



(43) International Publication Date
5 February 2009 (05.02.2009)

(10) International Publication Number
WO 2009/017900 A2

- | | |
|--|---|
| (51) International Patent Classification:
<i>E21B 47/12</i> (2006.01) | H. [US/US]; 6230 Clear Canyon Drive, Katy, TX 77450 (US). |
| (21) International Application Number:
PCT/US2008/067892 | (74) Agent: DUPHORNE, Darin, H. ; Baker Hughes Incorporated, P.O. Box 4740, Houston, TX 77027-4740 (US). |
| (22) International Filing Date: 23 June 2008 (23.06.2008) | (81) Designated States (<i>unless otherwise indicated, for every kind of national protection available</i>): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW. |
| (25) Filing Language: English | (84) Designated States (<i>unless otherwise indicated, for every kind of regional protection available</i>): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, |
| (26) Publication Language: English | |
| (30) Priority Data:
11/833,049 2 August 2007 (02.08.2007) US | |
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[Continued on next page]

- (54) Title:** APPARATUS AND METHOD FOR WIRELESSLY COMMUNICATING DATA BETWEEN A WELL AND THE SURFACE

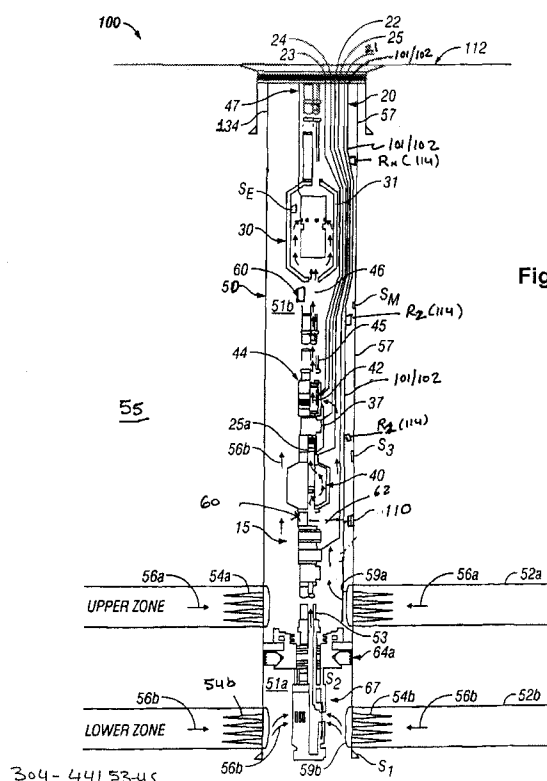


Fig. 1A

(57) Abstract: In one aspect, wellbore apparatus is disclosed that includes: a conduit in the wellbore that has a non-liquid medium therein; and a transducer that is configured to transmit radio frequency signals through the medium. In another aspect, a method is disclosed that includes: placing a conduit in the wellbore that contains a non-liquid medium therein; and transmitting information in the form of radio frequency signals through the medium.



FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,
NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG,
CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished
upon receipt of that report*

**APPARATUS AND METHOD FOR WIRELESSLY COMMUNICATING
DATA BETWEEN A WELL AND THE SURFACE**

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0001] This disclosure relates to apparatus and methods for wirelessly communicating data between a well and the surface.

2. Background Information

[0002] Wells (also referred to as “wellbores” or “boreholes”) are drilled and completed to produce hydrocarbons (oil and gas) from one or more production zones penetrated by a wellbore. A typical completed well may include a metallic casing that lines the well. Cement is generally placed between the casing and the well to provide a seal between the formation surrounding the well and the casing. Perforations made in the formation through the casing at selected locations across from the producing formations (also referred to as the “production zones” or “reservoirs”) allow the formation fluid containing the hydrocarbons to flow into the cased well. The formation fluid flows to the surface via a production tubing placed inside the casing because the pressure in the production zone is generally higher than the pressure caused by the weight of the fluid column in the well. An artificial lift mechanism, such as an electrical submersible pump (“ESP”) or a gas-lift mechanism is often employed when the formation pressure is not adequate to push the fluid in the well to the surface.

[0003] A variety of devices are used in the well to control the flow of the fluid from the production zones to optimize the oil and gas production over the life of the well. Remotely-controlled flow control valves and chokes are often used to control the flow of the fluid. Chemicals are injected at certain locations in the well via one or more tubes that run from the surface to the production zones to inhibit the formation of harmful chemicals, such as corrosion, hydrate, scale, hydrogen sulfide, methane, asphaltene, etc. A number of sensors are typically placed in the well to provide information about a

variety of downhole parameters, including the position of the valves and chokes, pressure, temperature, fluid flow rate, acoustic signals responsive to water front and surface or downhole induced signals in the subsurface formations, resistivity, porosity, permeability, water-cut, etc. The measurement data is typically transmitted to the surface via conductors, such as electrical wires, that run from the surface to selected locations in the well. Signals are also sent from the surface to the downhole sensors and devices via such conductors to control their operations. Such conductors (also referred to herein as data communication “links”) sometimes degrade over time. It is therefore desirable to have a data communication system that may be less prone to degradation.

[0004] The present disclosure provides improved apparatus, systems and methods for communicating data between a well and the surface.

