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(54) PIPELINE INSTRUMENTATION AND CONTROL SYSTEM

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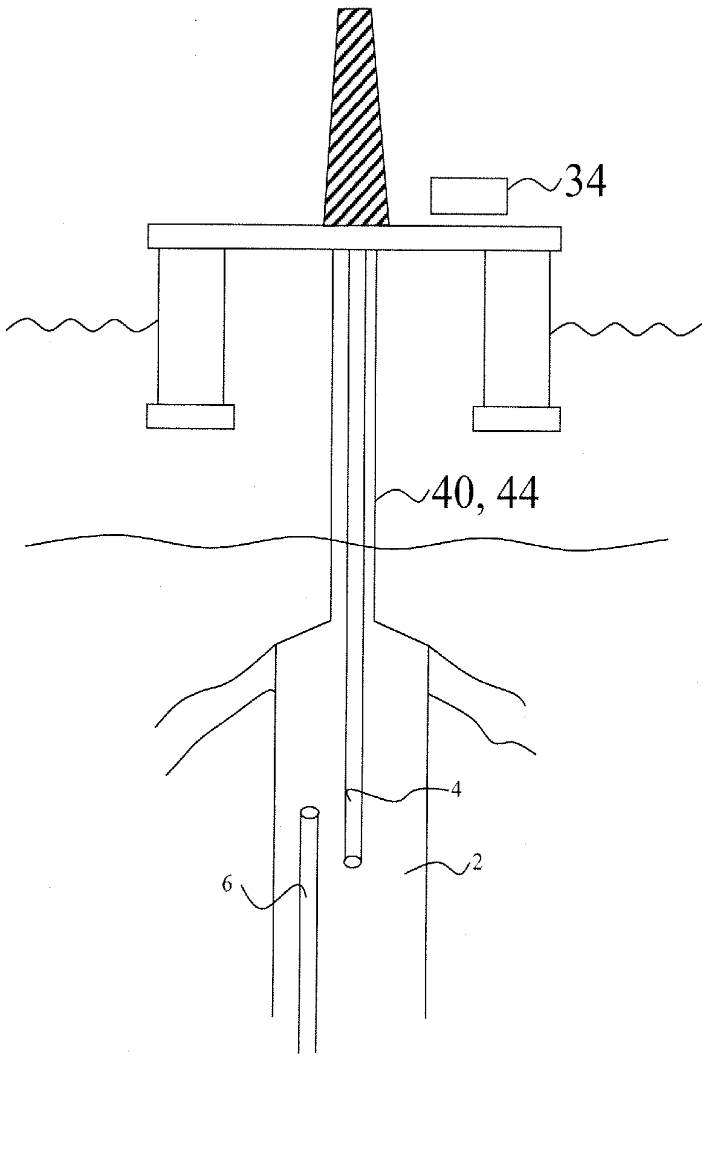
(57) **ABSTRACT**

A pipeline instrumentation and control system comprising a first electrically insulated radiating cable for controlled radiation and reception of electromagnetic signaling carried to a second electrically insulated radiating cable wherein first and second electrically insulated radiating cables are axially disposed along a production well pipe and wherein first axially radiating cable comprises a section configured to substantially overlap second radiating cable section and further wherein electrical signals present in first radiating cable section is configured to induce a corresponding signal in said second radiating cable section to facilitate the transfer of electromagnetic radiation therebetween. The present invention provides reliable data communication from any location within the production system and improves reservoir management, well planning and resource exploitation.



