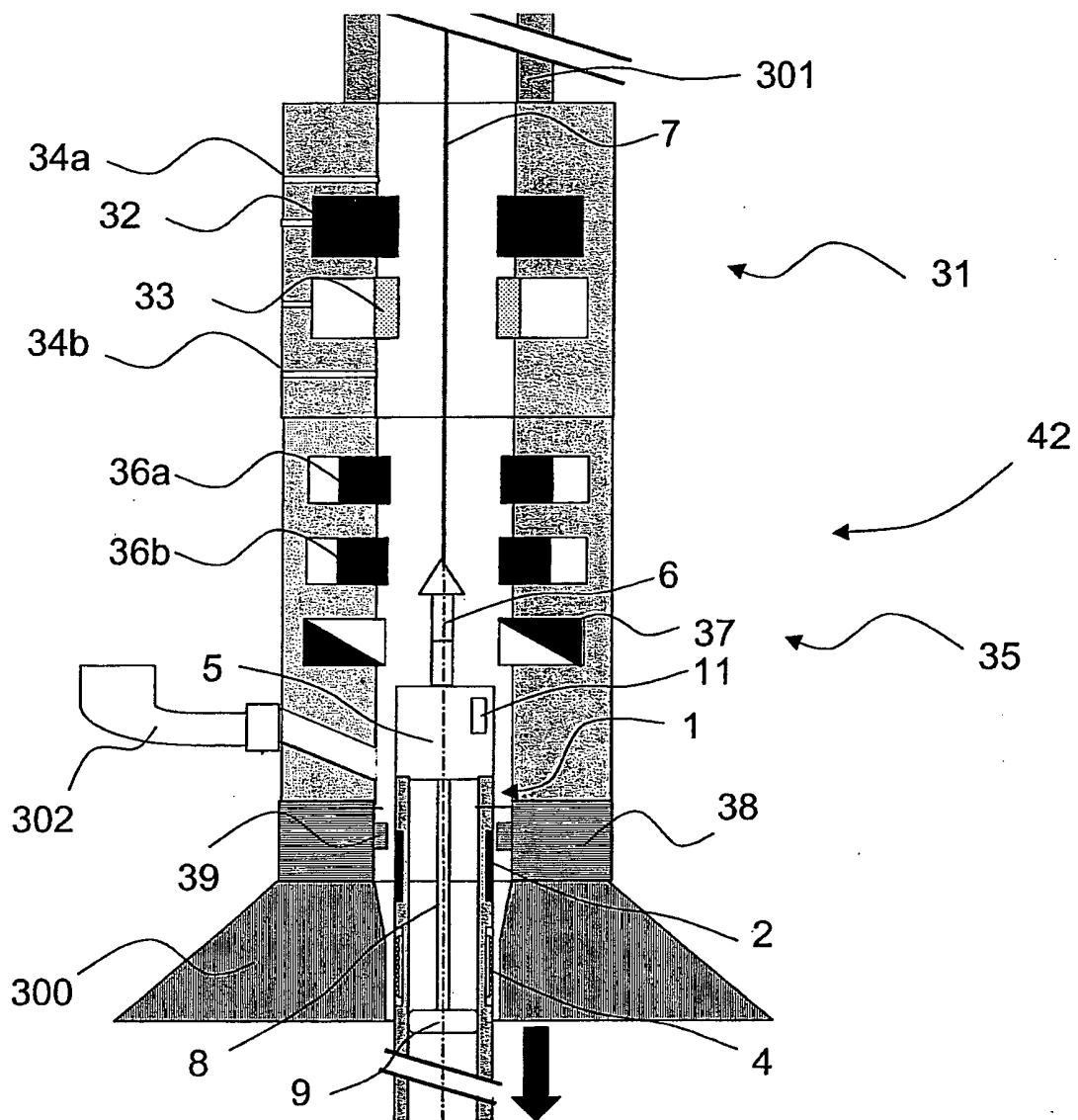


Fig. 7

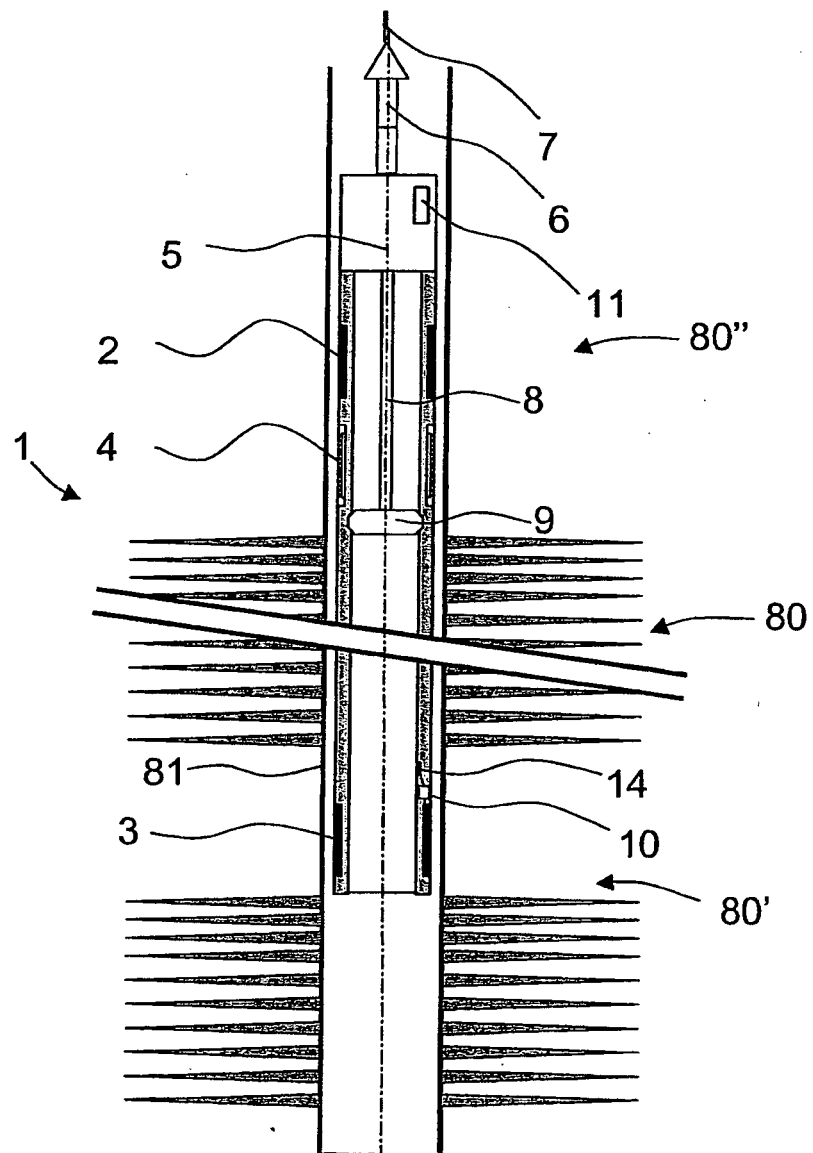