SUMMARY

[0005] In one aspect, a well data communication system is disclosed that includes a conduit placed in a well, the conduit having a non-liquid medium therein, and a transducer that transmits wireless signals through the medium in the conduit that are representative of a selected information. The system may further include one or more repeaters associated with the conduit that receive the wireless signals transmitted by the transducer and retransmit the received signals wirelessly through the medium in the conduit. The system may further include a receiver that receives the signals transmitted by the transducer or the repeaters and a processor that processes the received signals to determine the selected information or to estimate a property of interest. The wireless signals may be radio frequency signals. The information may relate to downhole sensor measurements, downhole devices, surface sensor measurements, surface devices, stored in a suitable medium, received from a remote unit, etc. The transducer and/or any of the repeaters may be a transceiver and each may further be an autonomous device. The system may further include a transducer at the surface that transmits wireless signals, such as radio frequency signals, to a location in the well (a “downhole location”) via the medium in the conduit or another conduit that runs from the surface to the downhole location. Each of the transducers and repeaters may transmit and/or receive signals at a plurality of frequencies.

[0006] In another aspect, an apparatus is disclosed for use in a well that includes a conduit that has a non-liquid medium therein and which conduit is configured to be deployed in the well, and a transmitter that is configured to transmit wireless signals, which may be radio frequency signals, from one a downhole location and/or a surface location via the medium in the conduit.

[0007] In another aspect, a method is disclosed that includes transmitting wireless signals relating to selected information through a non-liquid filled conduit deployed in a well.

[0008] Examples of the more important features of a well data communication system and methods have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may be appreciated. There are, of course, additional features that will be described hereinafter and which will form the subject of the claims. The summary is provided to provide the reader with broad information and is not intended to be used in any way to limit the scope of the claims.

BRIEF DESCRIPTION

[0009] For a detailed understanding of the apparatus and methods for communicating information between a well and the surface, reference should be made to the following detailed description, taken in conjunction with the accompanying drawings, in which like elements generally have been given like numerals, wherein:

FIG. 1A shows a schematic diagram of an exemplary well that is configured to provide data communication between devices in the well and a surface controller according to one embodiment of the disclosure;

FIG. 1B shows a schematic diagram of certain controllers and devices at the surface that may be utilized to establish data communication between the well and the surface according to one embodiment of the disclosure; and

FIG. 2 shows a functional block diagram of a transducer that may be utilized to transmit wireless signals in a well system, such as shown in **FIGS. 1A** and **1B**.

DETAILED DESCRIPTION OF EMBODIMENTS

[00010] **FIGS. 1A and 1B** (collectively referred to as “**FIG. 1**”) collectively show schematic diagrams of one embodiment of a well system **100** that includes a data communication system between a completed well **50** and the surface **112** according to one embodiment of the disclosure. **FIG. 1A** shows the schematic diagram of the equipment of the well system that is below the surface **112**, while **FIG. 1B** shows the functional block diagram of exemplary equipment of the well system **100** that may be placed at the surface **112**. The system **100** shows the well **50** formed in a formation **55** that produces formation fluids **56a** and **56b** (such as hydrocarbons) from two exemplary production zones **52a** (upper production zone) and **52b** (lower production zone) respectively. The well **50** is shown lined with a casing **57** containing perforations **54a** adjacent the upper production zone **52a** and perforations **54b** adjacent the lower production zone **52b**. A packer **64**, which may be a retrievable packer, positioned above or uphole of the lower production zone perforations **54a**, isolates the lower production zone **52b** from the upper production zone **52a**. A screen **59b** adjacent to the perforations **54b** may be installed to prevent or inhibit solids, such as sand, from entering into the wellbore from the lower production zone **54b**. Similarly, a screen **59a** may be used adjacent the upper production zone perforations **59a** to prevent or inhibit solids from entering into the well **50** from the upper production zone **52a**.

[00011] Formation fluid **56b** from the lower production zone **52b** enters the annulus **51a** of the well **50** through the perforations **54a** and into a tubing **53** via a flow control valve **67**. The flow control valve **67** may be a remotely controlled sliding sleeve valve or any other suitable valve or choke that is configured to regulate the flow of the fluid from the annulus **51a** into the production tubing **53**. An adjustable choke **40** in the tubing **53** may be used to regulate the fluid flow from the lower production zone **52b** to the surface

112. The formation fluid **56a** from the upper production zone **52a** enters the annulus **51b** (the annulus portion above the packer **64**) via perforations **54a**. The formation fluid **56a** enters production tubing or line **45** via inlets **42**. An adjustable valve or choke **44** regulates the fluid flow into the tubing **45**. Each valve, choke and other devices in the well may be operated electrically, hydraulically, mechanically and/or pneumatically by a surface controller, such as a control unit **150** and/or by a downhole controller, such as a control unit **60**. The fluid from the upper production zone **52a** and the lower production zone **52b** enter the line **46**.

[00012] When the formation pressure is not sufficient to push the fluid **56a** and/or fluid **56b** to the surface, an artificial lift mechanism, such as an electrical submersible pump (ESP), gas lift system or other desired systems may be utilized to lift the fluids from the well **50** to the surface **112**. In the system **10**, an ESP **30** in a manifold **31** is shown as the artificial lift mechanism, which receives the formation fluids **56a** and **56b** and pumps such fluids via tubing **47** to the surface **112**. A cable **134** provides power to the ESP **30** from a surface power source **132** (**FIG. 1B**). The cable **134** also may include two-way data communication links **134a** and **134b** (**FIG. 1B**), which may include one or more electrical conductors or fiber optic links to provide two-way signal and data communication between the ESP **30**, ESP sensors S_E and an ESP control unit **130**.