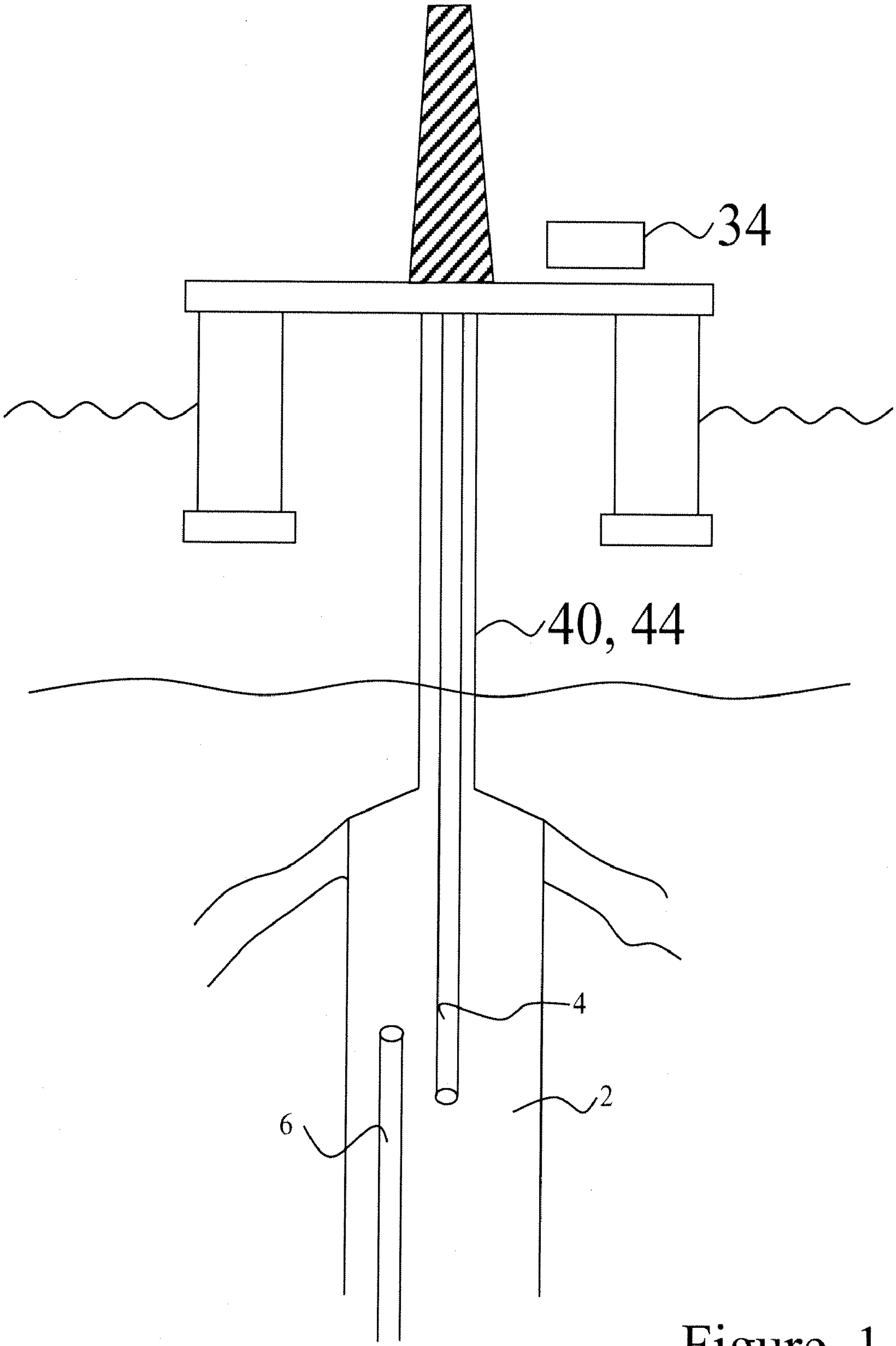


Figure 1

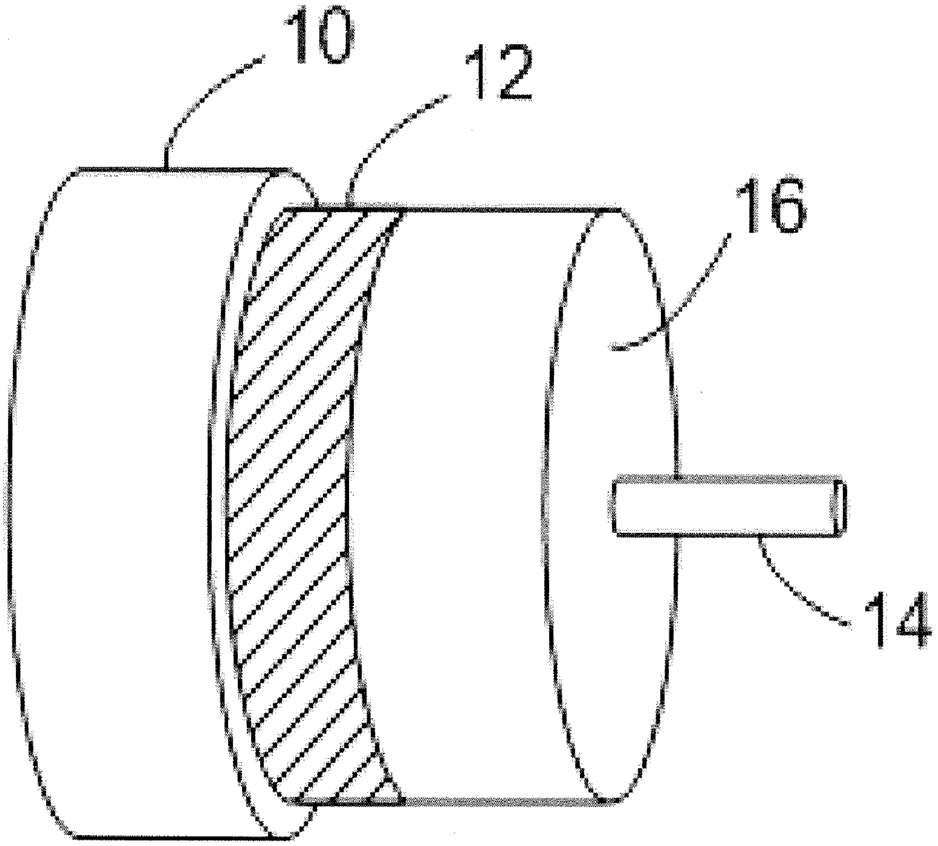


Figure 2

