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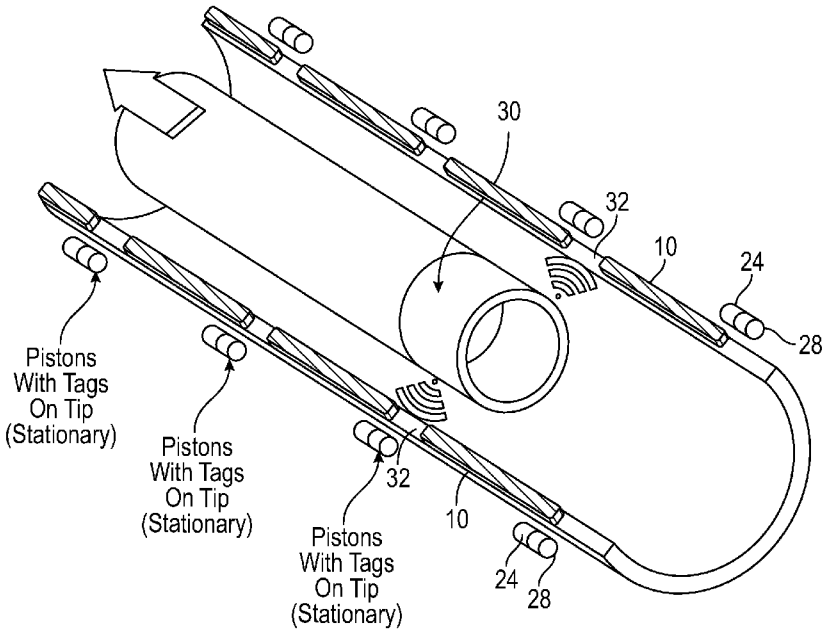


FIG. 5

(57) Abstract: A method includes periodically sending an interrogating signal to a transponder installed on a piston, the piston being configured to seal a drainage port of a downhole tool, shielding the transponder from the interrogating signal when the piston is in a first position, and transmitting the interrogating signal through a perforated metal medium to activate the transponder when the piston is in a second position.

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DOWNHOLE DETECTION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present document is based on and claims priority to U.S. Provisional Application Serial No. 62/816,789, filed March 11, 2019, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] Gravel packs are used in wells for removing particulates from inflowing hydrocarbon fluids. In a variety of applications, gravel packing is performed in long horizontal wells by pumping gravel suspended in a carrier fluid down the annulus between the wellbore and a screen assembly. The carrier fluid is returned to the surface after depositing the gravel in the wellbore annulus. To return to the surface, the carrier fluid flows through the screen assembly, through base pipe perforations, and into a production tubing, which routes the returning carrier fluid back to the surface. Additionally, some applications utilize alternate path systems having various types of shunt tubes, which help distribute the gravel slurry. In some applications, inflow control devices have been combined with screen assemblies to provide control over the subsequent inflow of production fluids.

[0003] More specifically, an APS-ICD (Alternate Path System – Inflow Control Device) downhole completions tool is a screened joint that may be used for (1) gravel packing, and (2) production. When the APS-ICD tool is in gravel packing mode, the surrounding annulus is packed with gravel that is pumped from surface. In the tool, the gravel flows through shunt tubes and nozzles to create an alternate flow path that bypasses sand bridges and fills in voids that may occur during the gravel pumping. To achieve the production of formation fluids, the gravel is dehydrated through the screened joint into drainage ports in the tool.

[0004] After the annulus is packed, the APS-ICD tool transitions from gravel packing mode to production mode. During production mode, a piston mechanism seals the drainage ports in the tool, directing all formation fluids through inflow control devices. Because the transition from gravel packing mode to production mode is a critical operation of the APS-ICD tool, a system and method to confirm the sealing of the drainage ports of the tool is necessary to establish a successful transition from gravel packing mode to production mode.

SUMMARY

[0005] According to one or more embodiments of the present disclosure, a method includes periodically sending an interrogating signal to a transponder installed on a piston, the piston being configured to seal a drainage port of a downhole tool, shielding the transponder from the interrogating signal when the piston is in a first position, and transmitting the interrogating signal through a perforated metal medium to activate the transponder when the piston is in a second position.

[0006] According to one or more embodiments of the present disclosure, a method includes coupling at least one transceiver and at least one transponder through a perforated metal medium.

[0007] According to one or more embodiments of the present disclosure, a method includes conveying a downhole tool in a wellbore, the downhole tool comprising: a gravel packing mode, and a production mode, initiating a gravel packing operation when the downhole tool is in the gravel packing mode, completing the gravel packing operation, transitioning the downhole tool from the gravel packing mode to the production mode, and confirming that the downhole tool has transitioned from the gravel packing mode to the production mode.

[0008] According to one or more embodiments of the present disclosure, a system includes at least one transponder, and at least one transceiver, wherein the at least one transceiver is coupled to the at least one transponder through a perforated metal medium.

[0009] However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:

[0011] FIG. 1(a) shows a downhole completions tool in a gravel packing configuration according to one or more embodiments of the present disclosure;

[0012] FIG. 1(b) shows a downhole completions tool in a production configuration according to one or more embodiments of the present disclosure;

[0013] FIG. 2(a) shows an application of one or more embodiments of the present disclosure to a downhole completions tool in an initial position;

[0014] FIG. 2(b) shows an application of one or more embodiments of the present disclosure to a downhole completions tool in a final position;

[0015] FIG. 3(a) shows an alternative application of one or more embodiments of the present disclosure to a downhole completions tool in an initial position;

[0016] FIG. 3(b) shows an alternative application of one or more embodiments of the present disclosure to a downhole completions tool in a final position;

[0017] FIG. 4(a) shows another alternative application of one or more embodiments of the present disclosure to a downhole completions tool in an initial position;

[0018] FIG. 4(b) shows another alternative application of one or more embodiments of the present disclosure to a downhole completions tool in a final position;

[0019] FIG. 5 shows an example of a downhole detection system according to one or more embodiments of the present disclosure;

[0020] FIGS. 6(a) and 6(b) show an example of how a downhole detection system according to one or more embodiments of the present disclosure compares to an example of a prior art detection system;

[0021] FIG. 7 shows an example of a power train block diagram according to one or more embodiments of the present disclosure; and

[0022] FIGS. 8(a) and 8(b) show a schematic of a power source for a transceiver of the downhole detection system according to one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0023] In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0024] In the specification and appended claims: the terms "up" and "down," "upper" and "lower," "upwardly" and "downwardly," "upstream" and "downstream," "uphole" and "downhole," "above" and "below," and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the disclosure.