[00013] Still referring to **FIGS. 1A and 1B**, in one aspect, a variety of sensors are placed at suitable locations in the well **50** to provide measurements or information relating to a number of downhole parameters of interest. In one aspect, one or more gauge or sensor carriers, such as a carrier **15**, may be placed in the production tubing to house any number of suitable sensors. The carrier **15** may include one or more temperature sensors, pressure sensors, flow measurement sensors, resistivity sensors, sensors that may provide information about density, viscosity, water content or water cut, etc., and chemical sensors that provide information about scale, corrosion, hydrate, paraffin, hydrogen sulfide, emulsion, asphaltene, etc. Density sensors may provide fluid

density measurements for fluid produced from each production zone and that of the combined fluid from two or more production zones. A resistivity sensor or another suitable sensor may provide measurements relating to the water content or the water-cut of the fluid mixture received from each production zones and/or for the combined fluid. Other sensors may be used to estimate the oil/water ratio and gas/oil ratio for each production zone and for the combined fluid. The temperature, pressure and flow sensors provide measurements for the pressure, temperature and flow rate of the fluid. Additional gauge carriers may be used to obtain the above-noted and other measurements relating to the upper production zone **52a**. Also, downhole sensors may be used at other desired locations to provide measurements relating to the presence and extent of chemicals downhole. Additionally, sensors S_1 - S_m may be permanently installed in the wellbore **50** to provide measurements, such as acoustic, seismic or microseismic measurements, formation pressure and temperature measurements, resistivity measurements and measurements relating to the properties of the casing **51** and formation **55**. Such sensors may be installed in the casing **57** or between the casing **57** and the formation **55**. Microseismic and other sensors may be used to detect water fronts, which may imbalance the composition of the fluids being produced, thereby providing early warning relating to the formation of certain chemicals. Pressure and temperature changes or expected changes may provide early warning of changes in the chemical composition of the production fluid. Additionally, the screen **59a** and/or screen **59b** may be coated with tracers that are released due to the presence of water, which tracers may be detected at the surface or downhole to determine or predict the occurrence of water breakthrough. EPS sensors S_E may provide information relating to the ESP **30**, such as power to the ESP, frequency, flow rate, temperature, pressure, differential pressure across ESP, presence of certain chemicals, such as corrosion, scale, hydrate, hydrogen sulfide, asphaltene, etc. Sensors also may be provided at the surface, such as a sensor for measuring the water content in the received fluid, total flow rate for the received fluid,

fluid pressure at the wellhead, temperature, etc. Other devices may be used to estimate the production of sand for each zone.

[00014] In general, sufficient sensors may be suitably placed in the well **50** and the surface **112** to obtain measurements relating to each desired parameter of interest. Such sensors may include, but are not limited to: sensors for measuring pressures corresponding to each production zone, pressure along the wellbore, pressure inside the tubings carrying the formation fluid, pressure in the annulus; sensors for measuring temperatures at selected places along the wellbore; sensors for measuring fluid flow rates corresponding to each of the production zones, total flow rate, flow through the ESP; sensors for measuring ESP temperature and pressure; chemical sensors for providing signals relating to the presence and extent of chemicals, such as scale, corrosion, hydrates, paraffin, emulsion, hydrogen sulfide and asphaltene; acoustic or seismic sensors that measure signals generated at the surface or in offset wells and signals due to the fluid travel from injection wells or due to a fracturing operation; optical sensors for measuring chemical compositions and other parameters; sensors for measuring various characteristics of the formations surrounding the well, such as resistivity, porosity, permeability, fluid density, etc. The sensors may be installed in the tubing in the well or in any device or may be permanently installed in the well. For example, sensors may be installed in the wellbore casing, in the wellbore wall or between the casing and the wall. The sensors may be of any suitable type, including electrical sensors, mechanical sensors, piezoelectric sensors, fiber optic sensors, optical sensors, etc. The signals from the downhole sensors may be partially or fully processed downhole by a downhole controller, such as controller **60**, which may include a microprocessor and associated electronic circuitry and programs and then communicated to the surface controller **150** (**FIG. 1A**) via a signal/data link, such as link **101**. The signals from downhole sensors may also be sent directly to the controller **150**.

[00015] A variety of hydraulic, electrical and data communication lines (collectively designated by numeral **20** (**FIG. 1A**)) are run inside the well **50** to operate the various devices in the well **50** to obtain measurements and other data from the various sensors in the well **50** and to provide power and data communication between the surface and downhole equipment. As an example, a tube or tubing **21** may supply or inject a particular chemical from the surface into the fluid **56b** via a mandrel **36**. Similarly, a tubing **22** may supply or inject a particular chemical to the fluid **56a** in the production tubing via a mandrel **37**. Separate lines may be used to supply the additives at different locations in the well **50** or to supply different types of additives. Lines **23** and **24** may operate the chokes **40** and **44** and may be used to operate any other device, such as the valve **67**. Line **25** may provide electrical power to certain devices downhole from a suitable surface power source. One or more non-liquid filled conduits, such as conduits **101** and **102** may be deployed in the well to establish two-way data communication between sensors and devices in the system. A downhole control unit, such as controller **60** and a surface controller, such as controller **150** may be used to process signals from these sensors and devices and then transmit desired information wirelessly via the conduits **101** and/or **102**. The sensors and the devices may communicate with the controllers by any suitable links, including, but not limited to, electrical conductors, optical fibers, acoustic signals, electromagnetic signals, and wireless signals..

