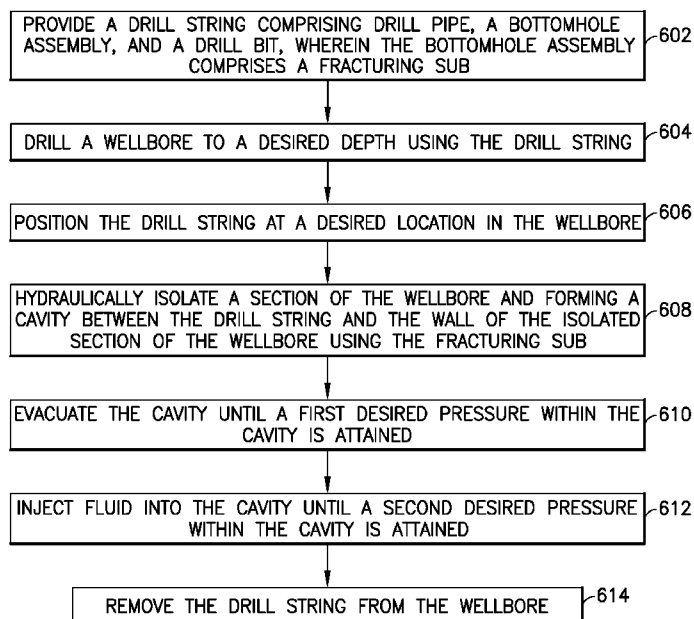




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[Continued on next page]

(54) **Title:** FRACTURING WHILE TRIPPING**FIG.6**

(57) **Abstract:** A drill string includes drill pipe and a modular fracturing sub. A processor can control the drill string to drill a wellbore to some desired depth. The drill string is positioned at a desired location in the wellbore and a section of the wellbore is hydraulically isolated, forming a cavity. Existing fluid may be evacuated from the cavity and fracturing fluid injected into the cavity until a desired level of fracturing is attained. Retrievable packers are used for the hydraulic isolation. A pump evacuates the existing fluid via ports in the fracturing sub. The ports may also be used when injecting fracturing fluid. Seismic sensors may be distributed along the drill string to monitor fracture growth. Logging-while-drilling tools may be integrated into the drill string. Fluid from the lower portion of the wellbore is blocked by a lower sealing unit on a bottomhole assembly.



TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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FRACTURING WHILE TRIPPING

Cross Reference To Related Applications

[0001] This application claims priority from Non Provisional Patent Application No. 14/642845 filed March 10, 2015, which is hereby incorporated by reference in its entirety.

Background

[0001] Driven by demand and corresponding rising oil and gas prices, shale oil and gas production has become economically attractive and given rise to a new era of production. The characteristics of shale reservoirs may typically be described as having extremely low permeability (e.g., 100–600 nano-Darcys), low porosity (e.g., 2–10%), and moderate gas adsorption (gas content 50–150 scf/ton). To achieve economical production and enhance recovery, large numbers of horizontal wells and massive, multistage hydraulic fracturing treatment (HFT) jobs have been performed in shale reservoirs.

[0002] A fracturing operation is normally done after a well is drilled and the drill pipe and bottomhole assembly (BHA) have been removed from the well. To prepare for the fracturing operation, an interval of interest is chosen, the interval is hydraulically isolated by at least two packers, and fracturing (“fracking”) fluid is injected into the space between the packers at high enough pressures to initiate and propagate one or more fractures in the formation.

Summary

[0003] A drill string includes drill pipe and a modular fracturing sub. A processor can control the drill string to drill a wellbore to some desired depth. The drill string is positioned at a desired location in the wellbore and a section of the wellbore is hydraulically isolated, forming a cavity. Existing fluid may be evacuated from the cavity and fracturing fluid injected into the cavity until a desired level of fracturing is attained. Retrievable packers are used for the hydraulic isolation. A pump evacuates the existing fluid via ports in the fracturing sub. The ports may also be used when injecting fracturing fluid. Seismic sensors may be distributed along the drill string to monitor fracture growth. Logging-while-drilling tools may be integrated into

the drill string. Fluid from the lower portion of the wellbore is blocked by a lower sealing unit on a bottomhole assembly.

[0004] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

Brief Description of the Drawings

[0005] The present disclosure is best understood from the following detailed description when read with the accompanying figures. It is emphasized that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion. Embodiments are described with reference to the following figures. The same numbers are generally used throughout the figures to reference like features and components.

[0006] Figure 1 is a schematic drawing of a drill string disposed in a wellbore and used to perform a fracturing operation, in accordance with the present disclosure.

