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- (71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.** [US/US]; 3000 North Sam Houston Parkway East, Houston, TX 77032-3219 (US).
- (72) Inventors: **SURJAATMADJA, Jim, B.**; 1105 Timbercreek Dr., Duncan, OK 73533 (US). **MARTYSEVICH, Vladimir, Nikolayevich**; 2727 Halstead Drive, Spring, TX 77386 (US).
- (74) Agents: **ROSE, Collin, A.** et al.; 1200 Smith Street, 14th Floor, Houston, TX 77002 (US).
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(54) Title: DOWNHOLE HYDRAULIC FRACTURING TOOL

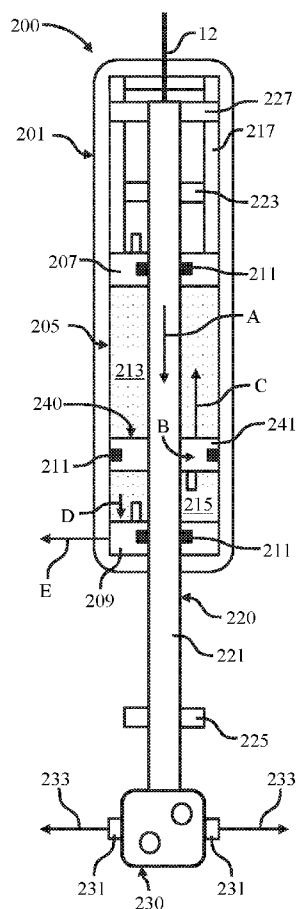


FIG. 2

(57) Abstract: A downhole tool for injecting fluid in a wellbore intersecting a subterranean formation. The tool can include a housing, a piston assembly moveably received in a chamber in the housing and dividing the chamber into an extension cavity and a retraction cavity, a rod assembly moveable within the housing and including a conduit, a nozzle in fluid communication with the conduit. The tool can release fluid in a cyclical pattern powered by pressurized fluid flowing through the conduit or a power source such as a pump with control lines in fluid communication with the cavities.



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Downhole Hydraulic Fracturing Tool

Background

[0001] This section is intended to provide background information to facilitate a better understanding of the various aspects of the described embodiments. Accordingly, it should be understood that these statements are to be read in this light and not as admissions of prior art.

[0002] Hydrocarbon-producing wells often are stimulated by hydraulic fracturing operations. A fracturing fluid may be introduced into a portion of a subterranean formation penetrated by a wellbore at a pressure sufficient to create or enhance fractures in the formation. Stimulating or treating the formation in such ways increases hydrocarbon production from the well.

[0003] In some hydraulic fracturing operations, the fracturing fluid enters the subterranean formation through one or more perforations. These perforations may be formed using a variety of techniques including jetting a fluid or detonating explosive charges into the casing or formation. Jetting releases a fluid through a nozzle at high pressure producing a narrow stream that erodes or washes away formation or casing materials. The fluid is generally supplied through the use of pumps or other pressurization equipment at the surface of the wellbore. Explosive charges can be carried using wireline or tubing, depending upon applications. Fluid jetting requires the use of a tubular, whether it is jointed pipe (using a rig) or coiled tubing.

Brief Description of the Drawings

[0004] For a detailed description of the embodiments of the invention, reference will now be made to the accompanying drawings in which:

[0005] FIG. 1 depicts a schematic of a jetting system deployed in a wellbore intersecting a subterranean formation, according to one or more embodiments;

[0006] FIG. 2 depicts a schematic of the downhole tool of FIG. 1, according to one or more embodiments;

[0007] FIG. 3 depicts a schematic of an extension drain valve in the downhole tool of FIG. 1, according to one more embodiments;

[0008] FIG. 4 depicts a schematic of a retraction drain valve and the piston assembly of FIG. 2, according to one more embodiments;

[0009] FIG. 5 depicts another schematic of the retraction drain valve and the piston assembly of FIG. 2, according to one or more embodiments;

[0010] FIG. 6 depicts another schematic of the downhole tool, according to one or more embodiments; and

[0011] FIG. 7 depicts a graph of a stroke signal of the downhole tool of FIG. 1, according to one or more embodiments.

Detailed Description

[0012] This disclosure provides a jetting tool for injecting fluid in a wellbore intersecting a subterranean formation. Specifically, the disclosure provides a downhole tool that releases fluid in a cyclical pattern and can be powered by the jetting fluid or a hydraulic power source.

[0013] Jetting tools are used to perforate the formation by releasing a fluid through a nozzle into the wellbore to create a fracture in the formation extending from the wellbore. Moving the jetting tool up and down the wellbore while it releases the fluid can produce a slot in the formation that runs along the wellbore axis. However, slotting generally is done by uncoiling and recoiling coiled tubing, which may rotate the jetting tool while it is slotting a perforation in the formation. The rotation of the jetting tool can prevent the slotting to occur in a repeatable pattern, resulting in a malformed, unpredictable shape of the slot.

[0014] As described below, a jetting system can include a mechanism that moves the nozzle in a cyclical pattern without moving the coiled tubing to position the nozzle. For example, a downhole tool can include a piston and rod that are powered by some of the pressurized jetting fluid to stroke the nozzle in a cyclical pattern. Thus, a slotted perforation can be formed in the formation without the unpredictability of moving coiled tubing.

[0015] FIG. 1 depicts a jetting system 100 for injecting a fluid into a wellbore 20, according to one or more embodiments. The jetting system 100 can include a hydraulic power source 10, a carrier 12 in fluid communication with the hydraulic power source 10, and a downhole tool 200 located on the carrier 12. The tool 200 can be deployed in a wellbore 20 intersecting a subterranean formation 30. The hydraulic power source 10 can include a pump with a fluid reservoir or any other suitable hydraulic power source to produce a fluid under enough pressure to exit the tool 200.