[0025] The present disclosure generally relates to a system and method for confirming a change in configuration or mode of a downhole completions tool. More specifically, the present disclosure relates to a system and method for confirming a change of a hybrid APS-ICD system from a gravel packing configuration or mode to a production configuration or

mode. The system and method according to one or more embodiments of the present disclosure may implement radio-frequency identification (RFID) technology.

[0026] Referring now to FIG. 1(a), a downhole completions tool in a gravel packing configuration is shown according to one or more embodiments of the present disclosure. According to one or more embodiments, the downhole completions tool is a hybrid APS-ICD system, in which inflow control devices are incorporated into an alternate path system. As shown in FIG. 1(a), the APS-ICD system may include a base pipe 10, a filter 12 disposed around the base pipe 10, and a drainage layer 14 disposed between the filter 12 and the base pipe 10. According to one or more embodiments of the present disclosure, the base pipe 10 may be a metal tubular member, and the filter 12 may be a screen or another type of filter medium, for example.

[0027] As further shown in FIG. 1(a), the base pipe 10 has two ends. At the first end, the base pipe 10 may include a coupling 16 for connecting to another screen assembly or another downhole completion tool, for example. Near the second end, the base pipe 10 may include at least one ICD 18 uphole of a high flow area 20 containing a plurality of perforations. In other embodiments, the at least one ICD 18 may also be disposed near the coupling 16 at the first end of the base pipe 10 without departing from the scope of the present disclosure. The base pipe 10 may also include a dart housing 22 disposed around the second end. According to one or more embodiments of the present disclosure, the dart housing 22 may include at least one dart or piston 24, which is configured to seal at least one drainage port 26 contained within the dart housing 22.

[0028] Still referring to FIG. 1(a), the hybrid APS-ICD system is shown in a gravel packing configuration, which may be the run-in-hole configuration of this downhole completions tool. As shown, in the gravel packing configuration, the at least one dart 24 has not been activated, and as such, the at least one dart 24 does not seal the at least one drainage port 26 in the dart housing 22. As such, after depositing gravel slurry in the wellbore annulus during a gravel packing operation, the carrier fluid from the gravel slurry returns through the filter 12, flows along the drainage layer 14 between the filter 12 and the base pipe 10, and into the dart housing 22. Because the at least one dart does not seal the at least one drainage port 26 in the dart

housing 22 when the hybrid APS-ICD system is in the gravel packing configuration, the carrier fluid continues to flow through the at least one drainage port 26, through the plurality of perforations in the high flow area 20, and into the interior of the base pipe 10 for returning to the surface, via a wash pipe and service tool, and casing annulus, for example. When the hybrid APS-ICD system is in the gravel packing configuration, very little to no carrier fluid flows into the interior of the base pipe 10 via the at least one ICD 18 in the base pipe 10.

[0029] After the gravel packing operation is complete, the hybrid APS-ICD system may transition from the gravel packing configuration shown in FIG. 1(a) to a production configuration (or intelligent flow management mode) shown in FIG. 1(b), according to one or more embodiments of the present disclosure. In one or more embodiments, the at least one dart 24 of the APS-ICD system may be activated hydraulically or mechanically, for example. Activation of the at least one dart 24 actuates the at least one dart 24 to shift and seal the at least one drainage port 26 in the dart housing 22, as shown in FIG. 1(b). Sealing of the at least one drainage port 26 by the at least one dart 24 causes the hybrid APS-ICD system to transition from the gravel packing configuration shown in FIG. 1(a) to the production configuration shown in FIG. 1(b).

[0030] Still referring to FIG. 1(b), in the production configuration, sealing of the at least one drainage port 26 by the at least one dart 24 isolates the high flow area 20 from the reservoir. As such, in the production configuration, the produced fluid will enter through the filter 12, travel along the drainage layer 14 between the filter 12 and base pipe 10, into the at least one ICD 18, which maintains uniform inflow rates across the completed zones in the well, and into the interior of the base pipe 10 for returning to the surface. In the production configuration, the production fluid may flow into a conventional ICD, a ResCheck ICD, or an AICD, without departing from the scope of the present disclosure.

[0031] One or more embodiments of the present disclosure are directed to confirming a successful transition of the APS-ICD system from gravel packing mode to production mode. That is, one or more embodiments of the present disclosure are directed to confirming the sealing of the at least one drainage port 26 by the at least one dart 24 by detecting the position

of one or more components of the dart 24 through holes or perforations in the tubular support, e.g., base pipe 10 of the filter 12.

[0032] According to one or more embodiments of the present disclosure, the detection system includes a transmitter-receiver *transceiver* and a transmitter-responder *transponder* coupled through ports or holes radially perforated across the tubular-metal support, e.g., base pipe 10, of the filter 12 or screen. In one or more embodiments of the present disclosure, the transponders, or tags, may be installed in each dart 24 or piston of the APS-ICD tool (each screened joint may have two). In other embodiments of the present disclosure, the transponders/tags may be installed in the wall of the base pipe 10 of the tool, in the wall of the dart housing 22, in an extension of the dart housing 22, or in a similar component surrounding the base pipe 10 of the tool. The transponders/tags are detected, or not detected, by the transceiver, or reader, which confirms the position of the dart 24 or piston. The non-detection happens when the tags are not aligned with the ports or holes in the tubular support or base pipe 10, in which case the metal shield of the tubular support obstructs the signal from the reader to the tags and vice versa. In one or more embodiments of the present disclosure, the dart 24 or piston is in an initial position prior to being fully activated either hydraulically or mechanically, as previously described. Further, the dart 24 or piston is in a final position when the dart 24 or piston sealingly engages the drainage port 26 in the dart housing 22 of the tool.