[0007] Figure 2 is a schematic drawing of the drill string of Figure 1 particularly positioned in the wellbore adjacent to and sealing off a zone of interest, in accordance with the present disclosure.

[0008] Figure 3 schematically shows a detailed view of a fracturing sub, in accordance with the present disclosure.

[0009] Figure 4 schematically shows the drill string of Figure 1 and multiple receivers at different locations in the drill string, in accordance with the present disclosure.

[0010] Figure 5 schematically shows a zone of interest in a wellbore as well as two stations within the zone of interest, in accordance with the present disclosure.

[0011] Figure 6 is a flowchart for a fracturing operation using a drill string, in accordance with the present disclosure.

Detailed Description

[0012] It is to be understood that the following disclosure provides many different embodiments, or examples, for implementing different features of various embodiments. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Moreover, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed interposing the first and second features, such that the first and second features may not be in direct contact.

[0013] Some embodiments will now be described with reference to the figures. Like elements in the various figures may be referenced with like numbers for consistency. In the following description, numerous details are set forth to provide an understanding of various embodiments and/or features. However, it will be understood by those skilled in the art that some embodiments may be practiced without many of these details and that numerous variations or modifications from the described embodiments are possible. As used here, the terms “above” and “below”, “up” and “down”, “upper” and “lower”, “upwardly” and “downwardly”, and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe certain embodiments. However, when applied to equipment and methods for use in wells that are deviated or horizontal, such terms may refer to a left to right, right to left, or diagonal relationship, as appropriate. It will also be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another.

[0014] The terminology used in the description herein is for the purpose of describing particular embodiments only and is not intended to be limiting. As used in the description and the appended claims, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms "includes," "including," "comprises," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0015] As used herein, the term "if" may be construed to mean "when" or "upon" or "in response to determining" or "in response to detecting," depending on the context. Similarly, the phrase "if it is determined" or "if [a stated condition or event] is detected" may be construed to mean "upon determining" or "in response to determining" or "upon detecting [the stated condition or event]" or "in response to detecting [the stated condition or event]," depending on the context.

[0016] A system and method to perform fracturing operations using a drill string is disclosed herein. While a well is drilled, logging-while-drilling (LWD) tools may be used to characterize the formation and determine one or more zones of interest for fracturing operations. The drill string may then be pulled back to a determined zone of interest and used to isolate at least a portion of that zone of interest. Fracturing fluid is conveyed through the drill pipe and injected into the isolated zone, causing the surrounding formation to fracture. In one or more embodiments, micro-seismic receivers are placed at different locations along the drill string and used to monitor the progress of the fracturing operation, which allows the operation to be controlled.

[0017] When a horizontal well is drilled, the operation generally starts with a vertical section drilled down to a certain depth. From there the well is “side-tracked” to form a deviated section that eventually lands in the reservoir formation at the depth of interest. Once in the desired reservoir formation, an operator attempts to drill the well in an optimum direction and depth,

which for “thin” reservoirs is some distance above the oil-water contact or some distance below the upper (shale) layer boundary. This tends to maximize the oil and gas production from the well. In some cases, for example where the reservoir is relatively thick and the permeability is relatively low, one may fracture the reservoir to increase the production rate. Since fractures usually penetrate on the order of hundreds of meters, the fracturing is generally used on formations with thicknesses comparable to the extent of fracture penetration. This is commonly the case with shale reservoirs, which are generally very thick and have permeabilities on the order of nano-Darcys. Other applicable reservoirs are tight carbonates, which can be several hundred meters thick and, by their nature, have low permeability.

[0018] At the time of fracturing the vertical section of the well is usually already cased so that the formation layers penetrated by that section of the well are already hydraulically sealed. The horizontal section may or may not be cased. The embodiments disclosed herein pertain to open-hole fracturing in which the horizontal section is not cased, but other contemplated embodiments are not limited to open-hole completions. In a typical fracturing operation, pipes are used to extend the casing down to the zone that is targeted for fracture. The zone of interest is isolated from the remainder of the well before fracturing fluid is pumped into the well. Operationally, a drilling rig is used to install the pipes, any casing, and any isolation mechanisms such as packers. Since rig operations are expensive and time-consuming, rig operation time (i.e., costs) can be reduced by performing the fracturing operation in the same “trip” that is used to finalize the drilling operation (or at least before the rig is removed from the well).

[0019] Figure 1 shows a section of horizontal well 110 being drilled using a drill bit 120, a bottomhole assembly (BHA) 130, and drill pipes 140, collectively referred to herein as a “drill string”. BHA 130 contains LWD tools that may be used to measure formation properties such as porosity, permeability, oil saturation, and other formation evaluation parameters used to decide whether to fracture a well and, if so, over what interval of the well. The LWD tools may also include a gamma ray tool that is used to “mark” the depth for going back to a particular depth of interest. The LWD tools may also comprise an acoustic tool that can be used to measure geomechanical properties of the rock. These measurements are useful in designing fracturing parameters such as pressure, flow rate, etc.