[0016] In one or more embodiments, the tool 200 can be attached to the carrier 12, which positions the tool 200 into the wellbore 20 and supplies it with jetting fluid as indicated by

arrow F. The carrier 12 may include, but is not limited to rigid carriers, non-rigid carriers, coiled tubing, casing, liners, etc. The term “carrier” as used herein means any device, device component, combination of devices, media, and/or member that may be used to convey, house, support, or otherwise facilitate the use of another device, device component, combination of devices, media, and/or member. The carrier 12 can include various cables or control lines, such as hydraulic control lines, electric control lines, or fiber optic cables. The control lines on carrier 12 can provide a communication data path or supply power to the downhole tool 200.

[0017] The tool 200 can include a housing 201 with extension devices 203 (*e.g.*, retaining springs, bow springs, or lugs) engaged with the wellbore 20 to stabilize the tool 200 to the wellbore 20 during the fluid injection process. A rod assembly 220 in fluid communication with the carrier 12 can be moveably coupled to the housing 201. The rod assembly 220 can be moveable within the housing 201. Attached to the rod assembly is a jetting assembly 230 housing one or more jet nozzles 231 configured to control the flow of fluid exiting the tool 200. The rod assembly 220 can extend or retract from the housing 201 (as indicated by the arrow S), moving the nozzles 231 away from or towards the housing 201 without uncoiling or recoiling the carrier 12 at the surface. Pressurized fluid flows through the nozzles 231 spraying jets of fluid 233 into the wellbore 20 and penetrating the formation 30 forming perforation slots 40. The jetting assembly 230 can have any number of nozzles 231, positioned in a variety of patterns along and around the nozzle assembly 230. Further, the nozzles 231 can be angled to produce any number of jets 233 in various angled orientations (*e.g.*, 45 degrees from perpendicular with the longitudinal axis of the wellbore 20).

[0018] In one or more embodiments, the pressurized fluid flowing through the tool 200 can include solid particles (*e.g.*, sand) mixed with a base fluid (*e.g.*, water). The pressurized fluid flowing through the tool 200 can include abrasives, acids, chelating acids, polymers, cement, proppant, fracturing fluid, any other chemicals (such as fuel and oxidizers), and combinations thereof. Further, the pressurized fluid can include any suitable substance or material that can be injected into the wellbore 20 through the tool 200. In addition, the tool 200 is not limited to perforating the formation, but can also be used to inject fluid into the wellbore 20 for other stimulation operations, such as acidizing, polymer injection, cementing, hydraulic fracturing, or other subterranean fluid injection applications. As examples, the tool 200 can be used to inject fluid to fix leaks in the wellbore 20, such as squeeze cementing or in plugging and

abandoning operations. In one or more embodiments, the tool 200 can be employed as a downhole hydraulic fracturing tool.

[0019] A travel joint 16 may be coupled between the tool 200 and carrier 12 to allow the rod assembly 205 to move freely within its stroke. As illustrated, the travel joint 16 is not drawn to scale and may have a stroke substantially similar to the stroke of the tool 200. In one or more embodiments, the carrier 12 can communicatively couple the tool 200 to a surface control unit 14 in communication with the hydraulic power source 10. The surface control unit 14 can include telemetry systems (*e.g.*, modem, transducer, or control lines) and information processing systems (*e.g.*, a processor). The processor of the surface control unit 10 can be configured to perform methods as described herein, such as controlling the operation of the tool 200..

[0020] A wellbore assembly 18 can be located uphole or downhole from the tool 200 in the wellbore 20. Further, an additional wellbore assembly 18 may be located in the wellbore 20, such as downhole from the tool 200. In one or more embodiments, the wellbore assembly 18 may be located on the tool 200. The wellbore assembly 18 can include any suitable device (such as a packer) configured to provide an annular barrier between sections of the wellbore 20 to fluidly isolate those sections (*e.g.*, an uphole section 21 and a downhole section 23). In one or more embodiments, the wellbore assembly 18 can include an anchoring device configured to resist motion along the carrier 12, such as unwanted motion in the carrier 12 produced above the wellbore assembly 18. The unwanted motion in the carrier 12 may be caused by expansion or contraction of the carrier 12 due to temperature changes in the wellbore 20. Optionally, the wellbore assembly 18 may include the anchoring device without the ability to fluidly isolate sections of the wellbore 20.

[0021] FIG. 2 depicts a schematic of the tool 200 of FIG. 1, according to one or more embodiments. The tool 200 can include a housing 201 and a chamber 205 in the housing 201. A piston assembly 240 can be moveable within the chamber 205. In particular, the chamber 205 can be defined in the housing 201 by two end caps 207, 209. Further, the end caps 207, 209 can include one or more seals 211 to prevent fluid from leaking into or from the chamber 205. Seals 211 can include elastomer seals, O-ring seals, annular seals, wiper seals, any other suitable fluid barrier, or combinations thereof.

[0022] The rod assembly 220 includes a conduit 221 that extends through the end caps 207, 209. The conduit 221 is in fluid communication with the carrier 12 and includes a flow path for receiving the pressurized fluid and communicating the fluid to the jetting assembly 230.

[0023] The piston assembly 240 can include a piston 241 coupled to the rod assembly 220 within the chamber 205 and is moveable with the rod assembly 220. The piston 241 divides the chamber 205 into an extension cavity 213 and a retraction cavity 215. Further, the piston assembly 240 can include one or more seals 211 to prevent fluid communication between the extension cavity 213 and the retraction cavity 215. In one or more embodiments, the piston assembly 240 may be in fluid communication with the conduit 221 to channel some of the pressurized fluid to at least one of the cavities 213, 215 as explained below. Rod actuators 223, 225 may also be coupled to the rod assembly 220 to control the flow of fluid out of the cavities 213, 215 as explained further.

[0024] FIG. 3 depicts a schematic of an extension drain valve 250 located on the end cap 207 of FIG. 2, according to one or more embodiments. The extension drain valve 250 includes an inlet port 251 in fluid communication with the extension cavity 213, an outlet port 253 in fluid communication with the space outside the housing 201 (*e.g.*, the wellbore 20), and a switch device 255 that controls whether inlet port 251 is open or closed. As illustrated, the drain valve 250 is closed preventing fluid from draining from the extension cavity 213. Thus, the drain valve 250 can control the flow of fluid out of the extension cavity 213.

