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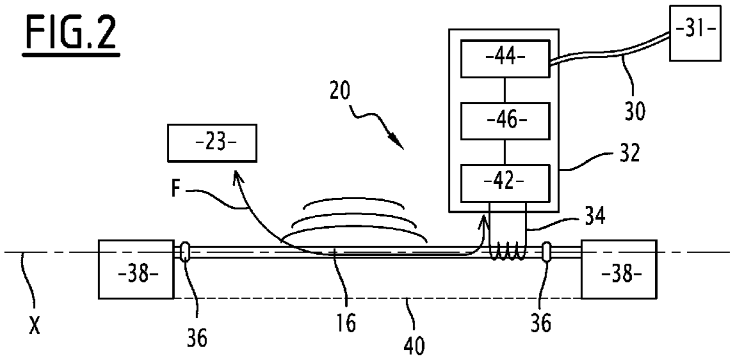
(54) **Title**: SUBSEA COMMUNICATION DEVICE CONFIGURED FOR BEING COUPLED TO A SUBSEA METALLIC CONDUCTOR, SUBSEA COMMUNICATION SYSTEM AND OIL & GAS PRODUCTION INSTALLATION INCLUDING SUCH A DEVICE

FIG.2



(57) **Abstract**: A subsea communication device (20) is configured for being coupled to at least one subsea metallic conductor (16) and for communicating data via radio waves. The subsea communication device (20) comprises: - a transceiver (32) for receiving data and/or transmitting data; and - at least one magnetic coupler (34), each magnetic coupler (34) being connected to the transceiver (32) and configured for magnetic coupling to a corresponding subsea metallic conductor (16); each subsea metallic conductor (16) forming then a subsea radio antenna.

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Subsea communication device configured for being coupled to a subsea metallic conductor, subsea communication system and oil & gas production installation including such a device

The present invention concerns a subsea communication device for communicating data via radio waves, preferably adapted for being used in an oil and gas production installation.

The present invention also relates to a subsea communication system for communicating data, comprising such a subsea communication device.

The present invention also relates to an oil and gas production installation, comprising such a subsea communication device.

The invention concerns particularly the field of subsea oil and gas production, or in other words relates to the exploration, drilling and development and production of oil and gas fields in underwater locations.

A subsea oil and gas production installation includes one or several wells with a flow line linked to a fixed platform, to a FPSO (Floating Production Storage and Offloading) or an onshore installation. Such an installation is used to develop reservoirs which require drilling of the wells from more than one location. The wells and the flow line are generally disposed in deep water. The flow line includes for example one or several subsea manifolds and one or several subsea pipelines. Such an installation also includes an autonomous underwater vehicle, also called AUV, for inspecting the flow line.

Actually, the AUV is controlled and powered from the surface by an operator via a remote control unit and the AUV communicates with the remote control unit either by sound waves or by low-frequency radio waves. In some cases, the AUV records data and delivers said data later when it comes back to a base station.

However, the data flow rate of the communication between the AUV and the remote control unit is very low, thereby limiting the quantity of data that can be transmitted in real time to the remote control unit by the AUV. Furthermore, if the frequency of the radio communication between the AUV and the remote control unit is stepped up in order to have a higher data flow rate, then the maximum communication distance between the AUV and the remote control unit decreases, which limits the use of the AUV.

A goal of the present invention is therefore to propose a subsea communication device for communicating data via radio waves which allows a better data flow rate while having a good maximum communication distance.

To this end, the invention relates to a subsea communication device configured for being coupled to at least one subsea metallic conductor and for communicating data via radio waves, the subsea communication device comprising a transceiver for receiving data and/or transmitting data; and at least one magnetic coupler, each magnetic coupler being connected to the transceiver and configured for magnetic coupling to a corresponding subsea metallic conductor; each subsea metallic conductor forming then a subsea radio antenna.

Thanks to the invention, the subsea communication device uses a subsea metallic conductor, such as an oil and gas subsea pipeline, as a subsea radio antenna, thereby allowing stepping up the communication frequency while keeping a good maximum communication distance due to the metallic conductor(s) acting as an antenna network. Further to stepping up the communication frequency, the data flow rate is increased. The metallic conductor could also be used to gather information from wireless sensors (such as constraint gauges…) along the metallic structure that induce their data directly on the metallic structure, the magnetic coupler 34 could then retrieve these data and send them to the topside.

According to other advantageous aspects of the invention, the subsea communication device comprises one or more of the following features taken alone or according to all technically possible combinations:

- the subsea communication device further comprises at least one low-pass filter, each low-pass filter being adapted for being fixed around an end of a corresponding subsea metallic conductor ;

- the subsea communication device comprises, for each coupled subsea metallic conductor, two low-pass filters, each one being adapted for being fixed around a corresponding end of said subsea metallic conductor ;

- each low-pass filter has a cut-off frequency comprised between 100 Hz and 100 kHz;

- at least one low-pass filter includes a ferrite collar having an inductance and a metallic collar having a capacitance, said low-pass filter forming a LC filter;

- the subsea communication device further comprises at least one pair of auxiliary magnetic couplers, each auxiliary magnetic coupler being configured for magnetic coupling to a corresponding subsea metallic conductor, each subsea metallic conductor forming then a subsea radio antenna, the two auxiliary magnetic couplers of a corresponding pair being connected together for propagating radio waves from one subsea metallic conductor to another;

- the two auxiliary magnetic couplers of a corresponding pair are directly connected; and

- the two auxiliary magnetic couplers of a corresponding pair are connected via a capacitor.