[0020] BHA 130 also comprises one or more fracturing subs 150 which provide the mechanical components to perform the fracturing operation. Once it is decided to perform the fracturing operation, BHA 130, which has generally drilled past the zone of interest 210 (see Figure 2), is pulled back to zone of interest 210 to perform the fracturing operation. This partial tripping (out) operation is guided by the gamma ray tool to ensure the fracturing sub 150 is in the zone of interest 210.

[0021] The zone of interest 210 can be isolated using retrievable packers 220 and 230, for example, which are part of fracturing sub 150. The drilling fluid in the isolated annulus of zone 210 is pumped into the annulus above (or below) the zone 210. Next, the fracking fluid is introduced into the isolated zone 210 at sufficiently high pressure to cause the formation to fracture. The high pressure fluid exerts radial pressure around the borehole wall which, in combination with the maximum and minimum stresses normally present in the formation, causes the rock to break (i.e., initiate a fracture) and propagate the fracture into the formation. The packers 220, 230 are released and the BHA is moved to the next location (station) within the zone of interest 210 or to the next zone of interest, if any, and the operation is repeated. When the zones of interest are fractured, the tripping out operation continues and the drill string is removed from the well. In this manner the drilling and fracturing has been performed in a single (i.e., last) trip.

[0022] Figure 3 shows a detailed view of a fracturing sub 150. Sub 150 comprises multiple spacing sections 310 and other components. Thus, sub 150 is modular, with the number of modules being a design parameter chosen to fit a particular purpose. Each section 310 is typically the same length as a standard drill pipe (i.e., a 30 ft. section or three such sections for a total length of 90 ft.). As Figure 5 shows, the zone of interest spanning the depths 510a to 510b can be divided into multiple stations spanning the depths 520a to 520b, 520c to 520d, etc. The zone of interest in Figure 5 has been divided into two stations, but there can be as many stations as desired. The drill string stops at each station and performs the fracturing operation before moving to the next station. The span of each station is generally limited by the length of sub 150, which in turn depends on the number of sections 310 and other components described below.

[0023] As stated above, fracturing sub 150 has at least two retrievable packers, shown as packers 320 in Figure 3. The at least two packers 320 are spaced apart to establish the operational length of a station (e.g., 520a to 520b). If the length of the station is known *a priori*, the number of sections and the locations of packers 320 can be determined before the BHA 130 is run into the well on the last trip. If the length of the station is not finalized before BHA 130 enters the well, multiple packers may be provided, but, in operation, only the pair spanning the desired station distance is activated for each hydraulic isolation. In one embodiment, a fixed length (packer separation) is used for the stations, eliminating the cost and complexity of extra packers.

[0024] The sub 150 also comprises at least one pumping unit 330, located close to the top (i.e., uphole end) of BHA 130. Pumping unit 330 is operated after packers 320 have been activated and hydraulic isolation has been established to pump the drilling fluid in the isolated zone out into other portions of the well annulus. The pumping unit 330 has one or more vents (ports) 332 that allow fluid to flow from the isolated zone annulus into pumping unit 330. Vent 332 can be opened and closed on command or it can be spring-loaded, with applied pressure causing it to open when the pump is on, while the spring closes it once the pump pressure drops below a certain threshold. Thus, while pumping the drilling fluid out, vent 332 is open, allowing the drilling fluid in the isolated zone annulus to be evacuated. In some cases it may be desirable to treat the formation wall for more efficient (typically imminent) fracturing operations. This may include acidization or treatment fluids that destroy the mud cake previously formed on the formation wall. If this is desired, the operative fluids are pumped from surface into the isolated zone. Once their operative effects are completed, their by-products may be pumped out of the isolated zone annulus into another portion of the well annulus using pumping unit 330.

[0025] In addition, sub 150 also comprises a sealing unit 340 that may be used to isolate the bottom (i.e., lower end) of sub 150 from the trailing (i.e., lower end of) BHA 130 and any other piping that may extend farther down. Sealing unit 340 can be or comprise a valve, for example, that can be actuated on command. This valve is used to hydraulically seal the bottom of sub 150 prior to operating pumping unit 330 and removing the drilling fluid in the isolated zone annulus. In another embodiment, the sealing unit 340 may operate using a sealing surface and a sealing ball that can be delivered to the sealing surface, thereby forming a seal.