[0025] FIG. 4 depicts a schematic of a retraction drain valve 260 located on the end cap 209, in accordance with one or more embodiments. The drain valve 260 includes an inlet port 261 in fluid communication with the retraction cavity 215, an outlet port 263 in fluid communication with the space outside the housing 201 (*e.g.*, the wellbore 20), and a switch device 265. As illustrated, the drain valve 260 is open allowing fluid to drain from the retraction cavity 215. Thus, the drain valve 260 can control the flow of fluid out of the retraction cavity 215.

[0026] Referring to FIGS. 3 and 4, the switch device 255, which is also illustrative of switch device 265, can control whether the drain valve 250 is opened or closed by moving to an open position or a closed position. Although, the discussion is for the switch device 255, the description is applicable to the switch device 265 as well. As illustrated, the switch device 255 is in a closed position and the drain valve 250 is closed, preventing fluid from draining from the extension cavity 213. Further, the switch device 255 can be moved to an open position, opening the drain valve 250. The open position of the switch device 255 can resemble the open position of the switch device 265 as illustrated in FIG. 4. That is, in the open position, a portion of the switch device 255 can be positioned in the extension cavity

213 to contact the piston assembly 240. In addition, when the drain valve 255 is open, fluid can flow through the inlet port 251 from the extension cavity 213 to the outlet port 253, allowing fluid to flow out of the housing 201 (*e.g.*, into the wellbore 20).

[0027] FIG. 4 also depicts a schematic of the piston assembly 240, according to one or more embodiments. The piston assembly 240 can include a valve 270, including an inlet port 271 in fluid communication with the conduit 221, an outlet port 273 in fluid communication with the extension cavity 213, an outlet port 275 in fluid communication with the retraction cavity 215, and a switch device 277. As illustrated, the outlet port 273 is open allowing fluid to flow into the extension cavity 213; and the outlet port 275 is closed preventing fluid from flowing into the retraction cavity 215 from the conduit 221. The switch device 277 can be coupled to the valve 270 to control which of the outlet ports 273, 275 is open or closed. The switch device 277 can be configured to switch a flow path in the valve 270 between the outlet ports 273, 275. In one or more embodiments, the piston assembly 240 can include a filter 279 in fluid communication with the conduit 221 and the outlet ports 273, 275. The filter 279 can include any suitable membrane or layer that prevents at least some of the solid particles (such as abrasives, proppant, tracers, cement, polymers, or any other solid particle) in the pressurized fluid from passing through the filter 279 while allowing at least some of the pressurized fluid to flow through the filter 279. As an example, the filter 279 can prevent abrasives mixed with the pressurized fluid from entering the extension cavity 213 or the retraction cavity 215. As illustrated, the filter 279 can be positioned in contact with the high flow rate jetting fluid in the conduit 221 to allow the jetting fluid to clean the filter 279 and prevent it from clogging.

[0028] The switch device 277 can control which cavity 213 or 215 is being filled by moving from an extension position to a retraction position. As illustrated, the switch device 277 is in the extension position such that the outlet port 273 is open, while the outlet port 275 is closed. In the extension position, a portion of the switch device 277 can be in the retraction cavity 215 to contact the end cap 209 during the stroke of piston assembly 240. Upon contact with the end cap 209, the switch device 277 can be moved to open the outlet port 275 and close the outlet port 273. In this retraction position, a portion of the switch device 277 can be in the extension cavity 213 to contact the end cap 207 during the stroke of the piston assembly 240.

[0029] In one or more embodiments, the pressurized fluid flows through the conduit 221 and into the jetting assembly 230. In the illustrated example of FIG. 4, some of the

pressurized fluid is diverted to the extension cavity 213 through the piston assembly 240. As the extension cavity 213 is filled with fluid, pressure in the extension cavity 213 increases, moving the piston assembly 240 towards the end cap 209. The retraction cavity 215 may contain fluid in it, and as such, this fluid can be drained through the end cap 209 outside of the housing 201 (*e.g.*, into wellbore 20). Referring to FIGS. 2 and 4, arrows A–E show exemplary flow paths of fluid within the tool 200 as the extension cavity 213 is filled and the retraction cavity 215 is drained by the stroke of the piston assembly 240. Further, the rod assembly 220 and the jetting assembly 230 can move with the stroke of piston assembly 240.

[0030] In cases where upper cavity 213 is being filled with fluid (as illustrated), the rod assembly 220 is moved down through the housing 201 and the actuator 223 approaches the switch device 255 of the end cap 207. The actuator 223 can be positioned on the rod assembly 220 to close the extension drain valve 250 when the piston assembly 240 reaches a predetermined position within its stroke (*e.g.*, at the end of its stroke, half-way through its stroke, 1 inch from the end, or any suitable position along the stroke of the piston assembly 240). When the actuator 223 contacts or moves the switch device 255, the contact can actuate the switch device 255, triggering the drain valve 250 to open and vent fluid from the extension cavity 213.

[0031] As the actuator 223 approaches the switch device 255, the piston assembly 240 also approaches the switch device 265. When the piston assembly 240 contacts or moves the switch device 265, the drain valve 260 is triggered to close and prevent fluid from draining from the retraction cavity 215. In addition, when the piston assembly 240 contacts the end cap 209, the contact can move the switch device 277, triggering the valve 270 to close the outlet port 273 and to open the outlet port 275. Thus, the stroke of piston assembly 240 can be reversed by opening the drain valve 250, closing the outlet port 273, opening the outlet port 275, and closing the drain valve 260. During this retraction or return stroke of the jetting assembly 230, the retraction cavity 215 can be filled with some of the pressurized fluid flowing through the conduit 221 while the extension cavity 213 can be drained of any fluid that it contains through the drain valve 250.

[0032] To return to the state illustrated in FIG. 4 (*i.e.*, the extension stroke of the jetting assembly 230), the actuator 225 can contact or move the switch device 265 to its open position, triggering the drain valve 260 to open. The piston assembly 240 can also contact or move the switch device 255, triggering the drain valve 250 to close. The end cap 207 can also

contact or move the switch device 277, triggering the outlet port 273 to open and the outlet port 275 to close.