[0033] Referring now to FIGS. 2(a) and 2(b), an application of the detection system according to one or more embodiments of the present disclosure is shown. Specifically, FIGS. 2(a) and 2(b) show a single-read positive application of the detection system according to one or more embodiments of the present disclosure. In this application of the detection system, the transponders/tags 28 may be installed on a tip of the darts 24 or pistons, and the transceiver/reader 30 may be installed in a service tool (such as a washpipe), pipes, or other objects placed inside the APS-ICD tool. FIGS. 2(a) and 2(b) respectively show an initial and a final position of the dart 24 or piston. In the initial position of the dart 24 or piston, as shown in FIG. 2(a), the transponder/tag 28 is covered by the metal of the base pipe 10, and as such is not readable through the hole 32 in the base pipe 10 of the tool. According to one or more embodiments of the present disclosure, the hole 32 in the base pipe 10 of the tool may be one of the perforations in the high flow area 20, or the hole 32 may be a perforation in the base

pipe 10 that is outside the high flow area 20. In the final position of the dart 24 or piston, as shown in FIG. 2(b), the transponder/tag 28 is exposed to the transceiver/reader 30 for detection through the hole 32 in the base pipe 10 of the tool. In this way, detecting that the transponder/tag 28 is able to receive the interrogating signal from the transceiver/reader 30, as shown in FIG. 2(b) for example, confirms that the dart 24 or piston is in the final position, thereby confirming a successful transition of the APS-ICD system from gravel packing mode to production mode in accordance with one or more embodiments of the present disclosure.

[0034] Referring now to FIGS. 3(a) and 3(b), an alternative application of the detection system according to one or more embodiments of the present disclosure is shown. Specifically, FIGS. 3(a) and 3(b) show a no-read positive application of the detection system according to one or more embodiments of the present disclosure. In this application of the detection system, the transponder/tag 28 may be installed in a wall of the base pipe 10 of the tool, in the wall of the dart housing 22, in an extension of the dart housing 22, or in a similar component surrounding the base pipe 10 of the tool, and the transceiver/reader 30 may be installed in a service tool (such as a washpipe), pipes, or other objects placed inside the APS-ICD tool. FIGS. 3(a) and 3(b) respectively show an initial and a final position of the dart 24 or piston. In the initial position of the dart 24 or piston, as shown in FIG. 3(a), the transponder/tag 28 installed in the wall of the base pipe 10 of the tool may be detected by the transceiver/reader 30. In the final position of the dart 24 or piston, as shown in FIG. 3(b), the transponder/tag 28 installed in the wall of the base pipe 10 of the tool is shielded by the dart 24 or piston, and the transceiver/reader 30 cannot detect the transponder/tag 28 through the hole 32 in the base pipe 10 of the tool. In this way, *not* detecting that the transponder/tag 28 has received the interrogating signal from the transceiver/reader 30, as shown in FIG. 3(b) for example, confirms that the dart 24 or piston is in the final position, thereby confirming a successful transition of the APS-ICD system from gravel packing mode to production mode in accordance with one or more embodiments of the present disclosure.

[0035] Referring now to FIGS. 4(a) and 4(b), another alternative application of the detection system according to one or more embodiments of the present disclosure is shown. Specifically, FIGS. 4(a) and 4(b) show a double-read positive application of the detection system according to one or more embodiments of the present disclosure. In this application of

the detection system, first and second transponders/tags 28(a), 28(b) may be installed in parallel on a tip of the dart 24 or piston, and the transceiver/reader 30 may be installed in a service tool (such as a washpipe), pipes, or other objects placed inside the APS-ICD tool. FIGS. 4(a) and 4(b) respectively show an initial and a final position of the dart 24 or piston. In the initial position of the dart 24 or piston, as shown in FIG. 4(a), the first transponder/tag 28(a) is exposed to the transceiver/reader 30 for detection through the hole 32 in the base pipe 10 of the tool, while the second transponder/tag 28(b) is shielded by the metal of the base pipe 10. In the final position of the dart 24 or piston, as shown in FIG. 4(b), the second transponder/tag 28(b) is exposed to the transceiver/reader 30 for detection through the hole 32 in the base pipe 10 of the tool, while the first transponder/tag 28(a) is shielded by the metal of the base pipe 10. In this way, detecting that the first transponder/tag 28(a) is able to receive the interrogating signal from the transceiver/reader 30, as shown in FIG. 4(a) for example, confirms that the dart 24 or piston is in the initial position, thereby confirming that the APS-ICD system is still in gravel packing mode, or at least is not in production mode. Moreover, detecting that the second transponder/tag 28(b) is able to receive the interrogating signal from the transceiver/reader 30, as shown in FIGS. 4(b) for example, confirms that the dart 24 or piston is in the final position, thereby confirming a successful transition of the APS-ICD system from gravel packing mode to production mode in accordance with one or more embodiments of the present disclosure.

[0036] The detection system according to one or more embodiments of the present disclosure may implement various coupling technologies when the transceiver/reader 30 transmits an interrogating signal through a hole 32 in the base pipe 10 to activate the transponder/tag 28. For example, the transceiver/reader 30 may be coupled to the transponder/tag 28 through the hole 32 in the base pipe 10 via inductive coupling or electromagnetic-wave wireless technology with corresponding communication protocols and platforms, such as automatic identification procedures (Auto-ID), RFID, NFC, Bluetooth, or WiFi, for example.

[0037] As previously described, the system and method according to one or more embodiments of the present disclosure may implement RFID technology. Using RFID technology, the transceiver may be known as the reader, and the transponder may be known as

the tag, as previously described. According to one or more embodiments of the present disclosure, the reader is active, periodically sending interrogating signals to passive tags that activate only when reached by a signal transmitted by the reader. The tags then respond to the reader's signal with their unique identification serial. The reader stores the information received by the tags in a memory module accessible at surface and compatible with analog and digital data retrievers and processors in accordance with one or more embodiments of the present disclosure. In other embodiments, the reader may be passive and the tags may be active, or both the reader and tags may be active without departing from the scope of the present disclosure.

[0038] Referring now to FIG. 5, an example of a downhole detection system according to one or more embodiments of the present disclosure is shown. Specifically, FIG. 5 shows a transceiver/reader 30 transmitting an interrogating signal through holes 32 in a metal medium such as a base pipe 10 to activate transponders/tags 28 installed on a tip of a dart 24 or piston, as previously described. In other embodiments, the transponders/tags 28 may be installed on the wall of the base pipe 10 instead of on the tip of the dart 24 or piston as previously described. Further, two transponders/tags 28 may be installed in parallel on the tip of the dart 24 or piston, as previously described. In one or more embodiments of the present disclosure, the reader 30 couples with the tags 28 while continuously moving in proximity to the tags 28, and/or by stopping in proximity to the tags 28. The tags 28 may remain stationary after the dart 24 or piston reaches the final position, which is the position where the dart 24 or piston sealingly engages the drainage port 26 in the dart housing 22 of the tool, as previously described.