Fig. 8a

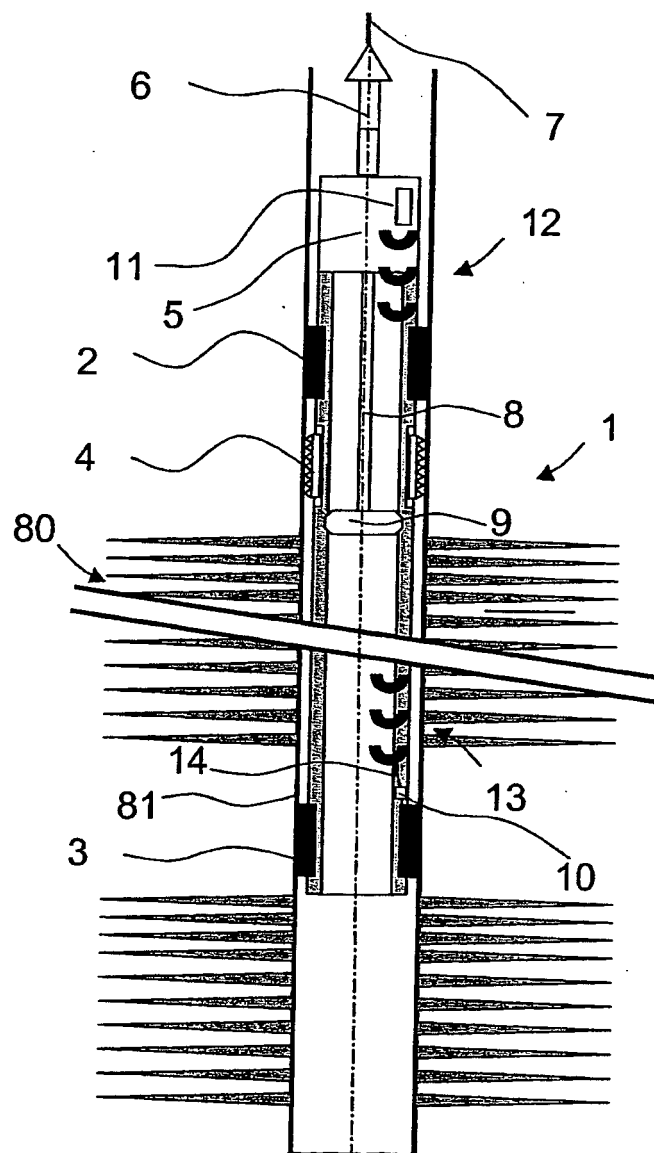


Fig. 8b