[0033] In one or more embodiments, the switch devices 255, 265, 277 can include one or more proximity sensors, such as a sonar sensor, an ultra-sonic sensor, an infrared sensor, a magnetometer, an optical sensor, an electric continuity sensor, or any suitable sensor configured to detect the proximity or contact between the end cap 207 and the actuator 223, the end cap 209 and the actuator 225, or the piston assembly 240 and the end caps 207, 209. As an example, the proximity sensors may detect when piston assembly 240 contacts end cap 209, sending a signal to the valve 270 to open the outlet port 275 and close the outlet port 273. The proximity sensors may also send signals to open the drain valve 250 and to close the drain valve 260. In one or more embodiments, the proximity sensors may detect a predetermined position of the piston assembly 240 (*e.g.*, 83% extended or retracted). Thus, the proximity sensors may detect thresholds of when to control the valves 250, 260, 270. These thresholds may be predetermined positions along the stroke of the jetting assembly 230 (*e.g.*, fully extended or retracted, 50% extended or retracted, 2% extended or retracted, etc.). In one or more embodiments, the switch devices 255, 265, 277 can include a biasing device, such as a spring, to adjust the sensitivity of the switch device detecting contact with at least one of the end caps 207, 209 and the actuators 223, 225.

[0034] Referring to FIG. 2, the housing 201 can include a track 217 configured to guide an azimuthal orientation of the jetting assembly 220. The rod assembly 220 can be moveably coupled to the track 217 through at least one of the rod actuator 223 and a guide 227 extending from the rod assembly 220. In addition, the jetting assembly 230 can be moveably coupled to the track 217 through the rod assembly 220. The guide 227 can include a wheel, a pin, or a cantilever extension extending from the rod assembly 220 and received in the track 217. In particular, the track 217 can be configured to rotate the jetting assembly 230 along its stroke, such as along a helix, a zigzag, or any other suitable rotational pattern. In particular, the rotational pattern on track 217 can produce a corresponding slot in the formation that follows the track 217. The rotational pattern can facilitate fluid injection from various azimuthal orientations of the jetting assembly 230 along the track 217. Further, the rod actuators 223, 225 can form a ring or disk attached to the rod assembly 220 to actuate the switch devices 255, 265 as the rod assembly 220 rotates on the track 217. In one or more embodiments, the track 217 can be positioned on the rod assembly 220, while a stationary guide 227 is positioned on the housing 201 and received in the track 217.

[0035] FIG. 5 shows a schematic of the piston assembly 240, according to one or more embodiments. Optionally, the piston assembly 240 can allow fluid to flow through both the outlet ports 273, 275 (as indicated by the arrows C and F) without the use of the valve 270. As illustrated, the drain valve 260 is open allowing fluid to vent through the outlet port 263, while the drain valve 250 is closed. This produces a pressure differential between the cavities 213 and 215. The stroke of the piston assembly 240 can move toward the lower pressure cavity (*e.g.*, the cavity 215) in the chamber 205. In addition, the stroke of the piston assembly can depend partially upon the size of the outlet ports 253, 263, 273, and 275. In particular, the size of the outlet ports 273, 275 can be smaller than the outlet ports 253, 263. In one or more embodiments, the volume of fluid that exits one of the outlet ports 273, 275 can be less than the volume of fluid that exits one of the outlet ports 253, 263. This can ensure that when the outlet port (253 or 263) of the drain valve (250 or 260) is open, it produces the lower pressure cavity between the cavities 213 and 215 to move the piston assembly 240 toward that open drain valve. Further, without the valve 270, this makes the tool 200 easier to adjust, as it would not depend upon the precise placement of the switch device 277. Optionally, the valve 270 can be used to prevent the loss of unnecessary fluid pressure by closing one of the outlet ports 273, 275 completely.

[0036] FIG. 6 depicts a schematic of the downhole tool 600, according to one or more embodiments. The downhole tool 600 can be used, as described above, with respect to the jetting system 100 of FIG. 1. Instead of being powered by the pressurized fluid flowing through carrier 12 and conduit 621, the tool 600 may stroke the piston assembly 640 by filling or draining cavities 613, 615 with hydraulic fluid from two or more control lines 683, 685. The carrier 12 may provide a communication path for the control lines 683, 685 to the tool 600 from the surface. In one or more embodiments, the control lines 683, 685 may be in communication with a hydraulic power source (*e.g.*, hydraulic power source 10) and a fluid reservoir located at the surface. The hydraulic power source can also be located on another downhole tool or on the tool 600. The control line 683 may be in fluid communication with the extension cavity 613, while the control line 685 may be in fluid communication with the retraction cavity 615. As illustrated, the control line 683 is in fluid communication with the extension cavity 613 through a passageway in the end cap 607; and the control line 685 is in fluid communication with the retraction cavity 615 through another passageway in the end cap 609. As the extension cavity 613 is filled with fluid from the control line 683, the retraction cavity 615 can be drained of fluid through the control line 685, moving the piston

assembly 640 towards the end cap 609 and resulting in the jetting assembly 630 extending away from the housing 601. Alternatively, the extension cavity 613 can be drained of fluid through the control line 683, while the retraction cavity 615 is filled with fluid through the control line 685, moving the piston assembly 640 towards the end cap 607 and resulting in the jetting assembly 630 moving towards the housing 601.

[0037] FIG. 7 depicts a graph of an exemplary stroke signal 701 of the tools 200, 600 over time. The ordinate represents the percentage of stroke relative to the center of the chambers 205, 605 (*e.g.*, where the piston assembly 240 is equidistance from the end caps 207, 209); and the abscissa represents time (*e.g.*, seconds). Referring to FIG. 7, positive fifty percent may represent a stroke fully retracted (*e.g.*, the piston assembly 240 contacts the end cap 207 or the jetting assembly 230 is 100% retracted), while negative fifty percent may represent a stroke fully extended (*e.g.*, the piston assembly 240 contacts the end cap 209 or the jetting assembly 230 is 100% extended). As illustrated, a local maxima 703 represents a point in time where the stroke of the piston assembly 240 is about 27.5 % of its stroke from the center of the chamber 205 (*e.g.*, the jetting assembly 230 is about 77.5 % retracted). A local minima 705 represents another point in time where the stroke of the piston assembly 240 is about 31 % of its stroke from the center of the chamber 205 (*e.g.*, the jetting assembly 230 is about 81 % extended).