[0039] Still referring to FIG. 5, the reader 30 may include an antenna wrapped around a service tool (such as the washpipe), pipes, or objects inside the APS-ICD tool, according to one or more embodiments. Another configuration contemplates several antennas placed around the service tool (such as the washpipe), pipes, or objects in the APS-ICD tool. Either configuration allows the reader 30 to have a reading coverage of 360 degrees.

[0040] Referring now to FIGS. 6(a) and 6(b), an example of how a downhole detection system according to one or more embodiments of the present disclosure compares to an example of a prior art detection system is shown. As shown in the prior art detection system

of FIG. 6(a), for example, the transponder/tag may be embedded in a metal medium such as a base pipe. A transceiver/reader transmits a signal to activate the embedded transponder/tag when the transceiver/reader comes in proximity to the embedded transponder/tag. That is, in the prior art detection system, the transceiver/reader does not transmit a signal through a hole in the metal medium to activate the embedded transponder/tag. In contrast, FIG. 6(b) shows an example of a downhole detection system in accordance with one or more embodiments of the present disclosure. As shown in FIG. 6(b), the transponder/tag 28 may be either axially or perpendicularly coupled to the transceiver/reader 30 when the transceiver/reader 30 transmits a signal through a hole 32 in the metal medium 10 to activate the transponder/tag 28 when the transceiver/reader 30 comes in proximity to transponder/tag 28.

[0041] As previously described, the detection system according to one or more embodiments of the present disclosure includes active transceivers/readers 30, which activate passive transponders/tags 28 when in proximity to the passive transponders/tags 28. In one or more embodiments, the downhole detection system may be powered by a surface power source. In other embodiments, the active transceiver/reader 30 of the downhole detection system may be powered by a standalone energy container, such as a battery, or by a power generation system, which is capable of harvesting energy from subterranean sources coming from the formation and/or wellbore conditioning operations. In such embodiments, the passive transponder/tag 28 does not need a power source.

[0042] As previously described, the active transceiver/reader 30 of the downhole detection system according to one or more embodiments of the present disclosure may be powered by a power generation system. In one or more embodiments of the present disclosure, the power generation system may include a roto-dynamic element, such as a turbine or micro turbine, which is capable of harvesting energy from the pressure differential of circulating fluid passing through the roto-dynamic element. The energy generated by the roto-dynamic element may be regulated and temporarily stored in a back-up battery, or similar energy storage element, attached to the transceiver/reader 30, for an on-demand energy architecture.

[0043] Referring now to FIG. 7, an example of a power train block diagram corresponding to the power generation system according to one or more embodiments of the present

disclosure is shown. As shown in FIG. 7, circulating fluid from the formation and/or wellbore conditioning operations creates a pressure differential across a roto-dynamic element, which may be a turbine or a micro turbine, for example. The energy generated by the roto-dynamic element may then be regulated by a regulator, such as a voltage regulator, for example. In one or more embodiments, the energy may then be temporarily stored in a back-up energy storage element attached to the transceiver/reader 30. In other embodiments, the back-up energy storage element may be omitted from the power generation system if fluid circulation is allowed while the transceiver/reader 30 needs to be active. In such embodiments of the present disclosure, the energy may be transferred directly from the regulator to the transceiver/reader 30 for powering the active transceiver/reader 30.

[0044] Referring now to FIGS. 8(a) and 8(b), a schematic of a power source for a transceiver/reader 30 corresponding to the power train block diagram of FIG. 7 is shown according to one or more embodiments of the present disclosure. Specifically, FIG. 8(a) shows the circulating fluid 34, roto-dynamic element 36, regulator 38, an optional back-up energy storage element 40, and the transceiver/reader 30, as previously described above. FIG. 8(b) shows a blown-up view of the roto-dynamic element 36, which may be a turbine or micro-turbine according to one or more embodiments of the present disclosure, as previously described.

[0045] In addition to the above, the downhole detection system according to one or more embodiments of the present disclosure may be implemented in additional applications. For example, the downhole detection system may be integrated on washpipes and similar service tools as part of the lower completion service string, storing the data in a module within the tool. Moreover, inductive coupling through a perforated metal medium can be used for asset tracking, downhole activation, and asset-, service-, and wellbore-condition monitoring and communication between passive and active device. Further, the memory module of the downhole detection system may be expanded to be compatible with real-time telemetry systems. The downhole detection system may be integrated in the operations of Thru-Bit, Coiled Tubing, and similar conveyance systems deployed in memory mode. As another example application, the downhole detection system may be deployed using Wireline (including Tractor conveyance system), Thru-Bit, Coiled Tubing, gravity-assisted, pressure-

assisted, and flow-assisted methods, and similar conveyance systems for any extended reach or horizontal wells.

[0046] Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

CLAIMS

What is claimed is:

1. A method comprising:
   periodically sending an interrogating signal to a transponder installed on a piston, the piston being configured to seal a drainage port of a downhole tool;
   shielding the transponder from the interrogating signal when the piston is in a first position; and
   transmitting the interrogating signal through a perforated metal medium to activate the transponder when the piston is in a second position.

2. The method of claim 1, wherein a transceiver transmits the interrogating signal through the perforated metal medium to activate the transponder when the piston is in the second position.

3. The method of claim 2, wherein, during the transmitting step, the transceiver is inductively coupled to the transponder.

4. The method of claim 2, wherein, during the transmitting step, the transceiver is electromagnetically coupled to the transponder.

5. The method of claim 2, wherein the transceiver comprises an antenna wrapped around a service tool inside the downhole tool.

6. The method of claim 2, wherein a reading coverage of the transceiver is 360 degrees.

7. The method of claim 2, wherein the transceiver and the transponder are in relative motion to one another during the transmitting step.