[00016] In one aspect, one or more conduits or tubing, such as tubing **101** and **102** are placed or run between a suitable location in the well **50** and the surface to establish wireless data communication between a well **50** and the surface **112**. These tubings may be made from any suitable material, such as an alloy or a composite material capable of withstanding the downhole environment for an extended time period. In one aspect, the tubings **101**, **102** may be filled with a suitable gas, such as air or an inert gas, such as nitrogen or argon. In another aspect, the tubings **101**, **102** may be partially, substantially or fully evacuated. In **FIG. 1**, tubing **101** is shown in signal communication with a

downhole transducer **110**, which may include an RF data transmitter an/or a transceiver. The transducer **110** may include a receiver that receives signals or data from one or more sensors, such as sensors S_1 - S_m in the well **50** and other devices. Such data or signals may be provided to the transducer **110** by coupling the sensors to the transducer via electrical, fiber optic or wireless links. The transducer may be an active device and may include a processor, memory and other circuitry that can process the signals received from the sensors, process the received signals and transmit the processed signals as wireless signals through the medium in the tubing **101** at one or more selected frequencies. A transducer **120** (FIG. 1B) spaced from the transducer **110** receives the wireless signals and sends the received signals to a surface controller or control unit **150**. The surface controller **150** decodes the signals received from the receiver **120** and uses the signals to manage one or more operations of the well system **100**. The surface controller also may send data signals to the transducer **120**, which transmits the received signals via the non-liquid media in the tubing **101** as wireless signals. Alternatively, a separate transducer **122** and tubing **102** may be used to send the wireless signals from the surface **112** to a downhole controller **60** via the non-liquid medium in the tubing **102**. Each of the transducers **110** and **120** may be configured to transmit the wireless signals at more than one frequency. The signals may be coded signals and may use any desired signals modulation technique, such as amplitude, phase and frequency modulation.

[00017] Wells can be very long and can extend to several thousand meters. In some such wells, the radio frequency signal transmitted by a transducer, such transducer **110**, may attenuate and may not be detectable by the receiver **120**. In other cases, it may be desirable to transmit radio frequency signals between a branch wellbores or a branch wellbore and a main wellbore or the surface via a conduit in which the signals may attenuate to an undesirable extent. Also, the transducer **110** over time may not be able to send signals that are strong enough to reach a desired receiver in the system **100**. In any such cases, one or more repeaters, such as $R_1 - R_n$, (generally designated by numeral **114**)

may be deployed in the well **50** and configured in a manner so that they can detect signals from the conduit medium and retransmit the detected signals to the receiver **120**. Similar transmitters may be deployed in conduit **102**.

[00018] Each of the transducers, such as transducer **110**, and the repeaters $R_1 - R_n$ may be an autonomous device. **FIG. 2** shows a functional diagram of an autonomous transducer or repeater **200** according to one embodiment of the disclosure. The device **200** may include: a processor **210**, such as a micro-controller, microprocessor or another suitable circuit combination; a data storage device or memory device **212**, such a solid state memory device (Read-only-memory "ROM," random access memory ("RAM", flash memory, etc.) that is suitable for downhole application; and one or more computer programs or sets of instructions **214** that may be stored in the memory **212** and which programs are accessible to the processor **210**. The processor **210** communicates with the memory **212** and the programs **214** via links **211** and **213** respectively. A power source **220** provides power to the processor as shown by link **231** and to the other components of the device **200** via link **223**. In operation, signals $T_1 - T_p$ from sensors and other devices may be received by an interface **230** that is configured to receive such signals. The interface **230** may be configured to condition such signals, such as by amplifying and digitizing the signals. The processor **210** processes receives the signals from the interface and processes such signals, such as by sequencing the signals, putting the signals in appropriate data packets, assigning addresses of the sensors or the devices from which such signals are received, etc. and sends such processed signals via link **241** to a transmitter **240** that transmits the signals wirelessly via the medium in the conduit. The wireless signals, such as radio frequency signals, sent from the surface via the conduits **101** and/or **102** are received by a second interface or a receiver **245**, which conditions the received signals and provides them to the processor **210**. The processor **210** then may process these signals and may control one or more downhole devices **260** in response to such signals. The processor may store any information in the memory device **212** and use

any programs **214** to perform one or more of the functions described herein. The processor **210** is shown to communicate with the receiver radio frequency **245** via link **243**, with downhole devices **260** via link **261**. Alternatively, the signals sent from the surface may be received by a downhole controller **60** or received by the transducer **110** and passed on to the controller **60**. Thus, in one aspect, the downhole transducer **110** receives signals from one or more devices or sensors in the well or from a controller in the well and transmits signals representative of the received signals as wireless signals, such as RF signals, through a non-liquid filled conduit placed in the well. A receiver spaced from the downhole transducer detects the RF signals and transmits to a surface controller for further use. The surface controller may send RF signals to a downhole receiver via the same or a separate non-liquid filled conduit. One or more repeaters placed between the transducer and the surface receiver may be used to receive and retransmit the signals sent by the transducer.

[00019] Referring back to **FIG. 1B**, in one aspect, the exemplary equipment shown in **FIG. 1B** may be utilized to manage and control the various operations of the well system **100** in response to the signals received from the downhole transducer **110**. In one aspect, the controller **150** may manage injection of additives from a chemical injection unit **120** into the well **50** to enhance production from one or more zones in response to the signals received from a chemical sensor that may provide information about the presence of certain chemicals, such as scale, hydrate, corrosion, asphaltene, hydrogen sulfide, etc. or in response to a water-cut sensor, resistivity sensor, etc.