[0038] The stroke signal 701 may represent the stroke of the piston assembly 240 over time. The stroke of piston assembly 240 and subsequently nozzles 231 can be configured to move with the stroke signal 701. In particular, the stroke signal 701 may be any suitable signal, such as a sinusoidal signal that varies in amplitude or frequency over time. Further, the illustrated stroke signal 701 oscillates about the center of chamber 205, but the stroke signal 701 may instead oscillate about any predetermined position along the stroke of the piston assembly 240. A processor may be configured to operate the tool 200 by stroking the piston assembly 240 according to the stroke signal 701. In one or more embodiments, the stroke of the piston assembly 240 can be controlled by adjusting the thresholds of the proximity sensors included in the switch devices 255, 265, 277. Optionally, the stroke of the piston assembly 640 can be controlled by varying the hydraulic fluid pumped or drained through control lines 683, 685. In one or more embodiments, the stroke of the piston assembly 240 may be paused or stopped to inject fluid at a predetermined position along its stroke, such as a position where the jetting assembly is 85% extended or retracted.

[0039] This discussion is directed to various embodiments of the invention. The drawing figures are not necessarily to scale. Certain features of the embodiments may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in the interest of clarity and conciseness. Although one or more of these embodiments may be preferred, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. It is to be fully recognized that the different teachings of the embodiments discussed may be employed separately or in any suitable combination to produce desired results. In addition, one skilled in the art will understand that the description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to suggest that the scope of the disclosure, including the claims, is limited to that embodiment.

[0040] Certain terms are used throughout the description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function, unless specifically stated. In the discussion and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to...” Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. In addition, the terms “axial” and “axially” generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms “radial” and “radially” generally mean perpendicular to the central axis. The use of “top,” “bottom,” “above,” “below,” and variations of these terms is made for convenience, but does not require any particular orientation of the components.

[0041] Reference throughout this specification to “one embodiment,” “an embodiment,” or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one embodiment of the present disclosure. Thus, appearances of the phrases “in one embodiment,” “in an embodiment,” and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

[0042] Although the present invention has been described with respect to specific details, it is not intended that such details should be regarded as limitations on the scope of the invention, except to the extent that they are included in the accompanying claims.

Claims

What is claimed is:

1. A downhole hydraulic fracturing tool for use with a fluid, comprising:
 - a housing comprising a chamber,
 - a rod assembly moveable within the housing and comprising a conduit including a flow path for the fluid,
 - a piston assembly coupled to the rod assembly and moveable within the chamber, wherein the piston assembly comprises a piston dividing the chamber into an extension cavity and a retraction cavity, and
 - a nozzle in fluid communication with the conduit and configured to control the flow of the fluid exiting the tool.
2. The downhole hydraulic fracturing tool of claim 1, further comprising:
 - a control line in fluid communication with the extension cavity,
 - an additional control line in fluid communication with the retraction cavity, and
 - a hydraulic power source in fluid communication with at least one of the control lines.
3. The downhole hydraulic fracturing tool of claim 1, wherein:
 - the piston assembly further comprises a valve including an inlet port and two outlet ports, and
 - the outlet ports include an extension outlet port in fluid communication with the extension cavity and a retraction outlet port in fluid communication with the retraction cavity.
4. The downhole hydraulic fracturing tool of claim 3, wherein the inlet port is in fluid communication with the conduit.
5. The downhole hydraulic fracturing tool of claim 3, wherein the piston assembly further comprises a switch device configured to switch a flow path in the valve between the outlet ports.
6. The downhole hydraulic fracturing tool of claim 3, wherein the piston assembly further comprises a filter in fluid communication with the conduit and the outlet ports of the valve.

7. The downhole hydraulic fracturing tool of claim 1, further comprising a track and the nozzle is moveably coupled to the track.
8. The downhole hydraulic fracturing tool of claim 8, wherein the track is configured to rotate the nozzle along the stroke of the nozzle.
9. The downhole hydraulic fracturing tool of claim 1, wherein:
 - the chamber includes an extension drain valve and a retraction drain valve,
 - the extension drain valve controls the flow of fluid out of the extension cavity, and
 - the retraction drain valve controls the flow of fluid out of the retraction cavity.
10. The downhole hydraulic fracturing tool of claim 9, wherein:
 - the rod assembly includes an extension actuator and a retraction actuator,
 - the extension actuator is positioned on the rod assembly to open the extension drain valve, and
 - the retraction actuator is positioned on the rod assembly to open the retraction drain valve.
11. A method of jetting fluid, comprising:
 - flowing fluid through a conduit;
 - moving a piston dividing a cavity and an additional cavity; and
 - releasing the fluid through a nozzle in fluid communication with the conduit and coupled to the piston.
12. The method of claim 11, further comprising:
 - channeling some of the fluid into the cavity;
 - venting another fluid from the additional cavity.
13. The method of claim 11, further comprising:
 - filling the cavity with another fluid through a control line; and
 - draining the additional cavity through an additional control line.

14. The method of claim 11, further comprising moving the nozzle according to a stroke signal.
15. The method of claim 11, further comprising rotating the nozzle.
16. The method of claim 11, further comprising closing a drain valve in fluid communication with the cavity.
17. The method of claim 11, wherein the channeling further comprises filtering the some of the fluid.
18. A jetting system, comprising:
a carrier; and
a jetting tool in fluid communication with the carrier, comprising:
a housing comprising a chamber,
a rod assembly moveable within the housing and comprising a conduit
including a flow path for fluid, wherein the piston assembly comprises
a piston dividing the chamber into an extension cavity and a retraction
cavity,
a piston assembly coupled to the rod assembly and moveable within the
chamber, and
a nozzle in fluid communication with the conduit.
19. The jetting system of claim 18, wherein:
the piston assembly comprises a valve including an inlet port and two outlet ports, and
the outlet ports include an extension outlet port in fluid communication with the
extension cavity and a retraction outlet port in fluid communication with the
retraction cavity.

