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(54) Wireless communication between tools

(57) The present invention relates to a downhole tool system for being submerged into a casing, comprising at least three tools. Furthermore, the invention relates to a communication method for communicating wirelessly between a first and a third tool separated by a second tool.

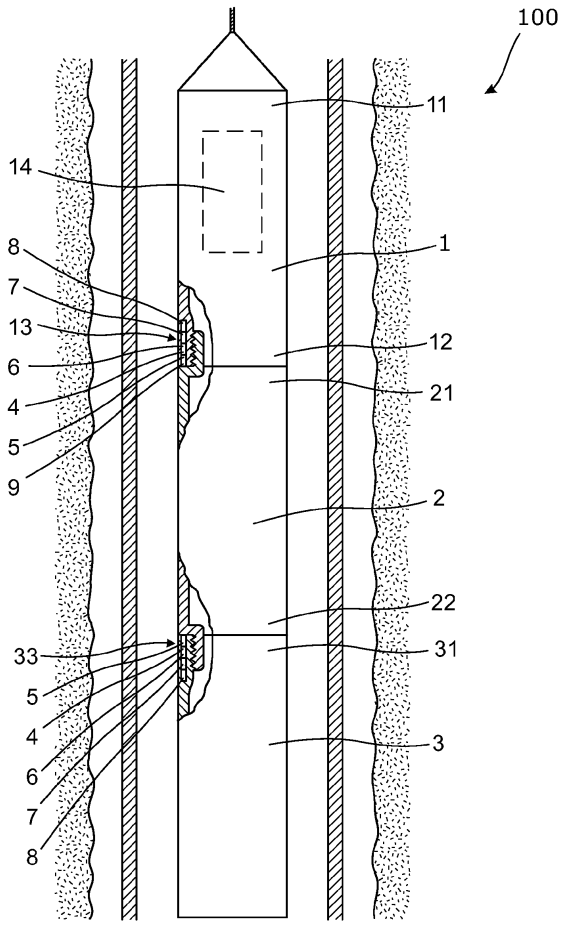

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a downhole tool system for being submerged into a casing, comprising at least three tools. Furthermore, the invention relates to a communication method for communicating wirelessly between a first and a third tool separated by a second tool.

Background art

[0002] Communication between surface and a tool in a well via acoustic signals in the well fluid is known. However, well fluid is most often very inhomogeneous as it comprises mud, scales, both oil and water, and gas bubbles. Therefore, the communication sometimes fails.

[0003] Sometimes, two operators work together to perform a well operation in the sense that a tool of one operator is arranged between the tools of another operator. However, when this is the case, communication between the tools of the other operator is hindered as these tools are separated by the tool of the one operator, through which communication is not possible. This is due to the fact that the one operator uses a different communication system than the other operator and that it is not possible to pull wires through the intermediate tool.

[0004] Since prior art acoustic communication through well fluid does not always function successfully, there is a need for an alternative communication form.

Summary of the invention

[0005] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved tool string enabling successful communication between two tools separated by an intermediate tool.

[0006] The above objects, together with numerous other objects, advantages, and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention by a downhole tool system for being submerged into a casing, comprising at least three tools:

- a first tool having a first and a second end and comprising a first communication device arranged at the second end,
- a second tool having a first end, which is connected with the second end of the first tool, and a second end, the second tool comprising a housing, and
- a third tool comprising a second communication device arranged at a first end, the first end of the third tool being connected with the second end of the second tool,

the first and second communication devices being a first and a second acoustic device, respectively,

wherein the second tool is arranged between the first and the third tool, and the first acoustic device arranged at the first end of the second tool sends and receives acoustic signals to and from the second acoustic device which is arranged at the first end of the third tool.

[0007] During a well operation, two operators may be forced to work together in the sense that one operator provides one tool and the other operator provides two tools, and the three tools are to be connected into one tool string where the tool of the one operator is arranged between the two tools of the second operator. In such a situation, the second operator must be able to communicate from one tool to the other through the intermediate tool. However, operators often use different communication systems, and sometimes, the second operator is not able to get communication cables into and through the intermediate tool. Therefore, there is a need for a tool system facilitating communication from one tool to another through an intermediate tool.