[0026] When an operator is ready to commence the actual fracturing operation, the fracturing fluid is pumped through drill pipes 140 and into the isolated zone. The fracturing fluid may contain the customary additives used in fracturing operations. A pumping rate is pre-determined to ensure a desired pressure is obtained inside the isolated zone, causing the formation to initiate a fracture. The applied pressure is further maintained to ensure the fracture is propagated to a desired length. This pumping rate can be adjusted as deemed necessary during the course of the fracturing operation. In one embodiment the flow into the isolated zone is through vents 332. In another embodiment the flow into the isolated zone is through a dedicated port which may have been enlarged to accommodate higher flow rates (not shown). In all cases, when the fracturing fluid is pumped into the isolated zone, the normal flow path to the drill bit is closed off so that the pressure is only applied to the isolated zone. The close-off can be done by a dedicated valve, for example (not shown).

[0027] The sub 150 may also comprise one or more micro-seismic receivers 350 that are used to detect and record the acoustic vibrations generated from the fracturing of the rock. These receivers 350 are commonly used in fracturing operations and their signals are processed to determine the lengths and directions of the fractures. The receivers 350, carried on sub 150, are sensitive to acoustic signals generated during the fracturing operation, but they are also sensitive to the events that happen close to sub 150. In particular, the receivers 350 can be used to accurately pinpoint the locations where the fractures initiated and their initial propagation directions away from the well.

[0028] To have information from more distant locations, one may place multiple receivers 350 at several locations along the wellbore, as well as on the earth's surface. Figure 4 shows the drill string with drill bit 120, BHA 130, fracturing sub 150, and multiple receivers 350 at different locations. With this arrangement, and possibly having one or more receivers 350 on the surface (not shown), it is possible to detect ample seismic signal to process and map the fractures. In one embodiment, the processing is done in real-time and operational parameters such as the pumping rate may be adjusted accordingly.

[0029] Figure 6 is a flowchart for one embodiment to perform fracturing operations using a drill string. A drill string comprising drill pipe, a bottomhole assembly, and a drill bit, wherein

the bottomhole assembly comprises a fracturing sub, is provided (602). A wellbore is drilled to a desired depth using the drill string (604). The drill string is partially withdrawn to a desired location in the wellbore (606). A section of the wellbore is hydraulically isolated and a cavity between the drill string and the wall of the isolated section of the wellbore is formed using the fracturing sub (608). The cavity is evacuated until a first desired pressure within the cavity is attained (610). Fluid is injected into the cavity until a second desired pressure within the cavity is attained (612). The drill string is removed from the wellbore (614).

[0030] Some of the techniques described above can be performed by a processor. The term “processor” should not be construed to limit the embodiments disclosed herein to any particular device type or system. The processor may include a computer system. The computer system may also include a computer processor (e.g., a microprocessor, microcontroller, digital signal processor, or general purpose computer) for executing any of the methods and processes described above.

[0031] The computer system may further include a memory such as a semiconductor memory device (e.g., a RAM, ROM, PROM, EEPROM, or Flash-Programmable RAM), a magnetic memory device (e.g., a diskette or fixed disk), an optical memory device (e.g., a CD-ROM), a PC card (e.g., PCMCIA card), or other memory device.

[0032] Some of the methods and processes described above, can be implemented as computer program logic for use with the computer processor. The computer program logic may be embodied in various forms, including a source code form or a computer executable form. Source code may include a series of computer program instructions in a variety of programming languages (e.g., an object code, an assembly language, or a high-level language such as C, C++, or JAVA). Such computer instructions can be stored in a non-transitory computer readable medium (e.g., memory) and executed by the computer processor. The computer instructions may be distributed in any form as a removable storage medium with accompanying printed or electronic documentation (e.g., shrink wrapped software), preloaded with a computer system (e.g., on system ROM or fixed disk), or distributed from a server or electronic bulletin board over a communication system (e.g., the Internet or World Wide Web).

[0033] Alternatively or additionally, the processor may include discrete electronic components coupled to a printed circuit board, integrated circuitry (e.g., Application Specific Integrated Circuits (ASIC)), and/or programmable logic devices (e.g., a Field Programmable Gate Arrays (FPGA)). Any of the methods and processes described above can be implemented using such logic devices.

[0034] While the embodiments described above particularly pertain to the oil and gas industry, this disclosure also contemplates and includes potential applications such as water wells or other wells primarily drilled to produce fluid from low permeability formations.

[0035] The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that such equivalent constructions do not depart from the scope of the present disclosure, and that they may make various changes, substitutions, and alterations herein without departing from the scope of the present disclosure.