20. The jetting system of claim 18, further comprising:

a hydraulic power source,

wherein the carrier comprises:

a control line in fluid communication with the extension cavity, and

an additional control line in fluid communication with the retraction cavity,

and

wherein the hydraulic power source is in fluid communication with at least one of the control lines.

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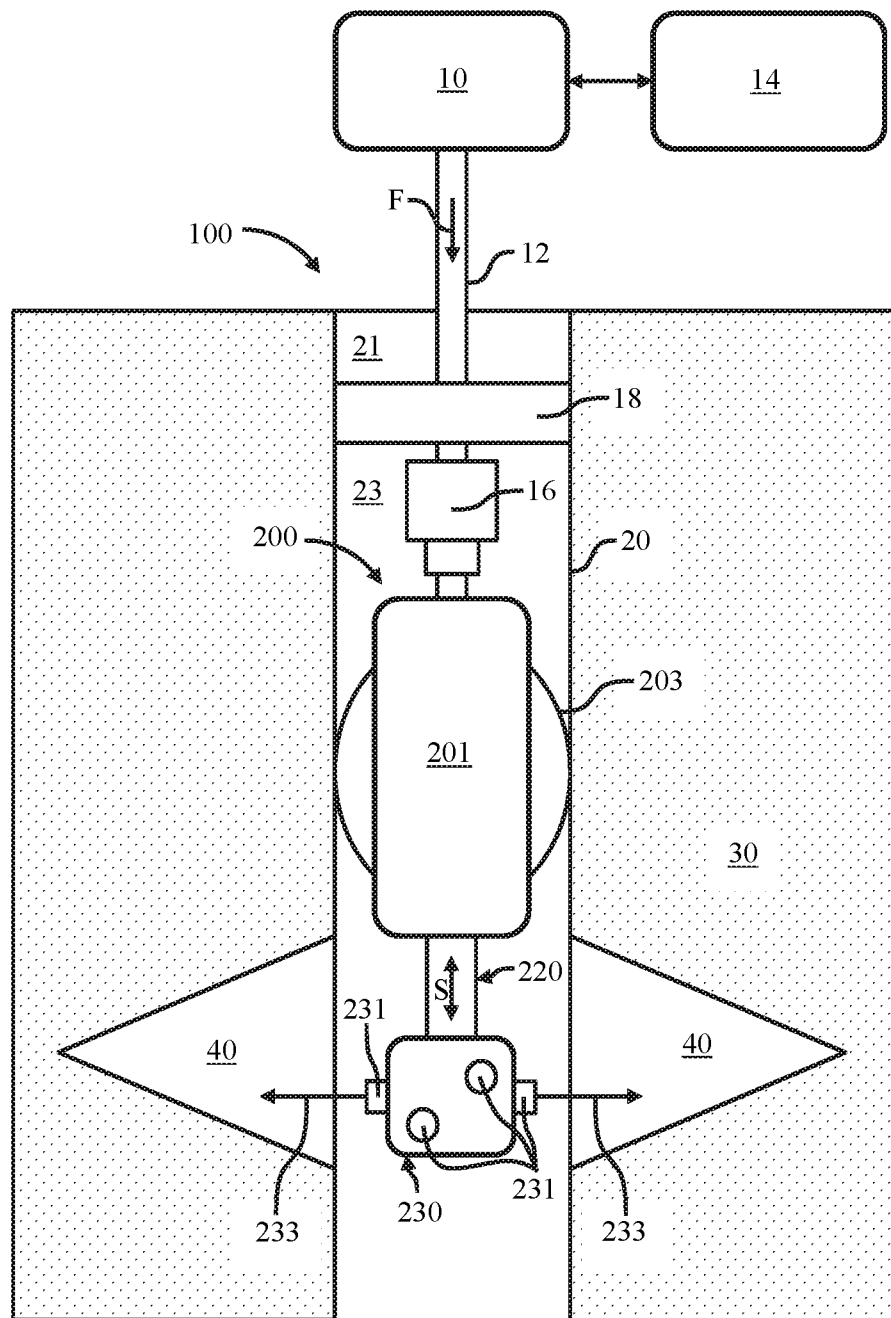


FIG. 1

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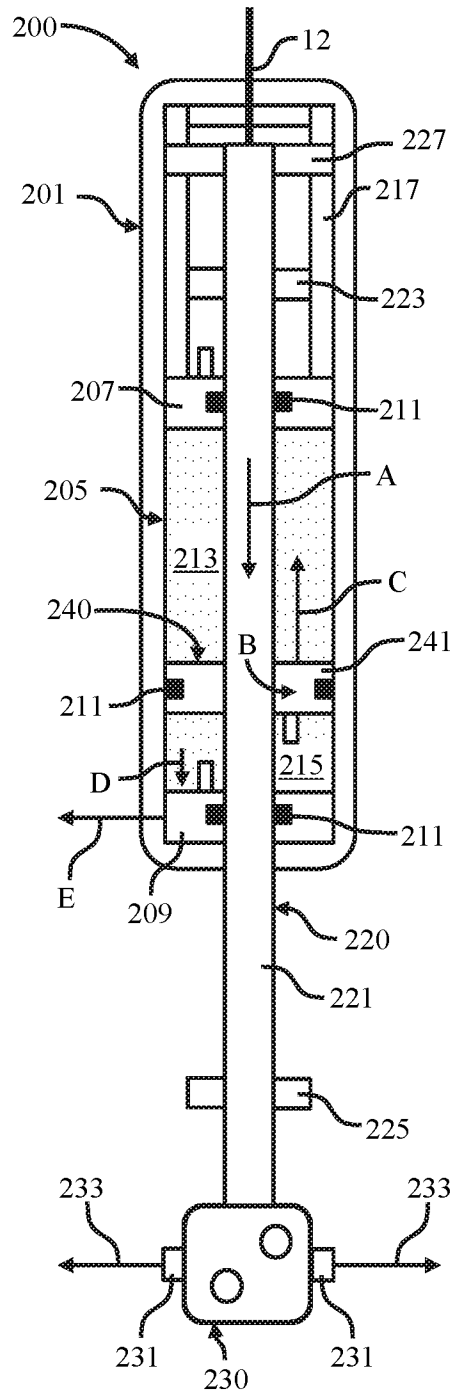