The invention also relates to a subsea communication system for communicating data, comprising:

- at least one subsea metallic conductor; and

- a subsea communication device coupled to at least one corresponding subsea metallic conductor and being configured for communicating data via radio waves,

wherein the subsea communication device is as defined above.

According to another advantageous aspect of the invention, the subsea communication system comprises the following feature:

- at least one subsea metallic conductor is a pipeline, preferably an oil and/or gas pipeline.

The invention also relates to an oil and gas production installation, comprising:

- at least one subsea production well, each one being configured for extracting oil and gas;

- at least one subsea manifold, each one being connected to one or several subsea production wells

- at least one oil and gas subsea pipeline, each one being connected to a corresponding subsea manifold;

- at least one riser, each one being connected to one or several oil and gas subsea pipelines; and

- a subsea communication device coupled to at least one corresponding oil and gas subsea pipeline and being configured for communicating data via radio waves,

wherein the subsea communication device is as defined above, each magnetic coupler being configured for magnetic coupling to the corresponding oil and gas subsea pipeline.

The invention will be better understood upon reading of the following description, which is given solely by way of a non-limitative example and with reference to the appended drawings, in which:

- Figure 1 is a schematic view of an oil and gas production installation including several subsea production wells, several manifolds connected to the production wells, several subsea pipelines connected to the manifolds for transporting the oil or the gas extracted via the production wells and a riser connected to the pipelines;

- Figure 2 is a schematic view of a subsea communication device according to a first embodiment, the subsea communication device including a transceiver and a magnetic coupler connected to the transceiver and magnetically coupled to a subsea pipeline of Figure 1 and a low-pass filter to protect electronic device from conducting high frequency current;

- Figure 3 is a schematic view of the magnetic coupler of Figure 2 according to a first example;

- Figure 4 is a view similar to that of Figure 3 according to a second example;

- Figure 5 is a schematic longitudinal sectional view of a low-pass filter included in the subsea communication device and being disposed around a subsea pipeline of Figure 1;

- Figure 6 is a view similar to that of Figure 2 according to a second embodiment; and

- Figure 7 is a view similar to that of Figure 2 according to a third embodiment.

In the following, the expression “substantially equal to” defines an equality relation to more or less 10%, preferably to more or less 5%.

In Figure 1, an oil and gas production installation 10 is disposed on an oil or gas field 11. The oil and gas production installation 10 includes several subsea production wells 12 and several manifolds 14 connected to the production wells 12. The oil and gas production installation 10 includes several subsea pipelines 16 for transporting the oil or gas extracted via the production wells 12, some of the pipelines 16 being connected to the manifolds 14.

The oil and gas production installation 10 also includes a riser 18 connected to some pipelines 16. The production wells 12, the manifolds 14 and the pipelines 16 form a flow line 19 for extracting and transporting the oil or the gas.

The oil and gas production installation 10 also includes a subsea communication device 20, shown in Figure 2, configured for being coupled to at least one subsea metallic conductor, such as a subsea pipeline 16. The subsea metallic conductor(s), such as the subsea pipeline(s) 16, and the subsea communication device 20 coupled to said subsea metallic conductor(s) form together a subsea communication system 21 for communicating data via radio waves. Alternatively, the subsea metallic conductor is an anchor cable, not shown, or any existing subsea metallic cable, not shown, disposed proximately to the subsea communication device 20.

In the example of Figure 1, the oil and gas production installation 10 also includes a Floating Production Storage and Offloading 22, usually called FPSO.

The oil and gas production installation 10 also includes an autonomous underwater vehicle 23, shown in Figure 2, also called AUV, for inspecting the flow line and more generally the oil or gas field 11.

Each production well 12 is configured for extracting oil or gas from the oil or gas field 11. Each production well 12 is well known and will not be described in further detail.

Each manifold 14 is connected to one or several subsea production wells 12 via respective jumpers 24 as known *per se*.

Each pipeline 16 is adapted for transporting the oil or gas extracted from the oil or gas field 11. Each pipeline 16 comprises a metallic body 26 surrounded by an outer layer 28, the metallic body 26 having an inner duct 29 for transporting the extracted oil or gas, as shown in Figure 5. The metallic body 26 is generally cylindrical and the outer layer 28 is an electrical insulator.

Each pipeline 16 when magnetically coupled to the subsea communication device 20 forms a radio antenna for further propagating the radio waves issued from the subsea communication device 20. When several pipelines 16 are magnetically coupled to the subsea communication device 20, they thus form a radio network.

The subsea extends in a longitudinal direction X. The length of each subsea pipeline 16 in the longitudinal direction X depends on the location of the production wells 12 and the manifolds 14. The maximum length of the subsea pipeline 16 is generally comprised between 1 km and 10 km.

Some pipelines 16 are connected to the manifolds 14 and some pipelines 16 are connected to other pipelines 16.

The riser 18 is connected to several subsea pipelines 16 and is configured for transporting the extracted oil or gas up to the FPSO 22. The riser 18 is well known and will not be described in further detail.