[0036] The Abstract at the end of this disclosure is provided to comply with 37 C.F.R. §1.72(b) to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

[0037] While only certain embodiments have been set forth, alternatives and modifications will be apparent from the above description to those skilled in the art. These and other alternatives are considered equivalents and within the scope of this disclosure and the appended claims. Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from this invention. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also

equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. § 112, paragraph 6 for any limitations of any of the claims herein, except for those in which the claim expressly uses the words ‘means for’ together with an associated function.

Claims

What is claimed is:

1. A method, comprising:
 - providing a drill string comprising drill pipe and a fracturing sub;
 - drilling a wellbore to a desired depth using the drill string;
 - positioning the drill string at a desired location in the wellbore;
 - hydraulically isolating a section of the wellbore and forming a cavity between the drill string and the wall of the isolated section of the wellbore using the fracturing sub;
 - and
 - injecting fluid into the cavity until a desired pressure within the cavity is attained.
2. The method of claim 1, wherein the positioning the drill string comprises placing the fracturing sub adjacent to a zone of interest.
3. The method of claim 2, wherein the positioning the drill string further comprises placing the fracturing sub adjacent to a subsurface station within the zone of interest.
4. The method of claim 1, wherein the hydraulically isolating comprises actuating two or more retrievable packers.
5. The method of claim 1, further comprising pumping fluid out of the isolated section.
6. The method of claim 5, further comprising passing the fluid through one or more ports in the fracturing sub.
7. The method of claim 1, wherein the desired pressure corresponds to a desired level of fracturing.
8. The method of claim 1, further comprising providing one or more seismic sensors and monitoring the fracturing using the one or more seismic sensors.

9. The method of claim 8, wherein the one or more sensors comprises a plurality of sensors distributed along the drill string.
10. A system, comprising:
- a drill string comprising drill pipe and a fracturing sub; and
 - a processor located at the earth's surface or carried on the drill string capable of:
 - drilling a wellbore to a desired depth using the drill string;
 - positioning the drill string at a desired location in the wellbore;
 - hydraulically isolating a section of the wellbore and forming a cavity between the drill string and the wall of the isolated section of the wellbore using the fracturing sub; and
 - injecting fluid into the cavity until a desired pressure within the cavity is attained.
11. The system of claim 10, wherein the fracturing sub comprises two or more retrievable packers.
12. The system of claim 10, wherein the fracturing sub comprises a pump.
13. The system of claim 10, wherein the fracturing sub comprises one or more ports.
14. The system of claim 13, wherein the one or more ports are activated remotely by command or automatically activated.
15. The system of claim 10, wherein the fracturing sub comprises one or more spacers.
16. The system of claim 10, wherein the fracturing sub comprises two or more modules.
17. The system of claim 10, further comprising one or more seismic sensors carried on and distributed along the drill string.
18. The system of claim 10, further comprising logging-while-drilling tools integral with the drill string.

19. The system of claim 10, further comprising a bottomhole assembly having a lower sealing unit.
20. The system of claim 19, wherein the lower sealing unit is selected from the group consisting of a valve and a sealing surface/sealing ball combination.

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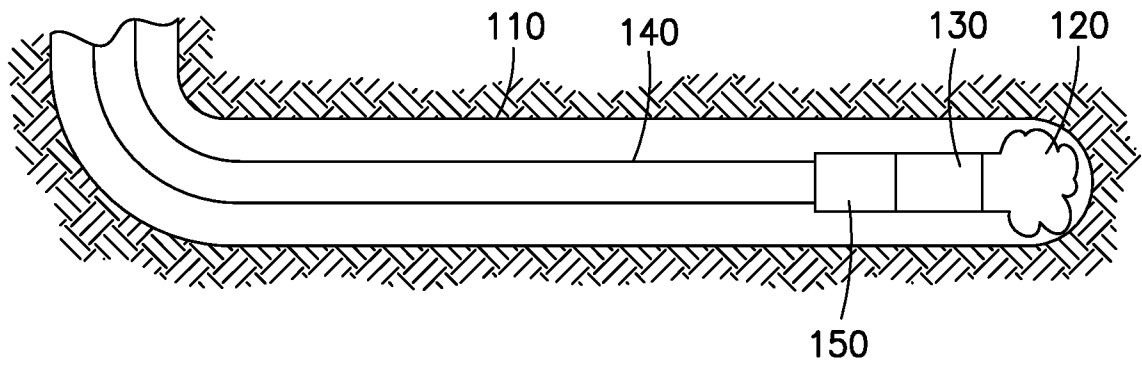