[0008] The acoustic devices arranged at each end of the intermediate tool are able to send acoustic signals propagating along the housing of the intermediate and second tool. The housing is often made of a solid material, increasing its transmitting ability compared to the transmitting ability in the surrounding well fluid which may be inhomogeneous and thereby be a poor transmitting media compared to a metal housing.

[0009] The three tools are most often connected by means of threaded connections providing a sufficiently firm connection for transmitting acoustic signals from the first or third tool to the second tool.

[0010] In an embodiment of the invention, the first and second acoustic devices may comprise means for converting data parameters into electric signals and transducers for receiving the electrical signal and generating acoustic signals propagating along the housing of the second tool.

[0011] Furthermore, the transducers may abut the ends of the second tool.

[0012] Moreover, the transducers of the first and second acoustic devices may face the second tool, causing the acoustic signals to propagate axially along the housing of the second tool.

[0013] In another embodiment, the first and second communication devices may be antennas instead of acoustic devices, sending and receiving radio waves.

[0014] Moreover, the antennas may transmit signals having a wavelength of 1-2 cm.

[0015] The third tool may be a logging tool.

[0016] Furthermore, the first tool may comprise an electronic motor.

[0017] In addition, the first and/or second communication device(s) may comprise a memory.

[0018] Also, the first and/or second communication device(s) may comprise a processing unit for processing data before converting the data into acoustic signals.

[0019] Moreover, the transducer may be a magneto-

strictive transducer.

[0020] Additionally, the acoustic devices may comprise piezoelectric microphones.

[0021] Furthermore, the first tool may be connected with a wireline.

[0022] Moreover, the first or third tool may comprise a driving unit, such as a downhole tractor.

[0023] In addition, the communication device may comprise a battery.

[0024] Also, the acoustic devices may comprise mechanical or electronic filters.

[0025] The present invention furthermore relates to a communication method for communicating wirelessly between a first and a third tool separated by a second tool, comprising the steps of:

- connecting the first tool with the second tool, the first tool comprising a first acoustic device and the second tool comprising a tool housing,
- connecting the third tool with the second tool, the third tool comprising a second acoustic device,
- sending acoustic signals from the first acoustic device to the second acoustic device, the signals propagating along the housing of the tool.

[0026] The communication method may further comprise the step of converting data parameters into electric signals.

Brief description of the drawings

[0027] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a partial cross-sectional view of a downhole tool system, and

Fig. 2 shows another embodiment of the downhole tool system.

[0028] All the figures are highly schematic and not necessarily to scale, and they show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

Detailed description of the invention

[0029] Fig. 1 shows a downhole tool system 1 comprising three tools; a first 1, a second 2 and a third 3 tool, arranged as a tool string. The first tool 1 is connected to a wireline at its first end 11 to power the tool string. In its second end 12, the first tool 1 is connected to a first end 21 of the second tool 2 by means of a threaded connection firmly connecting the first 1 and second 2 tools. In its second end 22, the second tool 2 is connected to a first end 31 of the third tool 3, also by means of a threaded connection.

[0030] Two operators may work together to perform a well operation in the sense that a tool of one operator is arranged between the tools of another operator. Thus, the first 1 and the third tool 3 come from a first operator and the second tool 2 comes from a second operator. Since the first 1 and third 3 tools are separated by the second tool 2, communication between the tools of the first operator cannot take place inside the tools in the conventional way since it is not possible to communicate through the second tool 2. This is due to the fact that the second operator uses a different communication system than the first operator and that it is not possible to pull wires through the intermediate tool without having to substantially reconstruct this tool.

[0031] Therefore, the first 1 and third 3 tools comprise communication devices 13, 33 in the form of acoustic devices. The acoustic device of the first tool 1 is arranged in a housing wall at the second end 12 of the first tool 1, abutting the first end 21 of the second tool 2, thereby being able to generate acoustic signals propagating axially along the housing 23 of the second tool 2. The acoustic device of the third tool 3 is arranged in a housing wall at the first end 31 of the third tool 3, abutting the second end 22 of the second tool 2, thereby also being able to generate acoustic signals propagating axially along the housing 23 of the second tool 2.