The subsea communication device 20 is configured for communicating data, on one hand, via radio waves with one or several subsea apparatus, and on the other hand, via a wired link 30 with a remote unit 31. The communication between the subsea apparatus and the remote unit 31 through subsea communication device 20 is preferably a bidirectional communication, i.e. a communication from the subsea apparatus to the remote unit 31 or from the remote unit 31 to the subsea apparatus, as illustrated by the bidirectional arrow F in Figure 2. Each subsea apparatus, such as the AUV 23, includes a radio transceiver and the remote unit 31 is for example placed in the FPSO 22.

The subsea communication device 20 is configured for being magnetically coupled to any kind of subsea metallic conductor. In the example of Figure 2, the subsea communication device 20 is magnetically coupled to a corresponding subsea pipeline 16.

The subsea communication device 20 comprises a transceiver 32 for receiving data and/or transmitting data, and a magnetic coupler 34 connected to the transceiver 32 and configured for magnetic coupling to a corresponding subsea metallic conductor, such as a corresponding subsea pipeline 16. The subsea metallic conductor, when magnetically coupled to the transceiver 32 by the magnetic coupler 34, forms a subsea radio antenna.

As an optional complement, the subsea communication device 20 comprises at least one low-pass filter 36, each low-pass filter 36 being adapted for being fixed around an end of a corresponding subsea metallic conductor and for protecting, against the radio waves, a subsea equipment 38 connected at said end of the corresponding subsea metallic conductor.

In the example of Figure 2, the subsea communication device 20 comprises two low-pass filters 36, each one for a respective end of the subsea pipeline 16 and for protecting a respective subsea equipment 38. The subsea equipment 38 is for example a wellhead. Each subsea equipment 38 connected to a respective end of the subsea pipeline 16 is laid on the seabed 40.

In the example of Figure 2, the wired link 30 is an optical fiber link and the remote unit 31 is a remote control unit for controlling the AUV 23.

The transceiver 32 is connected on one hand to the magnetic coupler 34 for being coupled to the corresponding subsea metallic conductor and on the other hand to the remote unit 31 via the link 30.

The transceiver 32 includes for example an electronic amplifier 42 connected to the magnetic coupler 34, a demodulator 44 connected to the remote unit 31 via the link 30 and a high-frequency modulator 46 connected between the electronic amplifier 42 and the demodulator 44.

The magnetic coupler 34 is configured for magnetic coupling to the corresponding subsea metallic conductor. In other words, the magnetic coupler 34 is mutual-inductively coupled with said subsea metallic conductor. In the example of Figure 2, the magnetic coupler 34 is configured for magnetic coupling to the subsea pipeline 16.

The magnetic coupler 34 is also designed for impedance matching the corresponding subsea metallic conductor with the transceiver 32. The impedance of the subsea metallic conductor depends on the diameter of said metallic conductor, on the distance between the seabed 40 and the metallic conductor, and also on properties of the medium in which the conductor is placed (salinity of the water, electromagnetic permeability of the water, permittivity of the water).

The magnetic coupler 34 includes a coil 48 which is disposed at least partially around the subsea metallic conductor, such as corresponding subsea pipeline 16. The magnetic coupler 34 also includes an electrical wet mate connector, not shown, at each end of the coil 48. The coil 48 is for example made of copper. In the example of Figure 3, the coil 48 has one or several turns 50, also called loops 50, entirely surrounding the subsea metallic conductor. In the alternative example of Figure 4, the coil 48 partially surrounds the subsea metallic conductor and is shaped like a boustrophedon.

Each low-pass filter 36 has a cut-off frequency comprised between 100 Hz and 100 kHz. The cut-off frequency is usually equal to a tenth of the communication frequency.

Each low-pass filter 36 is therefore adapted for filtering the high-frequency radio waves circulating through the subsea metallic conductor, such as the subsea pipeline 16, and thus for protecting from said radio waves a corresponding subsea equipment 38 connected at one end of the subsea metallic conductor.

At least one low-pass filter 36 includes a ferrite collar 52 having an inductance L and a metallic collar 54 having a capacitance C, as shown in Figure 5. Said low-pass filter 36 with the ferrite collar 52 and the metallic collar 54 thus forms a LC filter. Preferably, each low-pass filter 36 includes said ferrite collar 52 and said metallic collar 54.

The electronic amplifier 42 is configured on one hand for injecting a high-frequency current in the corresponding subsea metallic conductor via the magnetic coupler 34 in order to transmit data to the subsea apparatus, such as the AUV 23. On the other hand, the electronic amplifier 42 is configured for receiving another high-frequency current corresponding to data received from the subsea apparatus.

Each high-frequency current has a frequency higher than 1 kHz, preferably higher than 10 kHz, and more preferably higher than 100 kHz, and for example up to 1 MHz, in order to increase the data flow rate of the bidirectional communication between the subsea apparatus and the subsea communication device 20. Therefore, high-frequency means a frequency higher than 1 kHz.

The current frequency corresponds to the communication frequency between the subsea apparatus and the subsea communication device 20.

The signal delivered by the amplifier 42 to the magnetic coupler 34 has for example an intensity comprised between 0.5 mA and 100 mA and a voltage comprised between 1 V and 10 kV. The power of the delivered signal is generally substantially comprised between 5W and 500W.

The demodulator 44 is configured for extracting an original information-bearing signal from a modulated carrier wave received from the subsea apparatus via the magnetic coupler 34 and the amplifier 42. In other words, the demodulator 44 is configured for recovering the information content from the modulated carrier wave received from the subsea apparatus. The demodulator 44 is then configured for sending said extracted signal to the remote unit 31 via the link 30.