[00020] In another aspect, the central controller **150** may control the operation of one or more downhole devices directly or via a downhole control unit **160** and lines **21-25** by sending commands via a link **161**. The commands may be instructions to alter the position of a choke or a sliding sleeve, etc and such commands may be in response to signals received from one or more downhole sensors, surface sensors, based on programmed instructions provided to the controller and/or signals received from a remote

controller, such as controller **185** that may communicate with the controller **150** via any suitable link **189**, such as Ethernet, the Internet, etc. In another aspect, the central controller **150** may control the operation of the ESP **30** directly or via an ESP controller **130**. The ESP controller may control power to the ESP from a power source **132** in response to the signals received from the ESP sensors and/or signals received from the central controller **150**.

[00021] Still referring to **FIGS. 1 and 2**, a system is disclosed that includes: a non-liquid filled-conduit (“conduit”) in a well; at least one sensor that provides signals relating to a parameter of interest; and a transducer in the wellbore that transmits wireless signals, such as radio-frequency signals, through the non-liquid medium in the conduit that are representative of the signals provided by the at least one sensor. The system may further include a repeater in the well that receives the signals transmitted by the transducer in the well and retransmits the received signals as radio frequency signals through the medium in the conduit. The system may further include a surface receiver that receives the signals transmitted by the transducer and a processor that process the signals received by the surface receiver to estimate the property of interest. The sensor in the well may be a: (i) pressure sensor; (ii) temperature sensor; (iii) an acoustic sensor; (iv) a flow rate measuring sensor; (v) a water-cut measurement sensor; (vi) a resistivity measurement sensor; (vii) a chemical detection sensor; (viii) a fiber optic sensor; and (ix) a piezoelectric sensor. The conduit may be: (i) substantially filled with air; (ii) substantially filled with a gas; or (iii) at least partially evacuated. The conduit may extend from a selected location in the wellbore to an uphole location. The uphole location may be: (i) a location at the surface of the earth; (ii) a location in the wellbore uphole of the data transmission device; (iii) a location at a sea bed; (iv) a location on a land rig; and (v) a location on an offshore platform. The sensors may communicate with the transducer in the well via: (i) an electrical wire; (ii) an optical fiber; and (iii) wirelessly.

[00022] Each transducer and/or repeater include: a circuit that receives the signals from the at least one sensor; and a signal conditioner that conditions the received signals; and a transmitter that transmits signals as radio frequency signals through the medium in the conduit. The system may further include a power source that provides electrical power to the transducer. The power source may be: (i) a battery; (ii) a power generation unit that generates electrical power in the wellbore; or (iii) a power unit at the surface that supplies electrical power via an electrical conductor disposed in or along the conduit. The conduit may be placed along a production tubing that carries fluid from the wellbore to the surface; along a casing in the well or between a casing in the well and the formation surrounding the well. Additionally, the transducer may: (i) receive analog signals from the at least one sensor and transmit analog signals that are representative of the received signals over a radio frequency; (ii) receive analog signals from the at least one sensor and transmit digital signals that are representative of the received signals over a radio frequency and/or receive digital signals from the at least one sensor and transmit digital signals that are representative of the received signals over a radio frequency.

[00023] In another aspect, the system may include: a plurality of sensors distributed in the wellbore, each sensor in the plurality of sensors providing the at least one? signals relating to a measurement made by such sensor; a conduit in the wellbore that is gas-filled or at least partially evacuated; a plurality of transceivers in the wellbore; and wherein each sensor in the plurality of sensors provides signals to a corresponding transceiver in the plurality of transducers, wherein each transceiver transmits the signals received from its associated sensor wirelessly through the conduit. Each transducer may comprise a unique address. Each transducer may be a transceiver. Energy to the transceivers may be provided by: (i) a battery; (ii) a thermoelectric generator; and (iii) a combination of a battery and a thermoelectric generator. Any transceiver also may include a sensor for taking a measurement relating to a parameter of interest, which may relate to health of the transceiver, formation or the well.

[00024] Also, a method for communicating information between a location in a wellbore and an uphole location is disclosed, which method comprises: placing a non-liquid filled conduit in the wellbore; placing at least one sensor in the wellbore that provides signals relating to a parameter of interest; placing a first device in the conduit downhole; receiving signals provided by the at least one sensor at the first device; transmitting signals representative of the received signals wirelessly by the first device through the conduit; and receiving the signals transmitted by the first device at a second device uphole of the first device; processing the received signals to estimate the property of interest; and recording the property of interest in a suitable medium. The method may further comprise one or more repeaters that receive the signals transmitted by the first device and transmits the received signals to the second device. The parameter of interest may be: (i) pressure; (ii) temperature; (iii) resistivity; (iv) fluid flow rate; (v) capacitance; (v) viscosity; (vi) density; (vii) presence of a chemical in the wellbore; (viii) paraffin; (ix) scale; (x) hydrate; (xi) hydrogen sulfide; (xii) asphaltene; (xiii) corrosion; (xiv) water content; and (xv) presence of gas.