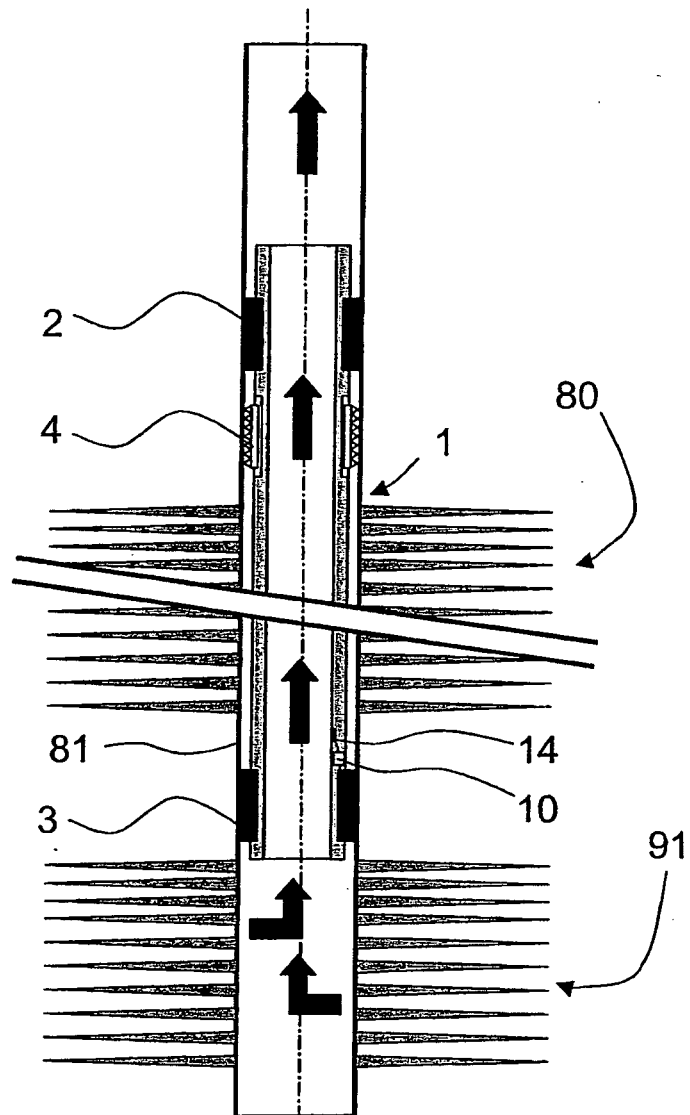


Fig. 9

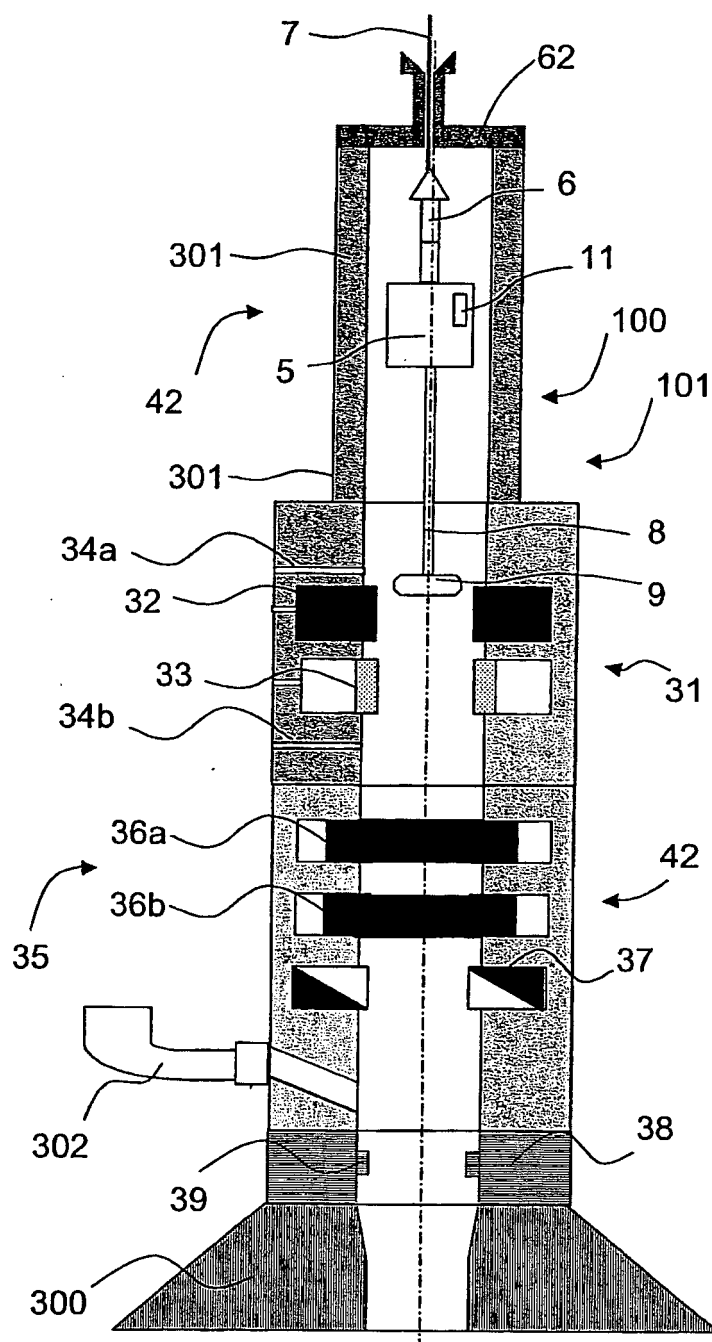


Fig. 10

REFERENCES CITED IN THE DESCRIPTION

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