The modulator 46 is configured for varying a carrier signal with a modulating signal that contains information to be transmitted in order to obtain a signal to be transmitted along the corresponding subsea metallic conductor. In other words, the modulator 46 is configured for conveying said information to be transmitted, such a digital or analog signal, inside another signal that can be physically transmitted. The signal issued by the modulator 46 is adapted to be injected by the electronic amplifier 42 in said subsea metallic conductor via the magnetic coupler 34.

The ferrite collar 52 and the metallic collar 54 each surround the subsea metallic conductor, such as the subsea pipeline 16. The ferrite collar 52 and the metallic collar 54 are preferably in contact with the subsea metallic conductor. The ferrite collar 52 and the metallic collar 54 are for example each made of two half-collars connected together.

In the example of Figure 5, the ferrite collar 52 and the metallic collar 54 are each in contact with the outer layer 28 of the pipeline.

Thus, when data are received by the subsea communication device 20 from the remote unit 31 via the link 30, they are modulated by the high-frequency modulator 56, and the high-frequency modulated signal is amplified by the amplifier 42 before being injected in the magnetic coupler 34. The high-frequency signal then flows in form of radio waves along the corresponding subsea metallic conductor, such as the subsea pipeline 16, the anchor cable, or any existing subsea metallic cable. Said high-frequency signal flows up to a corresponding subsea equipment, such as the AUV 23, which is located proximately to the subsea metallic conductor in a radial direction perpendicular to the longitudinal direction X.

Conversely, when a data signal is received by the subsea communication device 20 from the corresponding subsea equipment via the subsea metallic conductor, it is transmitted through the magnetic coupler 34 and the amplifier 42 up to the demodulator 44 where the information content is recovered from the received signal and the extracted signal is then sent to the remote unit 31 via the link 30.

In other words, each subsea metallic conductor which is magnetically coupled to the subsea communication device 20 forms a radio antenna and allows a better propagation of the radio waves in the sea, in particular a farther data transmission. Particularly, it allows a bidirectional communication between the subsea communication device 20 and the AUV 23 as long as the AUV 23 moves along the subsea metallic conductor in a radial proximity to said conductor, such as the subsea pipeline 16, even if the AUV 23 is far from the subsea communication device 20.

The subsea communication device 20 also permits a better data flow rate in comparison with the prior art subsea communication device, as the communication frequency of the subsea communication device 20 is higher than 1 kHz, which is higher than the low-frequency of the prior art subsea communication device.

Furthermore, each low-pass filter 36 allows protecting a corresponding subsea equipment 38 connected at one end of the subsea metallic conductor from the radio waves flowing through said subsea metallic conductor.

The subsea communication device 20 according to the invention therefore allows a better data flow rate while having a good maximum communication distance.

Figure 6 illustrates a second embodiment of the invention, wherein the elements which are the same as in the first embodiment, previously described, are identified by identical reference numbers, and are not described again.

According to the second embodiment, the subsea communication device 20 is magnetically coupled to two subsea metallic conductors, such as a first subsea pipeline 16A and a second subsea pipeline 16B. The subsea metallic conductors are fixed together but are insulated from each other by an electrical insulator 60.

According to the second embodiment, the subsea communication device 20 then further comprises at least one pair of auxiliary magnetic couplers 70, each auxiliary magnetic coupler 70 being configured for magnetic coupling to a corresponding subsea metallic conductor, each subsea metallic conductor forming then a subsea radio antenna.

The two auxiliary magnetic couplers 70 of a corresponding pair are connected together for propagating radio waves from one subsea metallic conductor to the other.

According to the second embodiment, the two auxiliary magnetic couplers 70 of a corresponding pair are directly connected via a wired electrical link 72.

In the example of Figure 6, the subsea communication device 20 comprises two auxiliary magnetic couplers 70, i.e. one pair of auxiliary magnetic couplers 70.

The skilled person will easily understand that the subsea communication device 20 further comprises an additional pair of auxiliary magnetic couplers 70 for each additional subsea metallic conductor fixed to one of the aforementioned subsea metallic conductors, in order to increase the number of subsea metallic conductors to which the subsea communication device 20 is magnetically coupled.

Each auxiliary magnetic coupler 70 is similar to the magnetic coupler 34 which has been previously described and the auxiliary magnetic coupler 70 will therefore not be described in further detail.

The operation of the subsea communication device 20 according to this second embodiment is similar to the operation of the subsea communication device 20 according to the first embodiment. Furthermore, the radio waves issued from the subsea apparatus to the remote unit 31 - or from the remote unit 31 to the subsea apparatus - flow between the first subsea pipeline 16A and the second subsea pipeline 16B via the two auxiliary magnetic couplers 70 which are directly connected via the wired electrical link 72.

The advantages of this second embodiment include the advantages of the first embodiment previously described.

In addition, the subsea communication device 20 according to this second embodiment allows a farther data transmission as the two subsea metallic conductors which are magnetically coupled together via the auxiliary magnetic couplers 70 form a longer radio antenna.

The subsea communication device according to this second embodiment therefore still allows a better data flow rate in comparison with the prior art subsea communication device while having a better maximum communication distance.