FIG. 2

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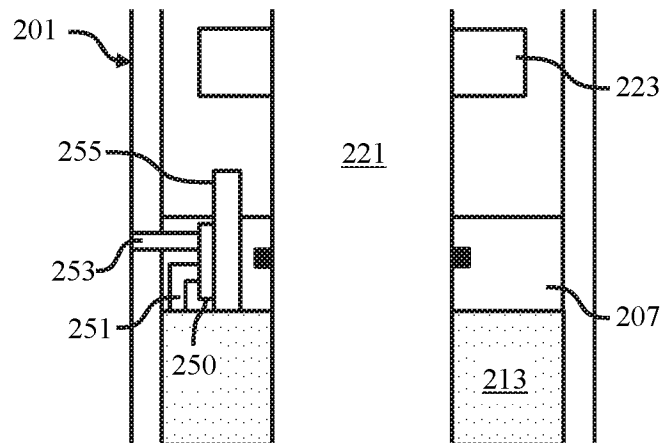


FIG. 3

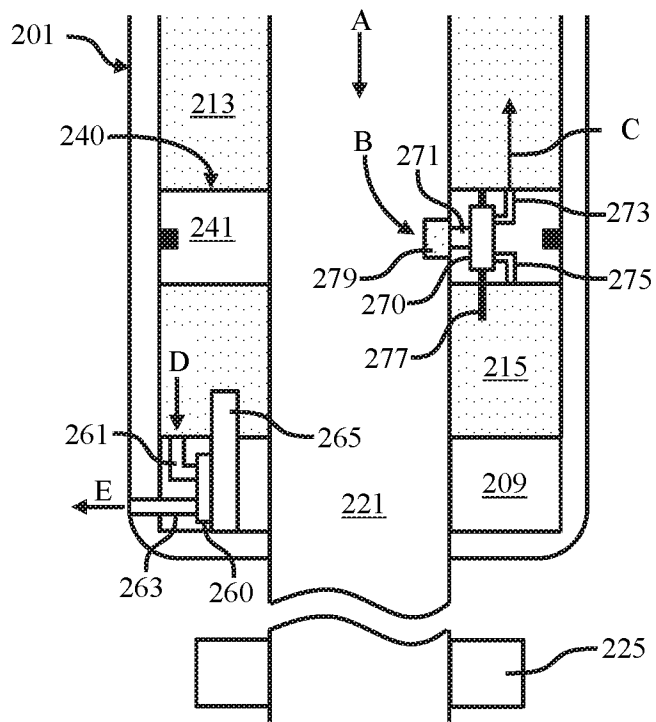


FIG. 4

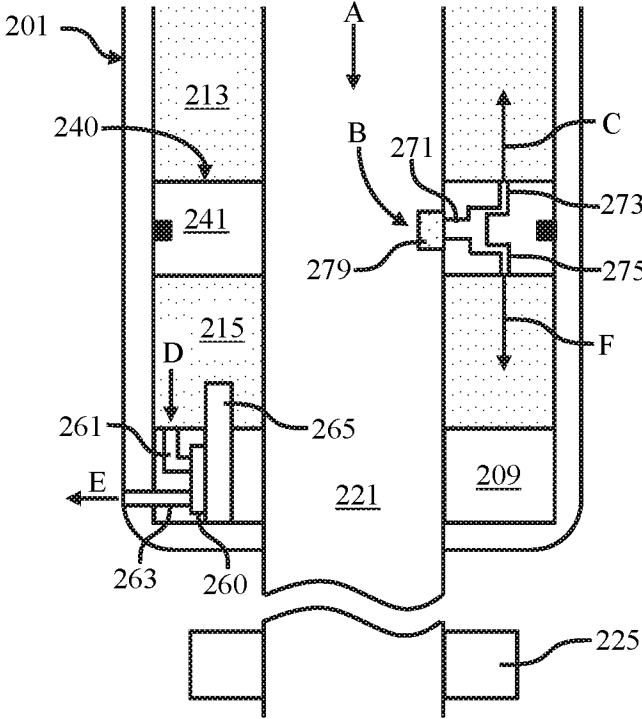


FIG. 5

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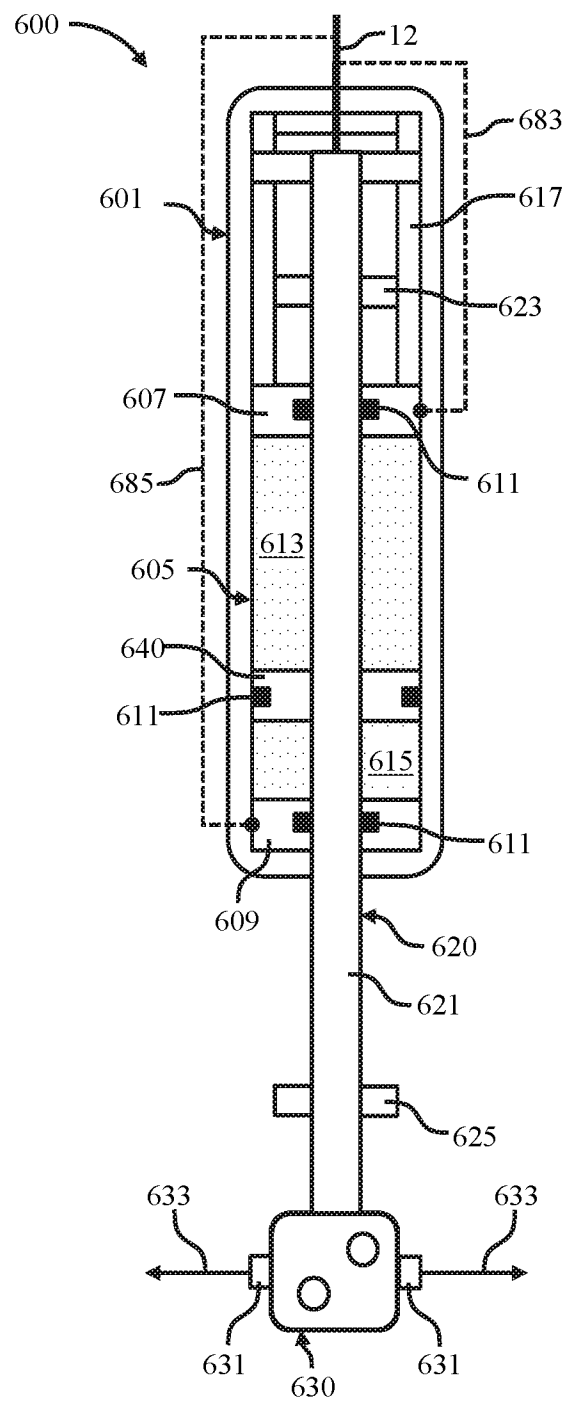