8. The method of claim 2, wherein the transceiver is powered by a battery.

9. The method of claim 2, wherein the transceiver is powered by a turbine that harvests energy from a pressure differential of fluid circulating through the turbine.

10. The method of claim 1, wherein the transponder responds with a unique identification serial, the method further comprising: storing information received by the transponder in a memory module.

11. A method comprising:

coupling at least one transceiver and at least one transponder through a perforated metal medium.

12. The method of claim 11, wherein the coupling step comprises inductive coupling.

13. The method of claim 11, wherein the coupling step comprises electromagnetic coupling.

14. The method of claim 11, wherein the coupling step occurs downhole in a wellbore.

15. The method of claim 14, wherein the at least one transponder is axially coupled to the at least one transceiver.

16. The method of claim 14, wherein the at least one transponder is perpendicularly coupled to the at least one transceiver.

17. The method of claim 11, wherein a reading coverage of the at least one transceiver is 360 degrees.

18. The method of claim 11, wherein the at least one transceiver is powered by a battery.

19. The method of claim 11, wherein the at least one transceiver is powered by a turbine that harvests energy from a pressure differential of fluid circulating through the turbine.

20. A method comprising:

conveying a downhole tool in a wellbore, the downhole tool comprising: a gravel packing mode; and a production mode;

initiating a gravel packing operation when the downhole tool is in the gravel packing mode;

completing the gravel packing operation;

transitioning the downhole tool from the gravel packing mode to the production mode; and

confirming that the downhole tool has transitioned from the gravel packing mode to the production mode.

21. The method of claim 20, wherein the transitioning step comprises sealing at least one drainage port in the downhole tool, and directing formation fluid through at least one inflow control device.

22. The method of claim 21,

wherein the at least one drainage port is sealed with a piston, and

wherein the confirming step comprises coupling at least one transceiver and at least one transponder through a perforated metal medium of the downhole tool.

23. The method of claim 22, wherein the at least one transponder is installed on the piston.

24. The method of claim 22, wherein the at least one transponder is installed in a wall of the perforated metal medium.

25. The method of claim 22, wherein the at least one transceiver is powered by a battery.

26. The method of claim 22, wherein the at least one transceiver is powered by a turbine that harvests energy from a pressure differential of fluid circulating through the turbine.

27. A system comprising:

at least one transponder; and

at least one transceiver,

wherein the at least one transceiver is coupled to the at least one transponder through a perforated metal medium.