Figure 7 illustrates a third embodiment of the invention, wherein the elements which are the same as in the first and/or second embodiments, previously described, are identified by identical reference numbers, and are not described again.

According to the third embodiment and similarly to the second embodiment, the subsea communication device 20 is magnetically coupled to two subsea metallic conductors, such as the first subsea pipeline 16A and the second subsea pipeline 16B.

According to the third embodiment, the subsea communication device 20 also further comprises at least one pair of auxiliary magnetic couplers 70, each auxiliary magnetic coupler 70 being configured for magnetic coupling to a corresponding subsea metallic conductor, each subsea metallic conductor forming then a subsea radio antenna.

The two auxiliary magnetic couplers 70 of a corresponding pair are connected together for propagating radio waves from one subsea metallic conductor to the other.

According to the third embodiment, the two auxiliary magnetic couplers 70 of a corresponding pair are connected via a capacitor 74.

In the example of Figure 7, the subsea communication device 20 comprises two auxiliary magnetic couplers 70, i.e. one pair of auxiliary magnetic couplers 70.

The skilled person will easily understand that the subsea communication device 20 further comprises an additional pair of auxiliary magnetic couplers 70 and an additional capacitor 74 for each additional subsea metallic conductor fixed to one of the aforementioned subsea metallic conductors, in order to increase the number of subsea metallic conductors to which the subsea communication device 20 is magnetically coupled.

The operation of the subsea communication device 20 according to this third embodiment is identical to the operation of the subsea communication device 20 according to the second embodiment, and will therefore not be described in further detail.

The advantages of this third embodiment include the advantages of the first and second embodiment previously described.

In addition, the subsea communication device 20 according to this third embodiment allows a better magnetic coupling between two subsequent subsea metallic conductors, as the capacitor 74 forms a high-pass filter.

The subsea communication device according to this third embodiment therefore still allows a better data flow rate in comparison with the prior art subsea communication device while having a very good maximum communication distance and permitting a better transmission quality between two subsequent subsea metallic conductors.

CLAIMS

1.-°A subsea communication device (20) configured f or being coupled to at least one subsea metallic conductor (16; 16A, 16B) and for communicating data via radio waves, the subsea communication device (20) comprising:

- a transceiver (32) for receiving data and/or transmitting data; and
- at least one magnetic coupler (34), each magnetic coupler (34) being connected to the transceiver (32) and configured for magnetic coupling to a corresponding subsea metallic conductor (16; 16A, 16B); each subsea metallic conductor (16; 16A, 16B) forming then a subsea radio antenna.

2.-° The subsea communication device (20) of claim 1, wherein it further comprises at least one low-pass filter (36), each low-pass filter (36) being adapted for being fixed around an end of a corresponding subsea metallic conductor (16; 16A, 16B).

3.-° The subsea communication device (20) of claim 2, wherein it comprises, for each coupled subsea metallic conductor (16; 16A, 16B), two low-pass filters (36), each one being adapted for being fixed around a corresponding end of said subsea metallic conductor (16; 16A, 16B).

4-° The subsea communication device (20) of claim 2 or 3, wherein each low-pass filter (36) has a cut-off frequency comprised between 100 Hz and 100 kHz.

5.-° The subsea communication device (20) of any on e of claims 2 to 4, wherein at least one low-pass filter (36) includes a ferrite collar (52) having an inductance (L) and a metallic collar (54) having a capacitance (C), said low-pass filter forming a LC filter.

6.-° The subsea communication device (20) of any on e of any one of the preceding claims, wherein it further comprises at least one pair of auxiliary magnetic couplers (70), each auxiliary magnetic coupler (70) being configured for magnetic coupling to a corresponding subsea metallic conductor (16A, 16B), each subsea metallic conductor (16A, 16B) forming then a subsea radio antenna,

the two auxiliary magnetic couplers (70) of a corresponding pair being connected together for propagating radio waves from one subsea metallic conductor (16A) to another (16B).

7.-° The subsea communication device (20) of claim 6, wherein the two auxiliary magnetic couplers (70) of a corresponding pair are directly connected.

8.-° The subsea communication device (20) of claim 6, wherein the two auxiliary magnetic couplers (70) of a corresponding pair are connected via a capacitor (74).

9.-°A subsea communication system (21) for communicating data, comprising:

- at least one subsea metallic conductor (16; 16A, 16B); and

- a subsea communication device (20) coupled to at least one corresponding subsea metallic conductor (16; 16A, 16B) and being configured for communicating data via radio waves,

wherein the subsea communication device (20) is according to any one of the preceding claims.

10.-°The subsea communication system (21) of claim 9, wherein at least one subsea metallic conductor is a pipeline (16; 16A, 16B), preferably an oil and/or gas pipeline (16; 16A, 16B).

11.-° An oil and gas production installation (10), comprising:

- at least one subsea production well (12), each one being configured for extracting oil and/or gas;

- at least one subsea manifold (14), each one being connected to one or several subsea production wells (12);

- at least one subsea pipeline (16; 16A, 16B) for transporting the extracted oil and/or gas;

- at least one riser (18), each one being connected to one or several subsea pipelines (16; 16A, 16B); and

- a subsea communication device (20) coupled to at least one corresponding subsea pipeline (16; 16A, 16B) and being configured for communicating data via radio waves,

wherein the subsea communication device (20) is according to any one of the preceding claims 1 to 8, each magnetic coupler (34) being configured for magnetic coupling to a corresponding subsea pipeline (16; 16A, 16B).