[00025] While the foregoing disclosure is directed to certain disclosed embodiments and methods, various modifications will be apparent to those skilled in the art. It is intended that all modifications that fall within the scopes of the claims relating to this disclosure be deemed as part of the foregoing disclosure. Also, an abstract is provided in this application with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

WHAT IS CLAIMED IS:

1. A system for communicating information between a wellbore and the surface, comprising:
a conduit containing non-liquid medium placed in the wellbore;
a transducer that is configured to transmit at a first location signals wirelessly through the medium in the conduit for reception of the transmitted wireless signals at a second location in the conduit.
2. The system of claim 1 further comprising a repeater receives the signals transmitted by the transducer and transmits wirelessly signals through the medium in the conduit that are representative of the signals received by the repeater.
3. The system of claim 1 further comprising: a surface receiver that receives the signals transmitted by the transducer and a processor that process the signals received by the surface receiver to determine the nature of the signals transmitted by the transducer..
4. The system of claim 1, wherein the wireless signals transmitted by the transducer relate to information receive from a sensor that is selected from a group consisting of:
(i) pressure sensor; (ii) temperature sensor; (iii) an acoustic sensor; (iv) a flow rate measuring sensor; (v) a water-cut measurement sensor; (vi) a resistivity measurement sensor; (vii) a chemical detection sensor; (viii) a fiber optic sensor; and (ix) a piezoelectric sensor.
5. The system of claim 1, wherein the wireless signals are radio frequency signals.

6. The system of claim 1, wherein the conduit is one of: (i) substantially filled with air; (ii) substantially filled with a gas; and (iii) at least partially evacuated.
7. The system of claim 1, wherein the conduit extends from a first location in the wellbore to a second location that is selected from a group consisting of: (i) a location at the surface of the earth; (ii) a location in the wellbore uphole of the data transmission device; (iii) a location at a sea bed; (iv) a location on a land rig; and (v) a location on an offshore platform.
8. The system of claim 1, wherein the transducer receives signals to be transmitted via one of: (i) an electrical wire; (ii) an optical fiber; and (iii) wirelessly.
9. The system of claim 1, wherein the transducer further comprises:
a circuit configured to receive the signals from at least one sensor; and
a signal conditioner configured to condition the received signals; and
a transmitter configured to transmit the conditioned signals as radio frequency signals through the medium in the conduit.
10. The system of claim 1 further comprising a power source that provides electrical power to the transducer, wherein the power source is selected from a group consisting of: (i) battery; (ii) a power generation unit that generates electrical power in the wellbore; and (iii) a power unit at the surface that supplies electrical power via an electrical conductor disposed in or along the conduit.
11. The system of claim 1, wherein the conduit is placed in the well in a manner that is one of: (i) along a production tubing that carries fluid from the well to the surface; (ii) along a casing in the wellbore; and (iii) between a casing and formation

surrounding the well.

12. The system of claim 1, wherein the transducer performs at least one function that is selected from a group of functions consisting of: (i) receives analog signals from at least one sensor and transmits analog signals that are representative of the received signals over a radio frequency; (ii) receives analog signals from at least one sensor and transmits digital signals that are representative of the received signals over a radio frequency; and (iii) receives digital signals from at least one sensor and transmits digital signals that are representative of the received signals over a radio frequency.

13. A method for communicating information between a downhole location in a well and an uphole location, the method comprising:
placing a conduit in the well, which conduit contains a non-liquid medium;
transmitting wireless signals through the medium in the conduit at a first location that are representative of selected information; and
receiving the signals transmitted through the medium at a second location in the conduit;
processing the received signals to obtain a parameter of interest; and
recording the parameter of interest in a suitable medium.

14. The method of claim 13 further comprising receiving the wireless signals at a repeater between the first and second locations and retransmitting such received signals wirelessly through the medium.

15. The method of claim 13, wherein the parameter of interest is selected from a group consisting of: (i) pressure; (ii) temperature; (iii) resistivity; (iv) fluid flow rate; (v) capacitance; (v) viscosity; (vi) density; (vii) presence of a chemical in the

wellbore; (viii) paraffin; (ix) scale; (x) hydrate; (xi) hydrogen sulfide; (xii) asphaltene; (xiii) corrosion; (xiv) water content; and (xv) presence of gas.

16. The method of claim 13, wherein the conduit is placed in a manner that is one of:
(i) inside a casing in the well; (ii) between a casing in the well and the formation surrounding the well; (iii) inside a production tubing that carries the well fluid.

17. A method for communicating data between a well and a surface location, comprising:
placing a conduit in the well that contains a non-liquid medium therein; and
transmitting wireless signals representative of a desired information as wireless signals through the non-liquid medium in the conduit.