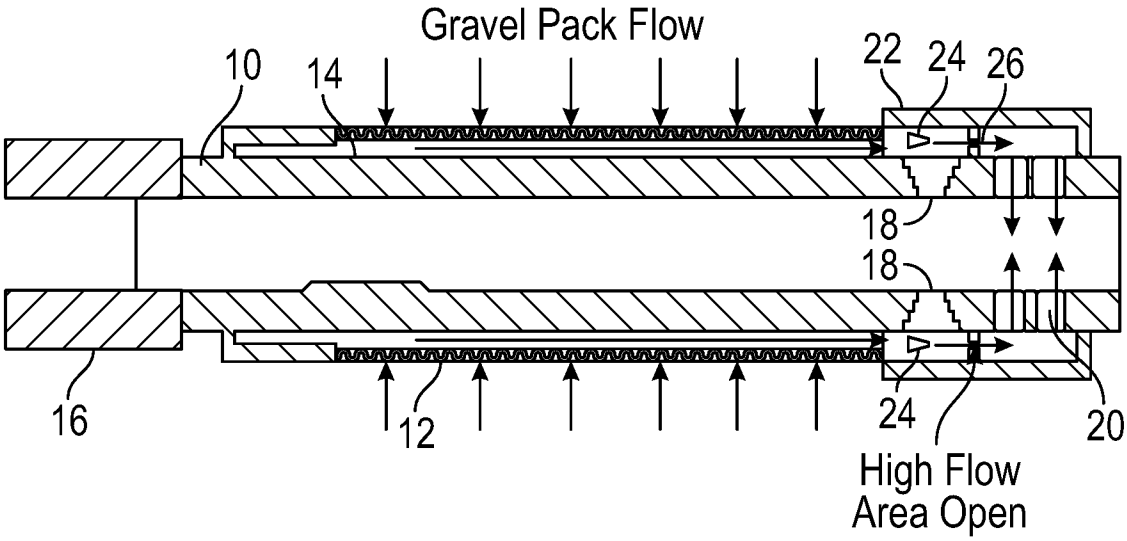

Gravel Pack Flow
10
14
22
24
26
18
18
16
12
24
20
High Flow
Area Open

FIG. 1a

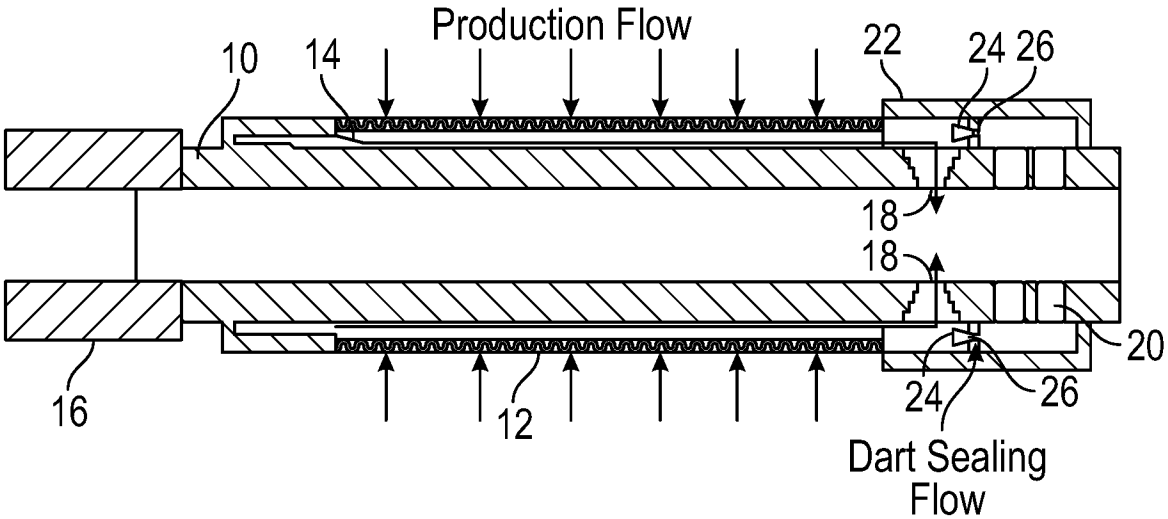

Production Flow
10
14
22
24
26
18
18
20
16
12
24
26
Dart Sealing
Flow

FIG. 1b

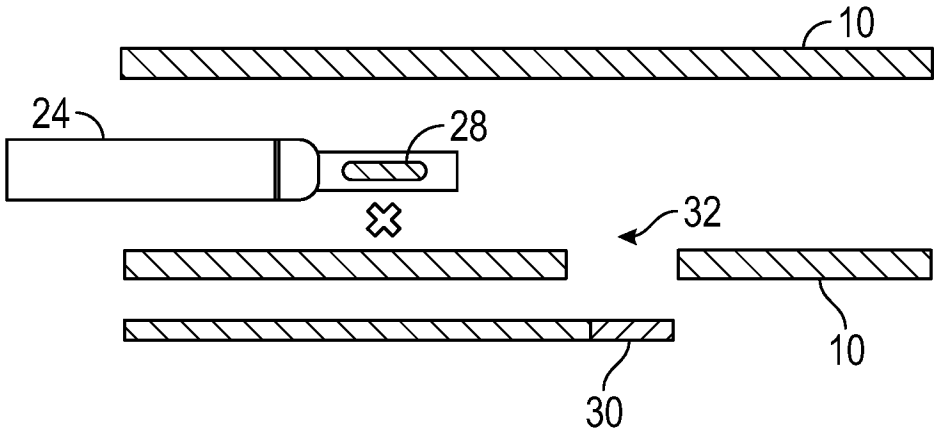


FIG. 2a

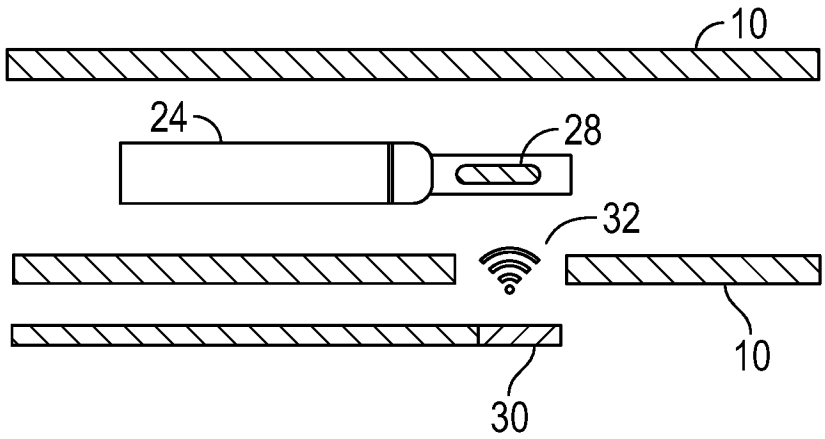


FIG. 2b