FIG. 1

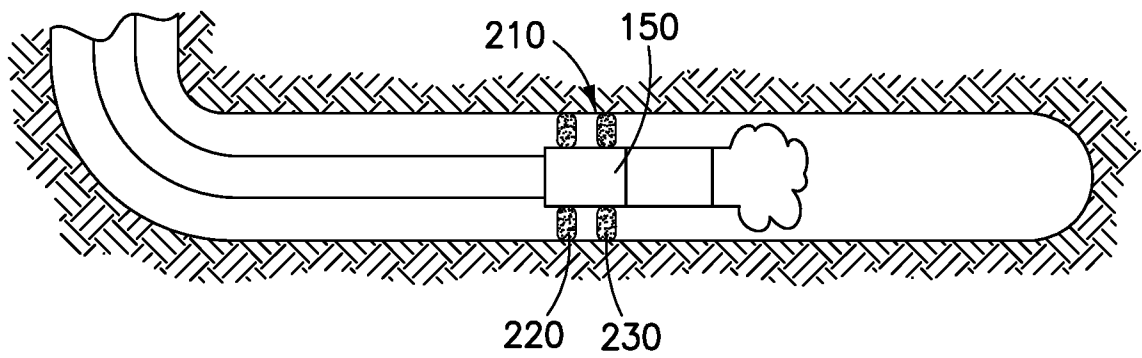


FIG. 2

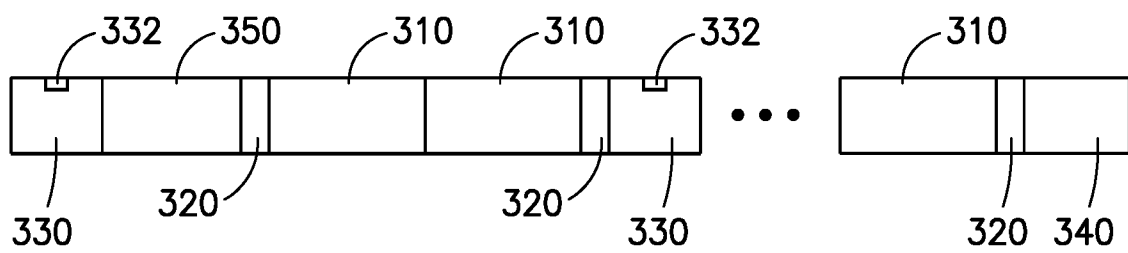


FIG. 3

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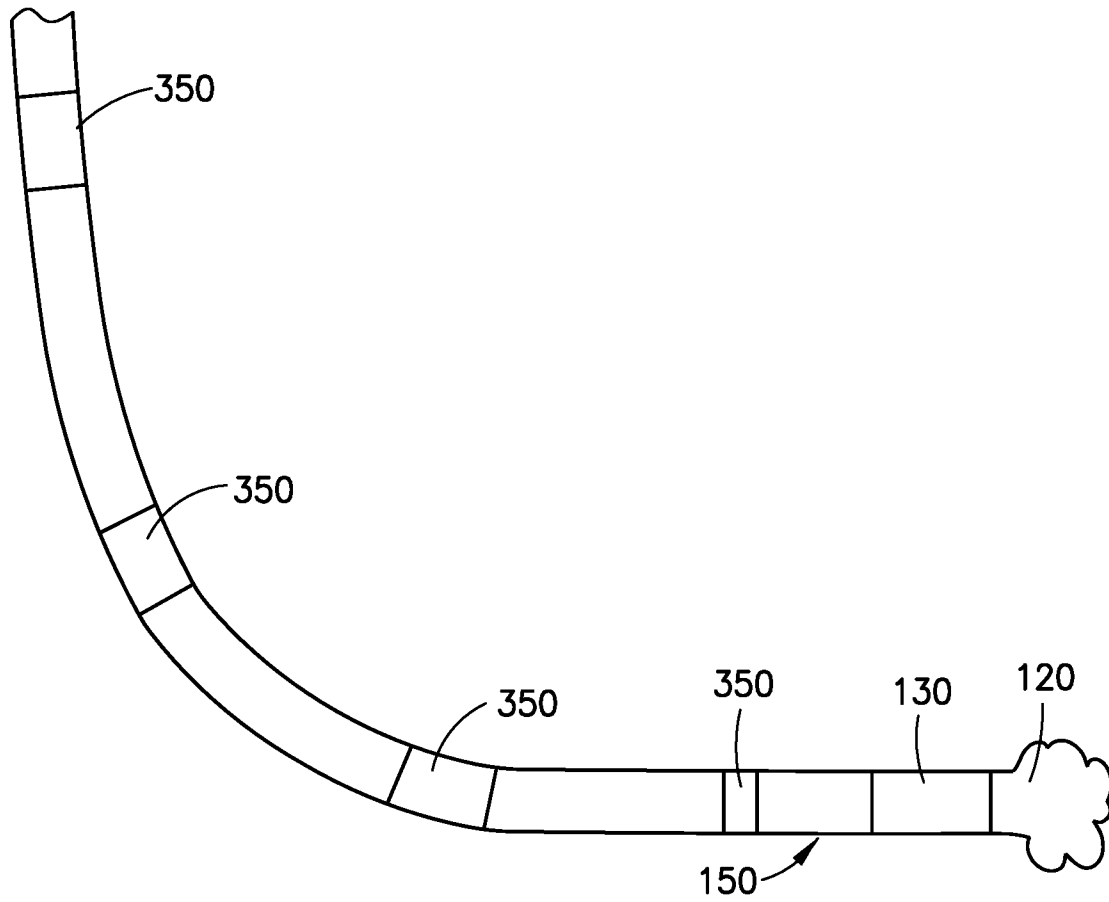