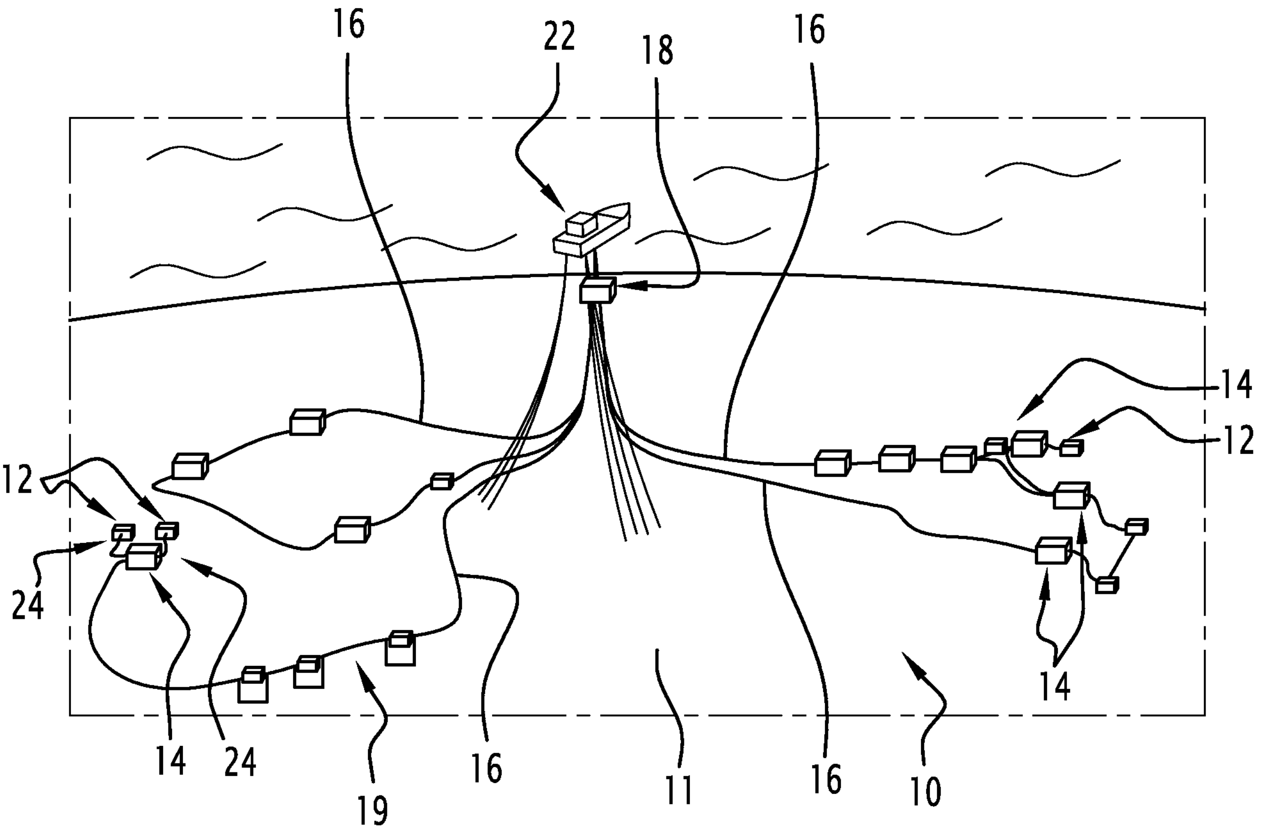
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FIG.1

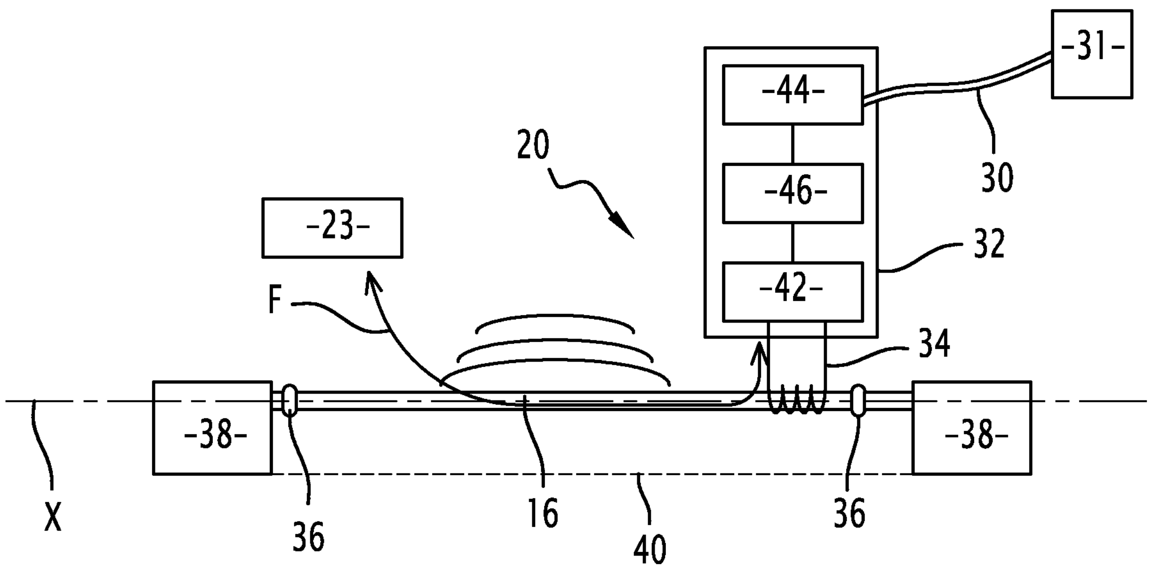
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FIG.2