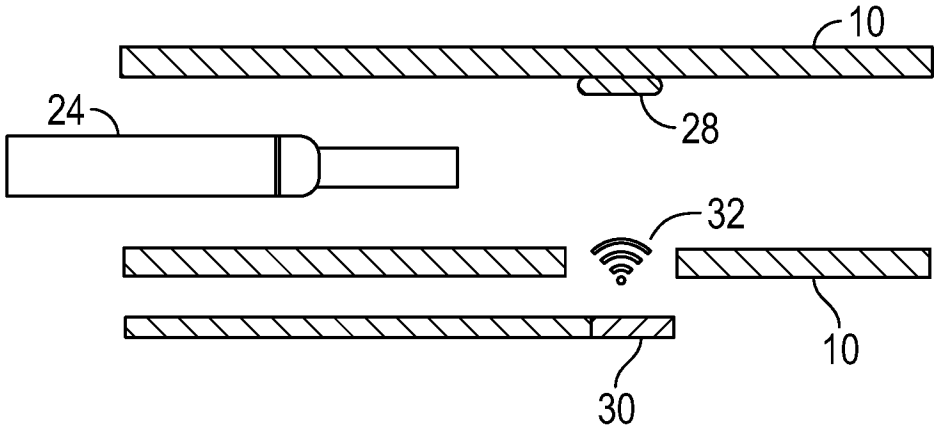


FIG. 3a

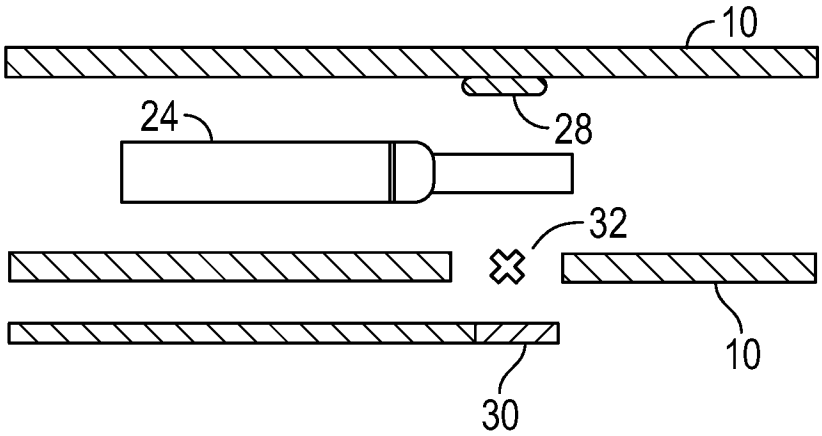


FIG. 3b

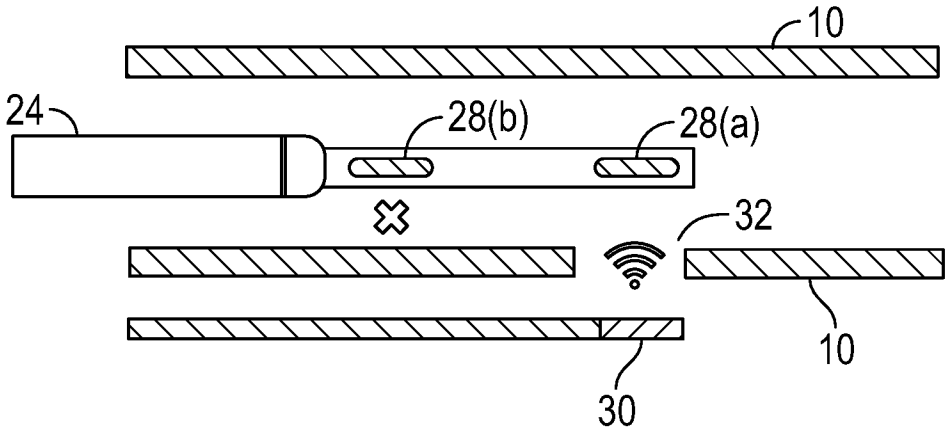


FIG. 4a

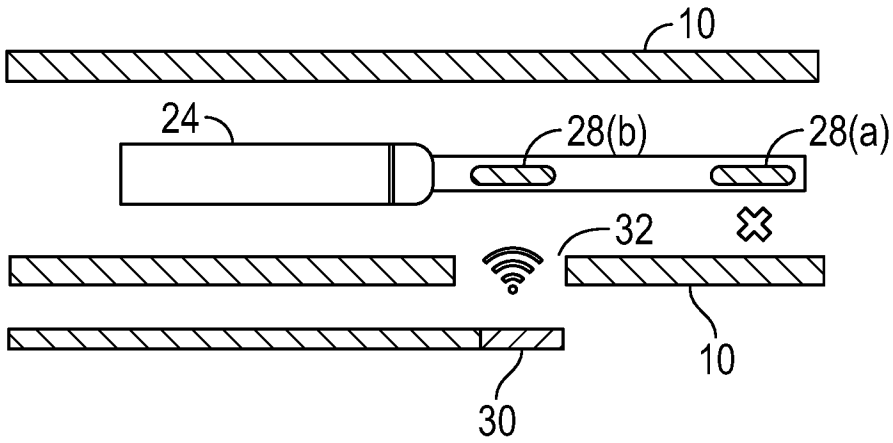


FIG. 4b

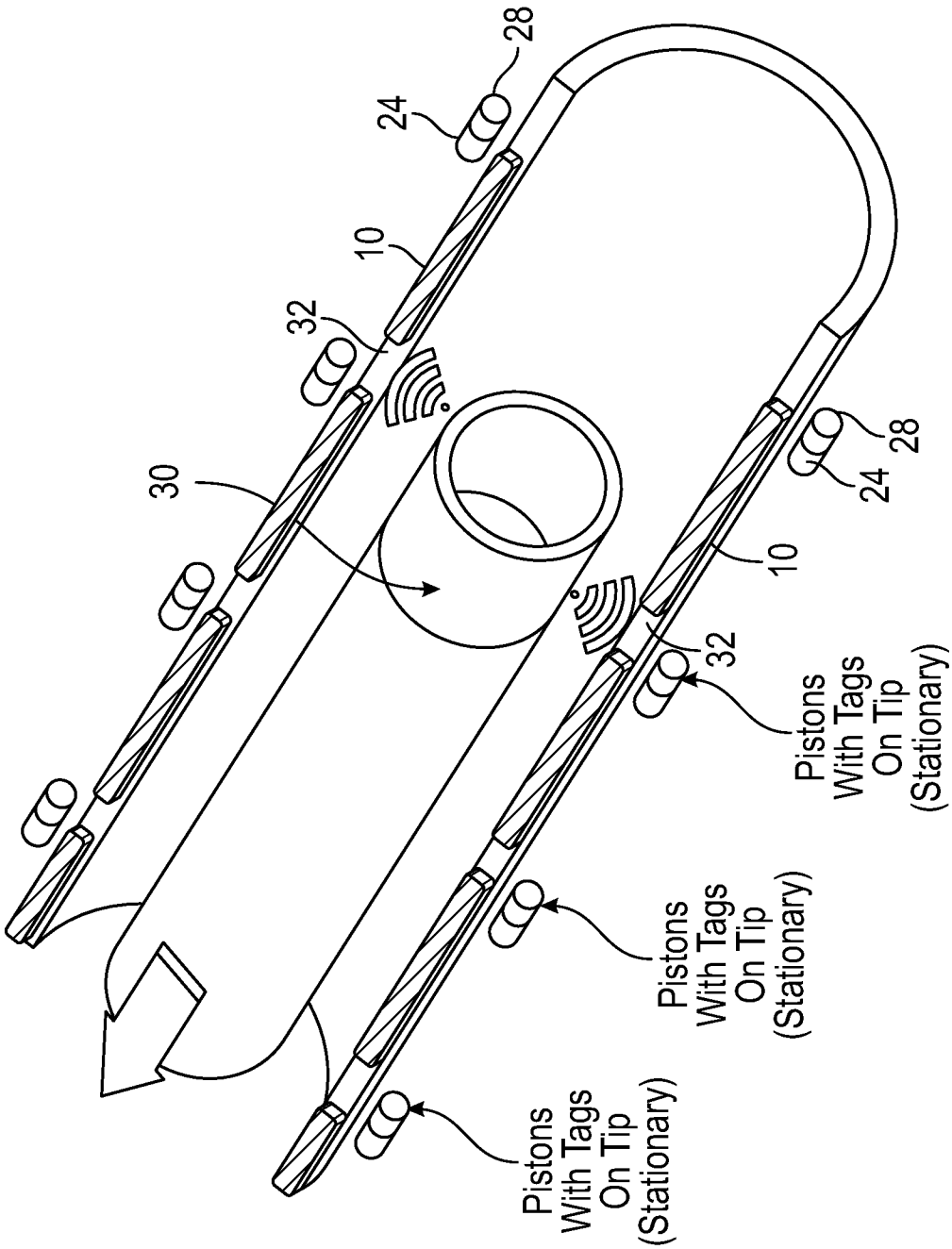

28
24
10
32
30
Pistons
With Tags
On Tip
(Stationary)
Pistons
With Tags
On Tip
(Stationary)
Pistons
With Tags
On Tip
(Stationary)