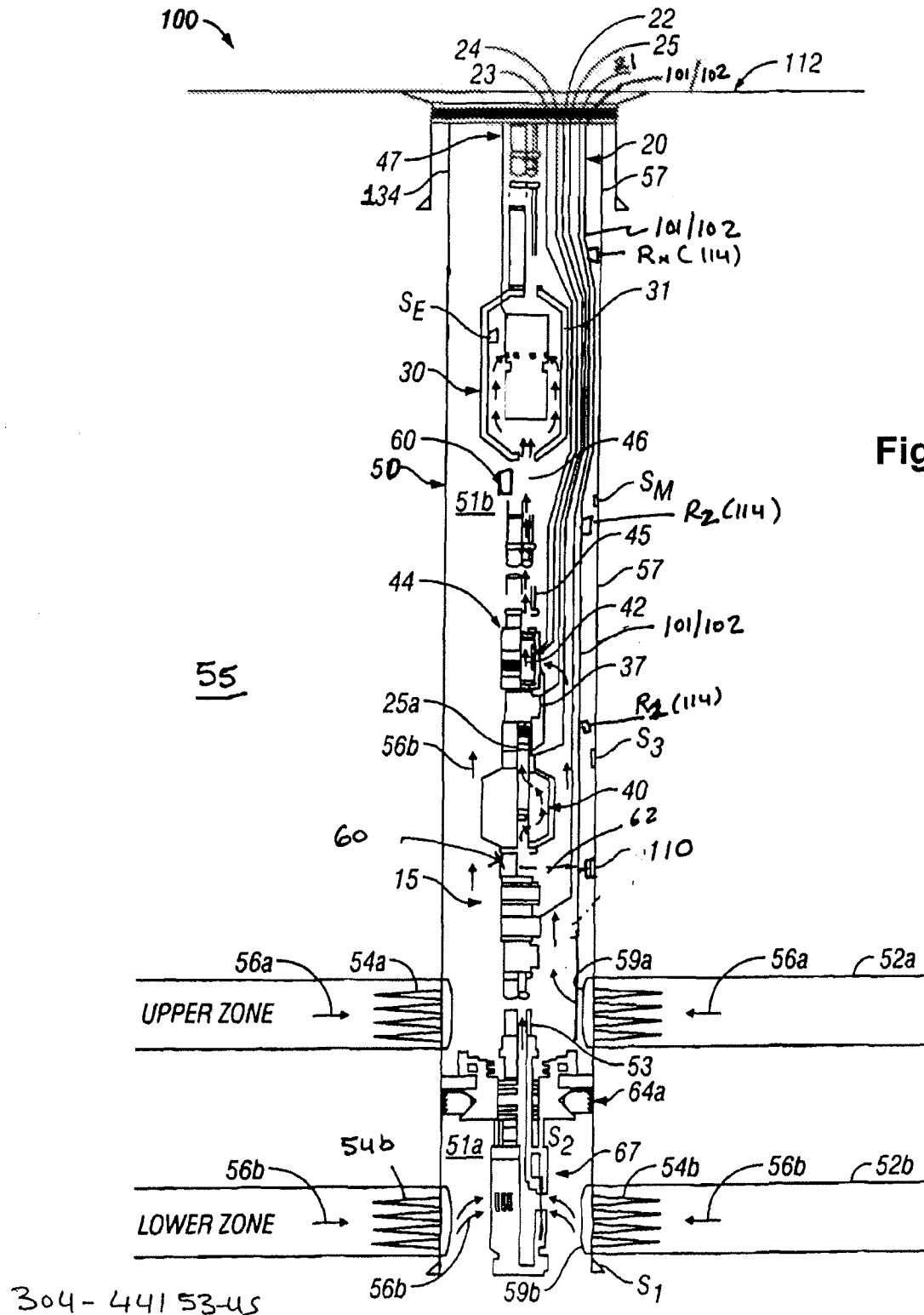
18. The method of claim 17 further comprising detecting the wireless signals in the conduit and processing the detected signals to ascertain the desired information.

19. The method of claim 18 further comprising recording the desired information in a suitable medium.

20. The method of claim 18 further comprising controlling an operation of a well system in response to processed signals..

21. An apparatus for use in a well, comprising:
a conduit containing a non-liquid therein and configured for deployment in the well;
and
a transmitter configured to transmit information wirelessly through the non-liquid medium in the conduit at a selected location in the conduit.

22. The apparatus of claim 21 further comprising receiving the wireless signals at second location spaced from the selected location and retransmitting the received signals wirelessly through the non-liquid medium in the conduit.