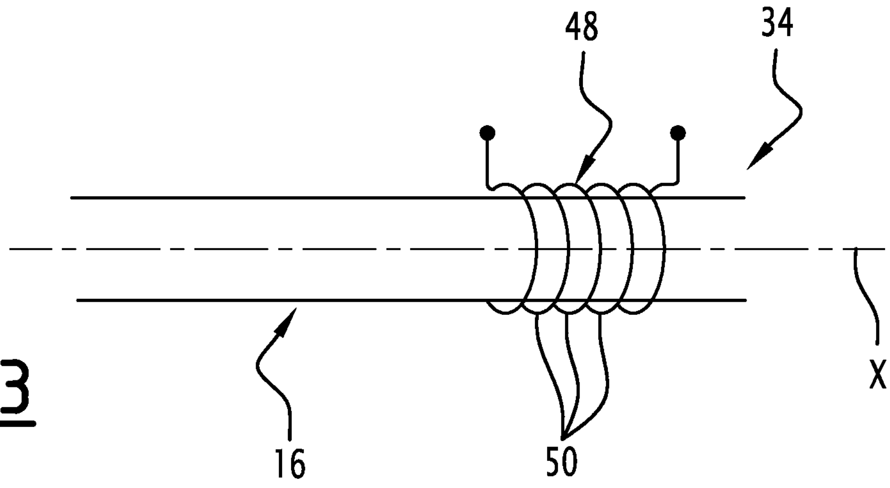

FIG.3

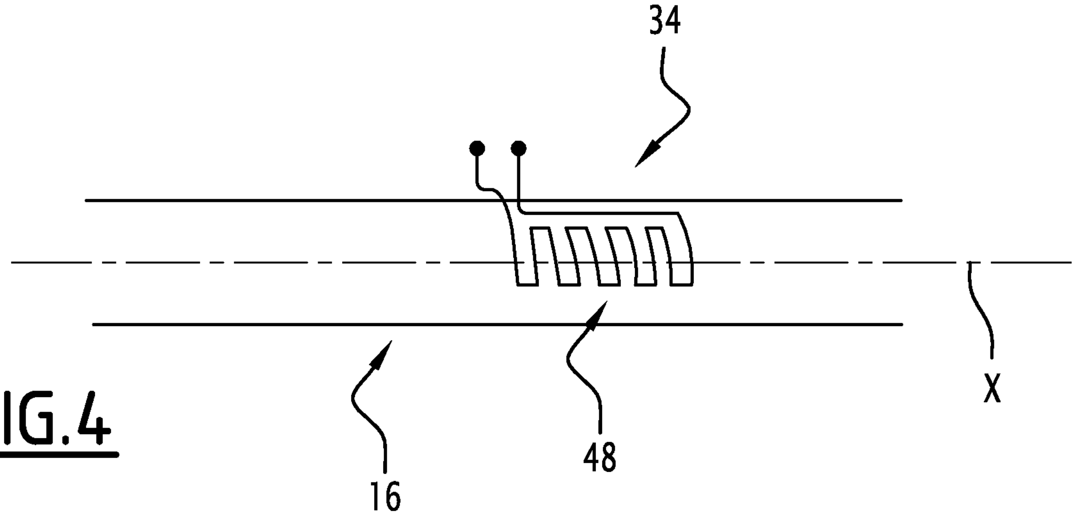

FIG.4

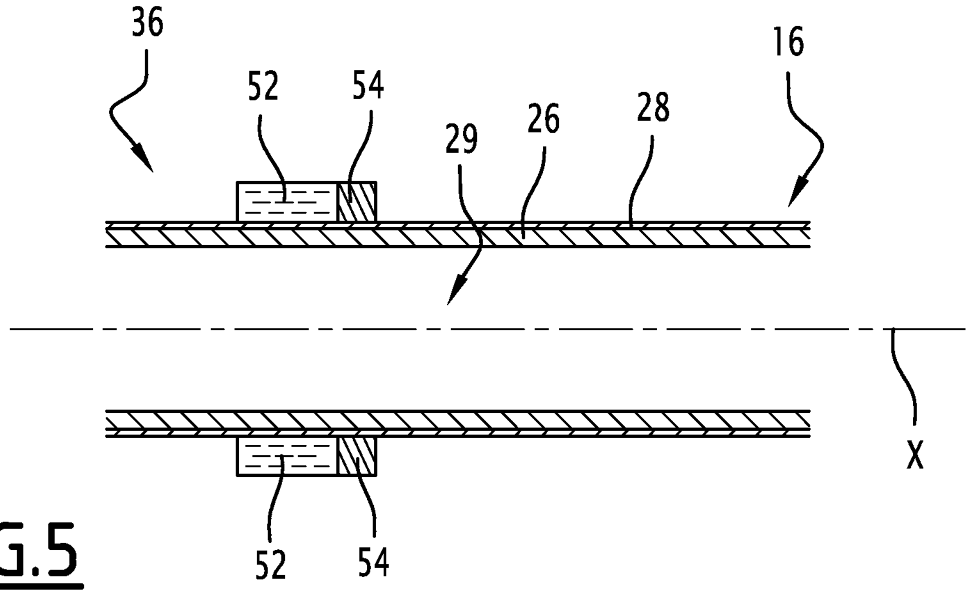

FIG.5

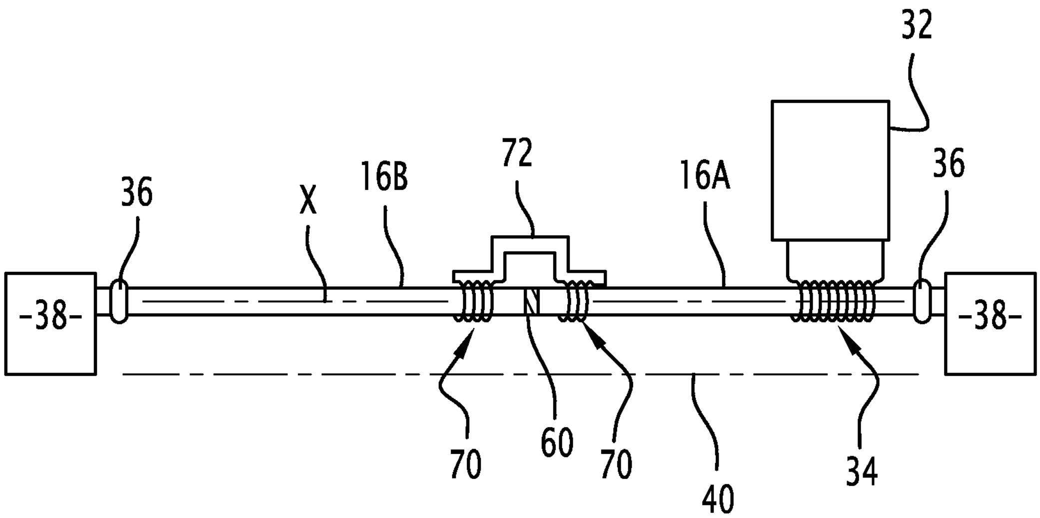
32
72
36
X
16B
16A
36
-38-
-38-
70
60
70
40
34

FIG.6

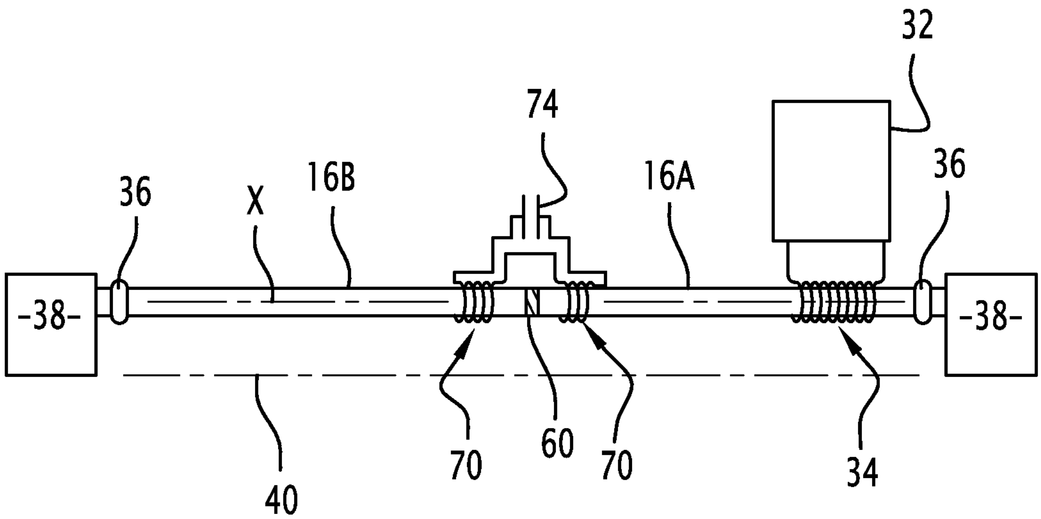
32
74
36
X
16B
16A
36
-38-
-38-
70
60
70
40
34

FIG.7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/003053

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B41/04 E21B47/00 E21B47/12 B63G8/00
ADD.

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 B63G

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2013/114138 A2 (WFS TECHNOLOGIES LTD [GB]) 8 August 2013 (2013-08-08) page 9, line 28 - line 34	1-9 10,11
Y	EP 1 953 570 A1 (SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBERGER TECHNOLOGY BV [NL]; SC) 6 August 2008 (2008-08-06) the whole document	10,11
X Y	WO 2011/114152 A2 (WFS TECHNOLOGIES LTD [GB]; JAFFREY ANDREW [GB]; HYLAND BRENDAN PETER [) 22 September 2011 (2011-09-22) figure 3	1-9 10,11
Y	US 2007/024464 A1 (LEMENAGER ERWANN [FR] ET AL) 1 February 2007 (2007-02-01) paragraph [0050] - paragraph [0051]	10,11

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

☒ See patent family annex.

* Special categories of cited documents :

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"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
8 September 2015	15/09/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Ott, Stéphane

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2014/003053

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