FIG. 5

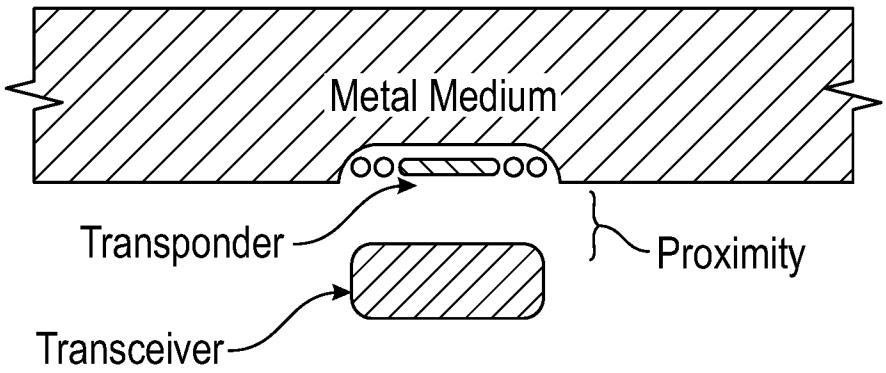


FIG. 6a
(Prior Art)

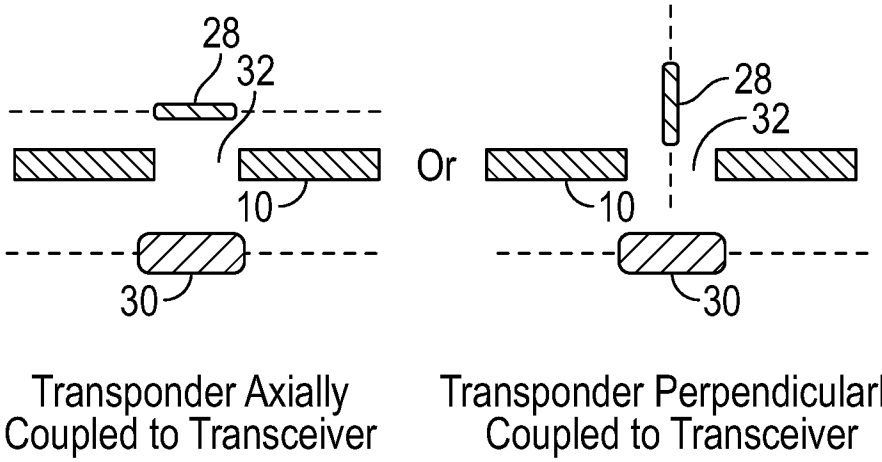


FIG. 6b

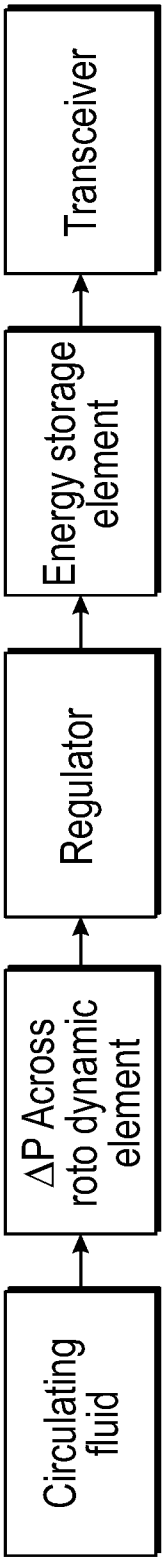


FIG. 7

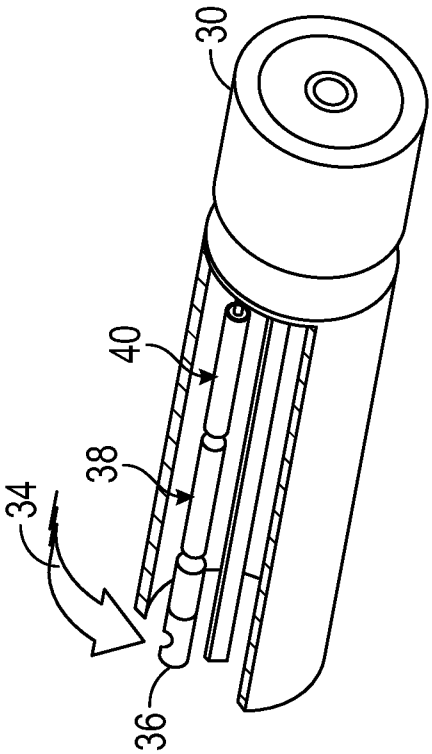


FIG. 8a

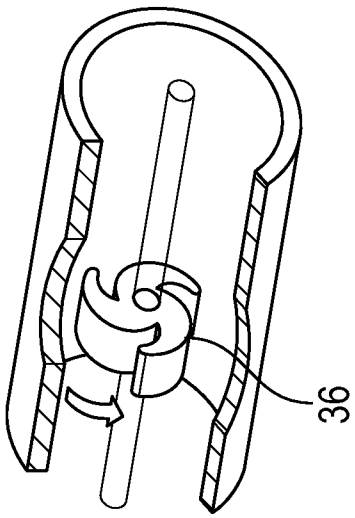


FIG. 8b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/021658

A. CLASSIFICATION OF SUBJECT MATTER

E21B 47/12(2006.01)i, E21B 34/14(2006.01)i, E21B 34/06(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 47/12; E21B 33/13; E21B 34/08; E21B 43/117; E21B 43/14; G01V 3/18; E21B 34/14; E21B 34/06

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: send, signal, piston, ICD(Inflow Control Device), drainage, transmit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0101341 A1 (WILLAUER, DARRIN L.) 23 April 2009 paragraphs [0002]-[0031]; and figures 1-5	1,20-21
Y		2-19,22-27
Y	US 2011-0199228 A1 (RODDY et al.) 18 August 2011 paragraphs [0059]-[0251]; and figures 5-34	2-19,22-27
A	US 2008-0053658 A1 (WESSON et al.) 06 March 2008 paragraphs [0011]-[0031]; and figures 1-3	1-27
A	US 2015-0034311 A1 (TUNGET, BRUCE L.) 05 February 2015 paragraphs [0115]-[0140]; and figures 22-27	1-27
A	WO 2012-082304 A2 (EXXONMOBIL UPSTREAM RESEARCH COMPANY et al.) 21 June 2012 paragraphs [0116]-[0190]; and figures 2-4N	1-27

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 July 2020 (02.07.2020)	**02 July 2020 (02.07.2020)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2020/021658

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