[0032] Each acoustic device comprises a transducer 5 facing the end of the housing 23 of the second tool 2. The transducers 5 may be magnetostrictive transducers transmitting acoustic signals in the form of longitudinal sonic waves along the housing 23 of the second tool 2.

[0033] In Fig. 2, the communication devices 13, 33 comprise antennas for sending and receiving radio waves having wavelengths of 1-2 cm. The antennas are arranged so that they project only partly from the outer faces of the first 1 and third tools 3 and extend parallel to the longitudinal extension of the tools. By having antennas transmitting signals with wavelengths of 1-2 cm, the radio waves propagate in the well fluid along the tool string without being substantially destroyed when hitting the wall of the tools 1, 2, 3 or the wall of the production casing 10.

[0034] The antennas are arranged in the housings of the first 1 and third 3 tools and are isolated from the other parts of the tools to improve the quality of the communication between the first 1 and third 3 tools.

[0035] The antennas may also be projecting parts of the tools and be projected as required and maintained inside the tools when the tool string is submerged into the casing 10.

[0036] By fluid or well fluid is meant any kind of fluid that may be present in oil or gas wells downhole, such as natural gas, oil, oil mud, crude oil, water, etc. By gas is meant any kind of gas composition present in a well, completion, or open hole, and by oil is meant any kind of oil composition, such as crude oil, an oil-containing fluid,

etc. Gas, oil, and water fluids may thus all comprise other elements or substances than gas, oil, and/or water, respectively.

[0037] By a casing is meant any kind of pipe, tubing, tubular, liner, string etc. used downhole in relation to oil or natural gas production.

[0038] In the event that the tools are not submergible all the way into the casing, a downhole tractor can be used to push the tools all the way into position in the well. A downhole tractor is any kind of driving tool capable of pushing or pulling tools in a well downhole, such as a Well Tractor®.

[0039] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. A downhole tool system (100) for being submerged into a casing (10), comprising at least three tools:

- a first tool (1) having a first (11) and a second end (12) and comprising a first communication device (13) arranged at the second end,
- a second tool (2) having a first end (21), which is connected with the second end of the first tool, and a second end (22), the second tool comprising a housing (23), and
- a third tool (3) comprising a second communication device (33) arranged at a first end (31), the first end of the third tool being connected with the second end of the second tool,

the first and second communication devices being a first and a second acoustic device, respectively, wherein the second tool is arranged between the first and the third tool, and the first acoustic device arranged at the first end of the second tool sends and receives acoustic signals to and from the second acoustic device which is arranged at the first end of the third tool.

2. A downhole tool system according to claim 1, wherein the first and second acoustic devices comprise means (4) for converting data parameters into electric signals and transducers (5) for receiving the electrical signals and generating acoustic signals propagating along the housing of the second tool.

3. A downhole tool system according to claim 2, wherein the transducers abut the ends of the second tool.

4. A downhole tool system according to any of the preceding claims, wherein the transducers of the first and second acoustic devices face the second tool, causing the acoustic signals to propagate axially along the housing of the second tool.

5. A downhole tool system according to any of the preceding claims, wherein the first and second communication devices are antennas instead of acoustic devices, sending and receiving radio waves.

6. A downhole tool system according to claim 5, wherein the antennas transmit signals having a wavelength of 1-2 cm.

7. A downhole tool system according to any of the preceding claims, wherein the third tool is a logging tool.

8. A downhole tool system according to any of the preceding claims, wherein the first tool comprises an electronic motor (14).

9. A downhole tool system according to any of the preceding claims, wherein the first and/or second communication device(s) comprise(s) a memory (6).

10. A downhole tool system according to any of the preceding claims, wherein the first and/or second communication device(s) comprise(s) a processing unit (7) for processing data before converting the data into acoustic signals.

11. A downhole tool system according to any of the preceding claims, wherein the transducer is a magnetostrictive transducer.

12. A downhole tool system according to any of the preceding claims, wherein the communication device comprises a battery (8).

13. A downhole tool system according to any of the preceding claims, wherein the acoustic devices comprise mechanical or electronic filters (9).