FIG. 6

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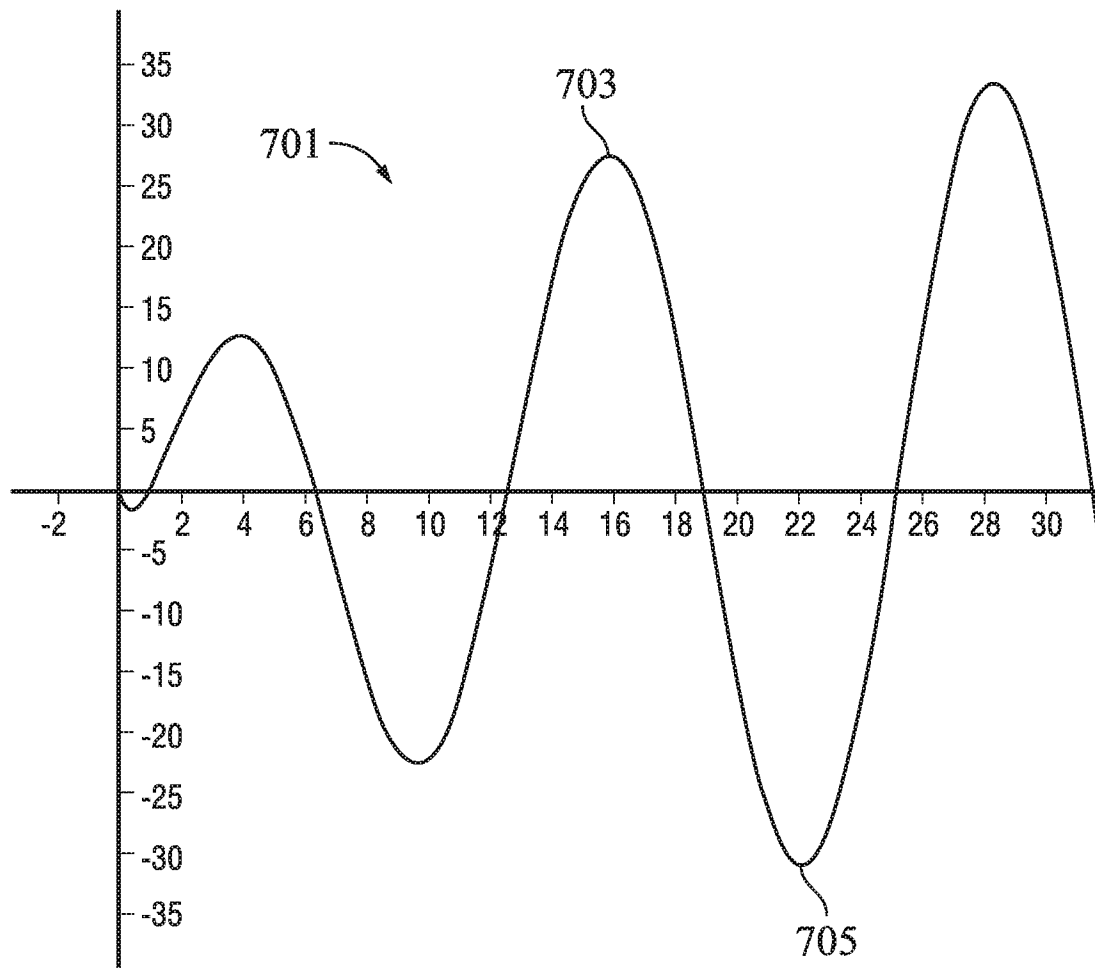


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/012351**A. CLASSIFICATION OF SUBJECT MATTER****E21B 43/26(2006.01)i, E21B 43/17(2006.01)i, E21B 41/00(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 43/26; E21B 23/04; E21B 43/114; E21B 43/267; E21B 21/00; E21B 29/00; E21B 7/04; E21B 43/17; E21B 41/00

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: downhole, fluid, hydraulic, fracturing, piston, nozzle, jet, and pressure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009-0107680 A1 (SURJAATMADJA, JIM B.) 30 April 2009 See paragraphs [0018]-[0019], [0029], [0033] and figures 1-4.	1-20
Y	US 2006-0090900 A1 (MULLEN et al.) 04 May 2006 See paragraphs [0069], [0076]-[0082], [0141]-[0145] and figures 5-6, 18.	1-20
A	US 2002-0162660 A1 (DEPIAK et al.) 07 November 2002 See claims 1-4 and figure 1.	1-20
A	US 6286599 B1 (SURJAATMADJA et al.) 11 September 2001 See claims 1, 3-6 and figures 3-5.	1-20
A	US 2014-0124201 A1 (SCHLUMBERGER TECHNOLOGY CORPORATION) 08 May 2014 See claims 1-2 and figure 1.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 September 2016 (12.09.2016)

Date of mailing of the international search report

12 September 2016 (12.09.2016)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

HAN, JOONG SUB

Telephone No. +82-42-481-3578



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/012351

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