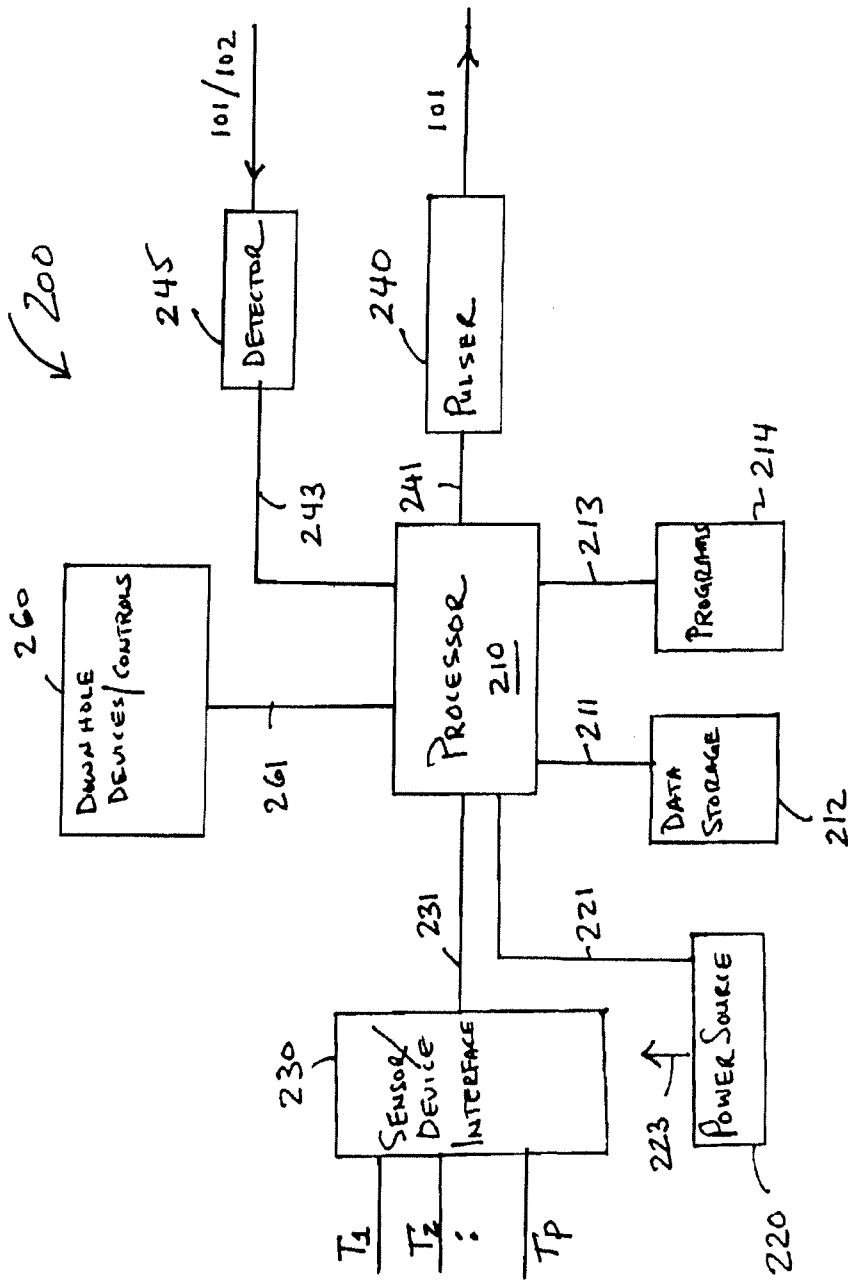


FIG. 2

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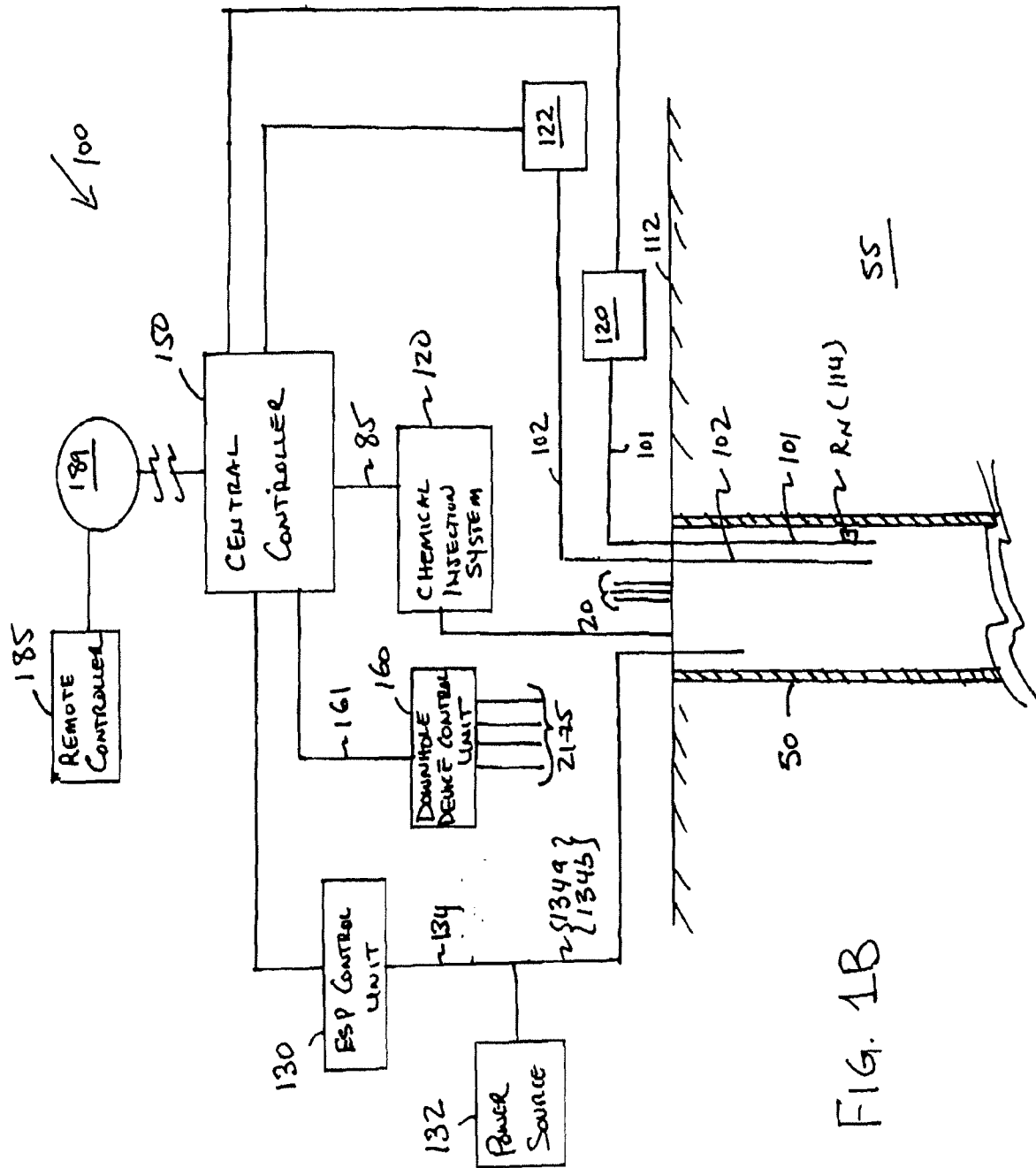


FIG. 1B

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