FIG. 4

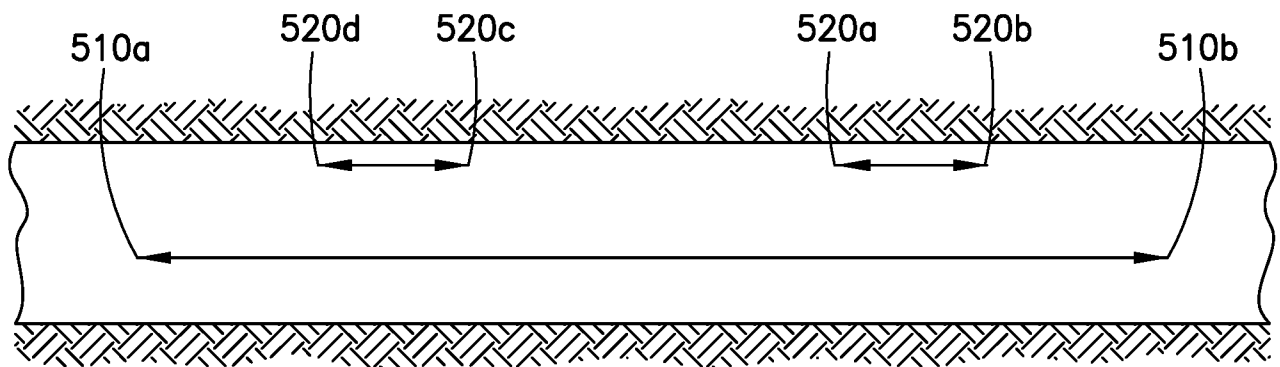


FIG. 5

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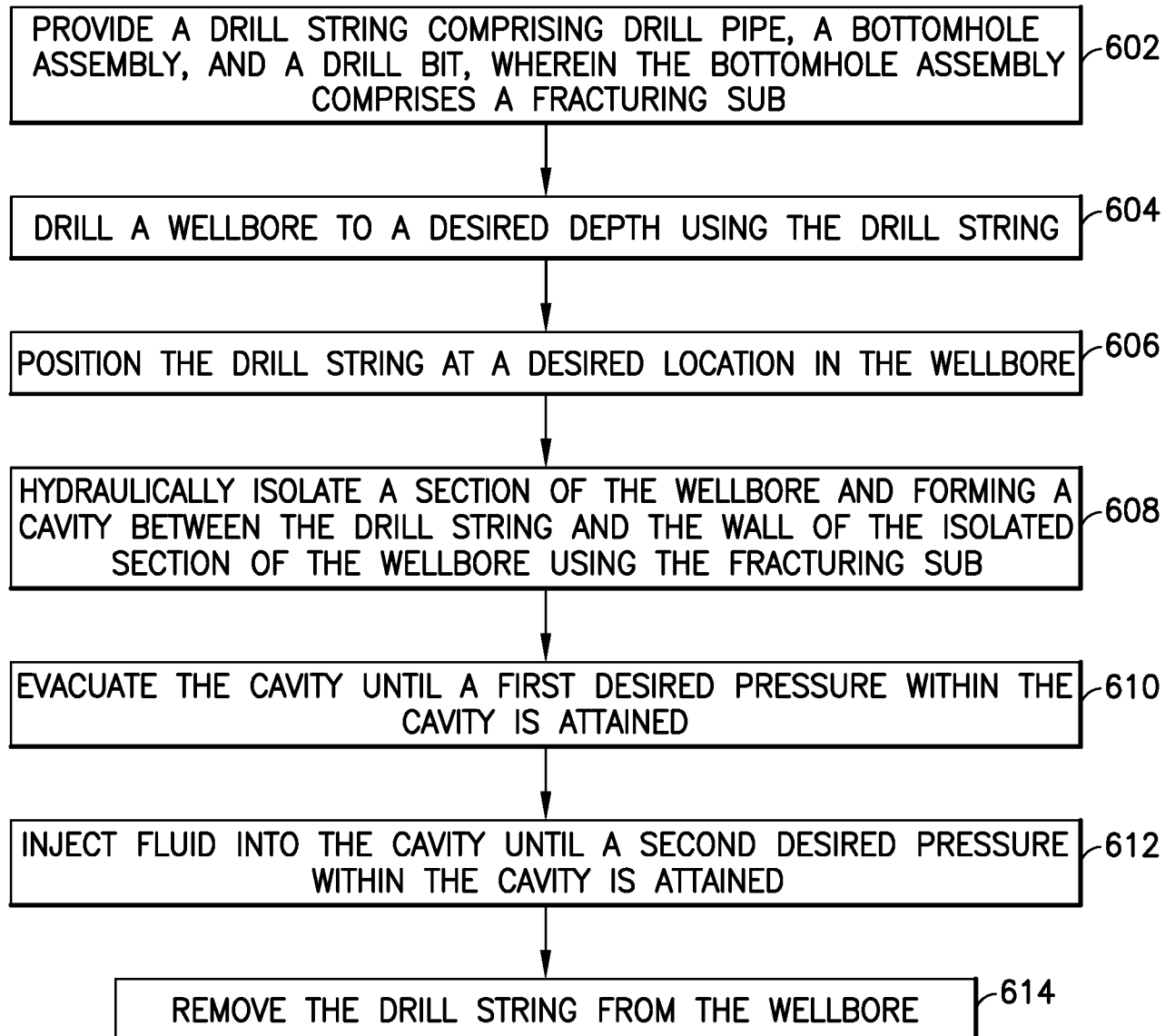