14. A communication method for communicating wirelessly between a first and a third tool separated by a second tool, comprising the steps of:

- connecting the first tool with the second tool, the first tool comprising a first acoustic device and the second tool comprising a tool housing,
- connecting the third tool with the second tool, the third tool comprising a second acoustic device,
- sending acoustic signals from the first acoustic device to the second acoustic device, the signals propagating along the housing of the tool.

15. A communication method according to claim 14, further comprising the step of converting data param-

eters into electric signals.

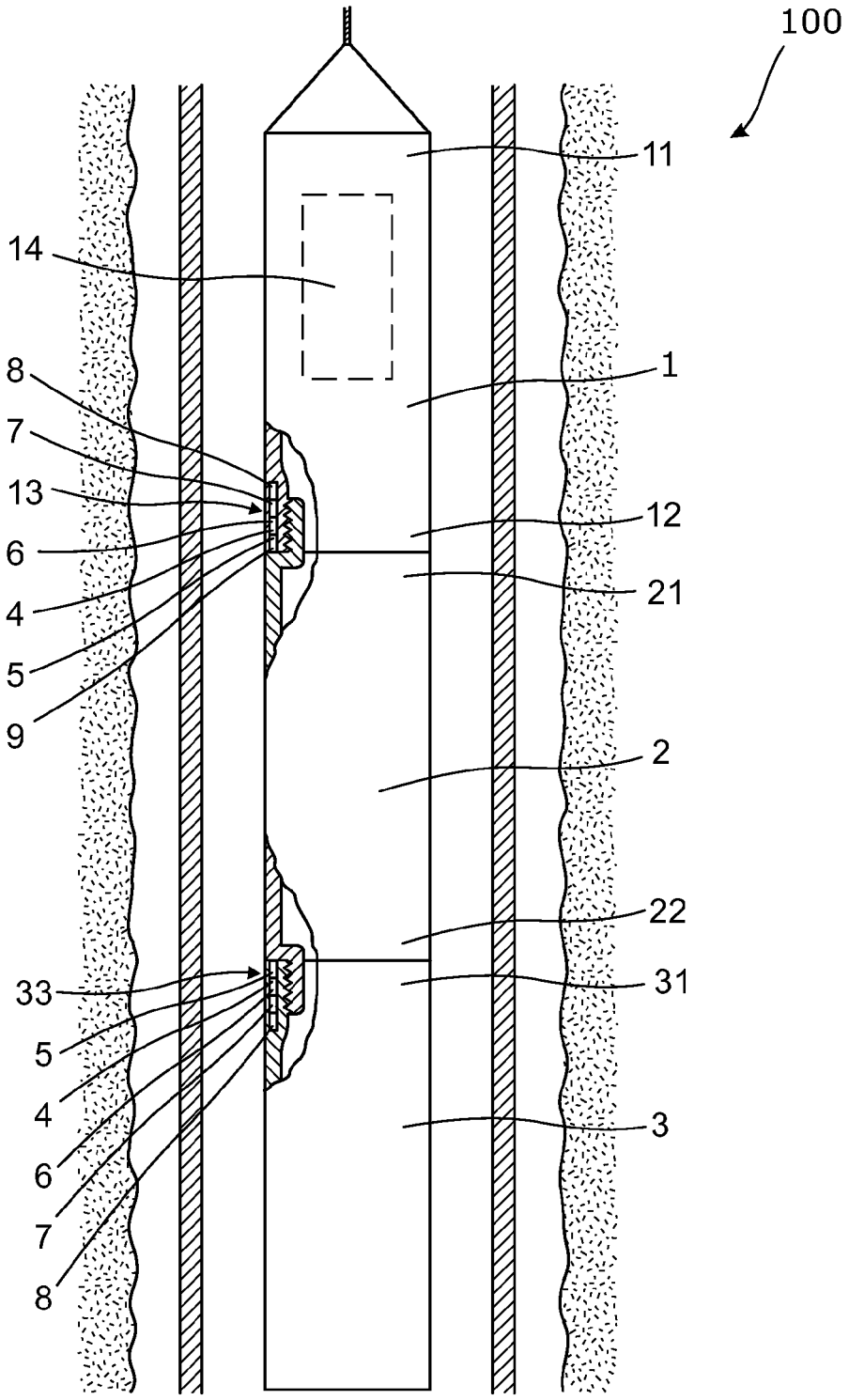

Fig. 1

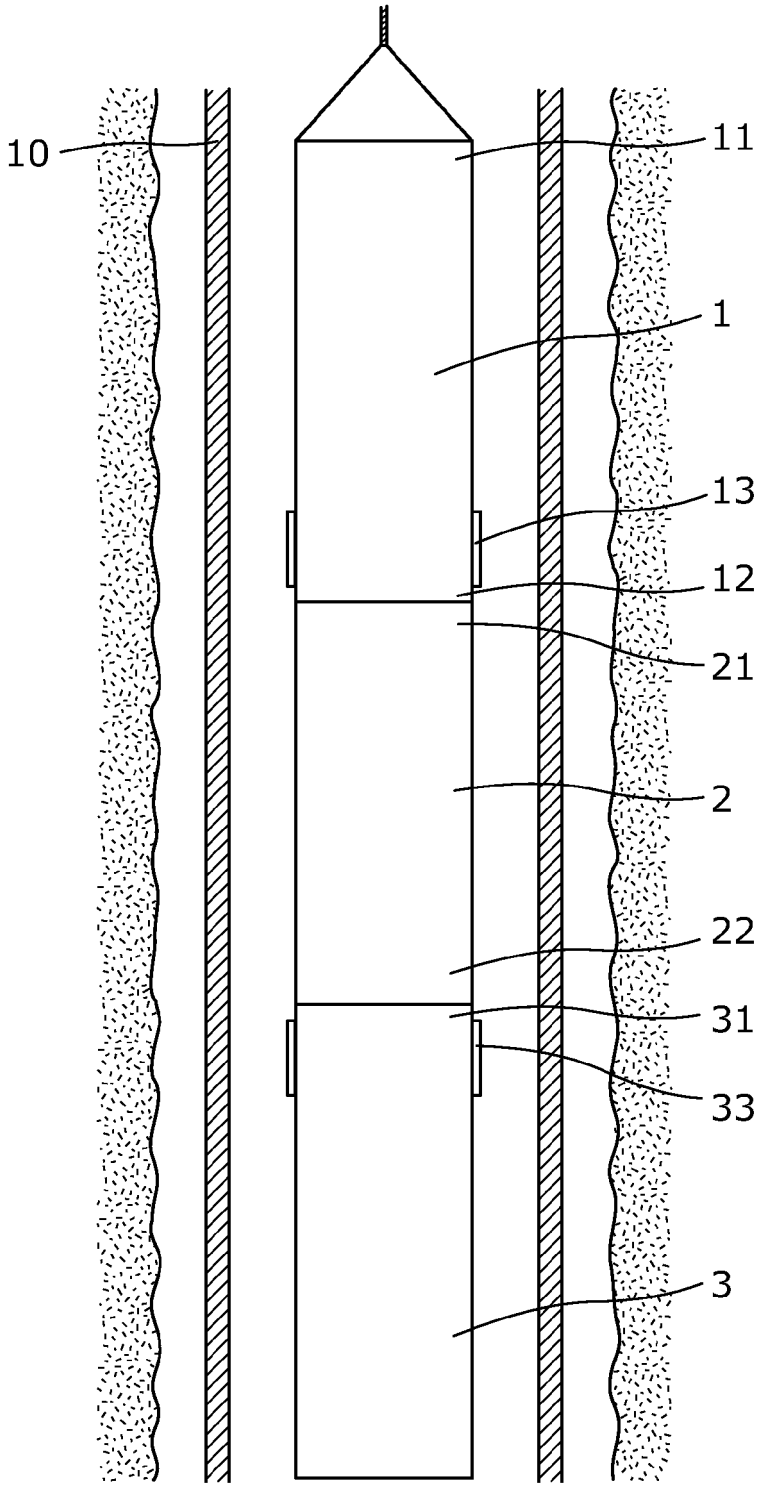

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 10 19 4466

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 May 2011	Morrish, Susan

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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1 EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 19 4466

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