FIG.6

A. CLASSIFICATION OF SUBJECT MATTER**E21B 43/17(2006.01)i, E21B 43/26(2006.01)i, E21B 33/12(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 43/17; E21B 43/04; E21B 43/114; E21B 33/124; E21B 43/26; E21B 47/14

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: drilling, fracture, single trip, injection, pressure, packer, isolation, fluid, sensor, seismic, port, remote, and BHA**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005-0284633 A1 (RICHARD, BENNETT) 29 December 2005 See abstract, paragraph [0025], and figure 4.	1-20
Y	US 2010-0044041 A1 (SMITH et al.) 25 February 2010 See abstract, paragraphs [0032], [0035], [0039], [0056], and figures 1, 4A, 4D.	1-20
Y	US 2014-0290936 A1 (WILLS et al.) 02 October 2014 See abstract, paragraphs [0015]-[0016], [0028], and figure.	8-9, 17
Y	WO 2014-130036 A1 (HALLIBURTON ENERGY SERVICES, INC.) 28 August 2014 See abstract, page 4, lines 4-18, and figure 2.	18-20
A	US 4474409 A (TREVITS et al.) 02 October 1984 See abstract, column 2, line 42 - column 3, line 3, and figure 1.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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Date of mailing of the international search report

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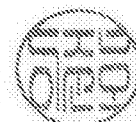
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/020389

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005-0284633 A1	29/12/2005	AU 2005-255028 A1 AU 255028 B2 BR PI0512101 A CA 2570378 A1 CA 2570378 C GB 2429485 A GB 2429485 B NO 20070205 A RU 2007101037 A RU 2390623 C2 US 7401648 B2 WO 2005-124091 A1	29/12/2005 30/06/2011 06/02/2008 29/12/2005 19/10/2010 28/02/2007 17/06/2009 12/01/2007 20/07/2008 27/05/2010 22/07/2008 29/12/2005
US 2010-0044041 A1	25/02/2010	AU 2009-284080 A1 AU 284080 B2 CA 2734351 A1 CA 2734351 C CO 6321177 A2 EP 2318654 A2 MX 2011001947 A US 8960292 B2 WO 2010-020747 A2 WO 2010-020747 A3	25/02/2010 06/08/2015 25/02/2010 08/04/2014 20/09/2011 11/05/2011 04/04/2011 24/02/2015 25/02/2010 26/05/2011
US 2014-0290936 A1	02/10/2014	AU 2012-271016 A1 AU 271016 B2 CA 2838840 A1 WO 2012-173924 A2 WO 2012-173924 A3	28/11/2013 04/12/2014 20/12/2012 20/12/2012 25/04/2013
WO 2014-130036 A1	28/08/2014	CA 2898736 A1 CN 104903541 A EP 2929135 A1 MX 2015008833 A US 2015-0068735 A1 US 9234408 B2	28/08/2014 09/09/2015 14/10/2015 14/10/2015 12/03/2015 12/01/2016
US 4474409 A	02/10/1984	None	