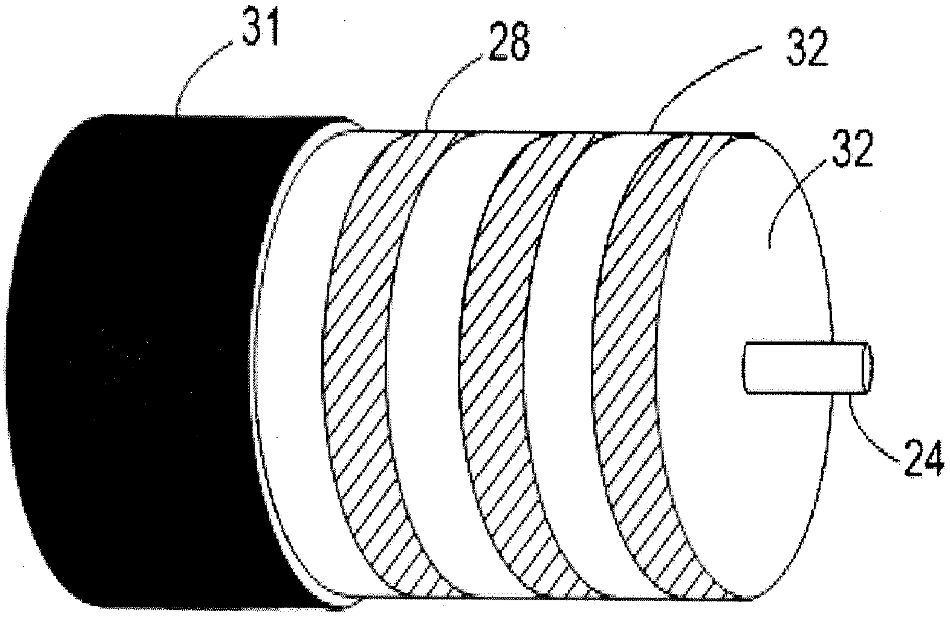


Figure 3

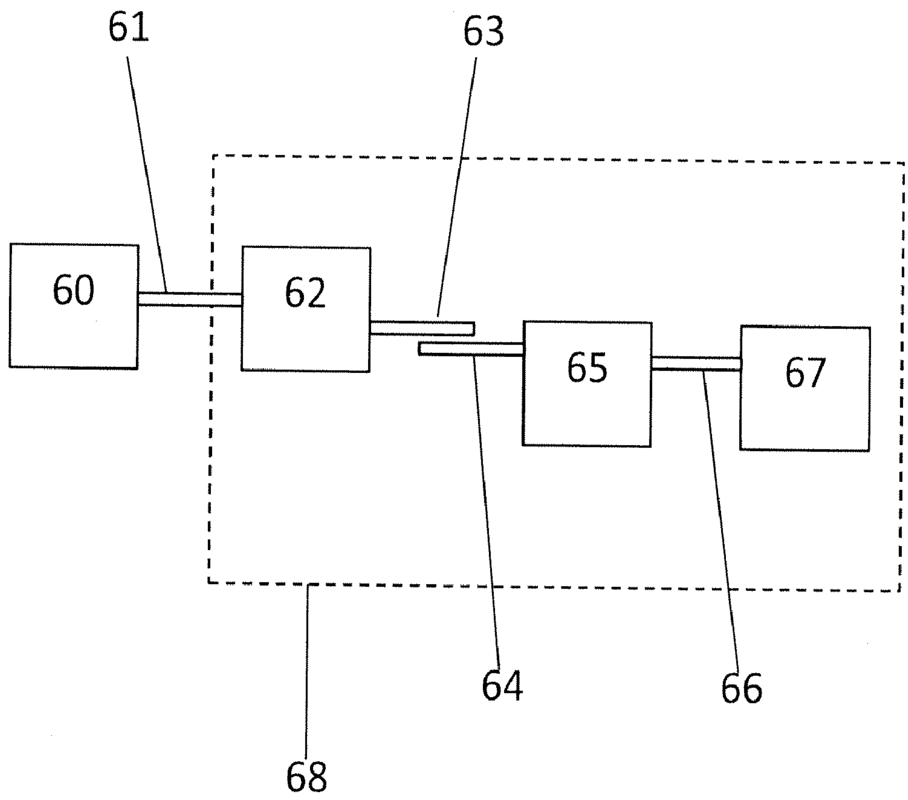


Figure 4a

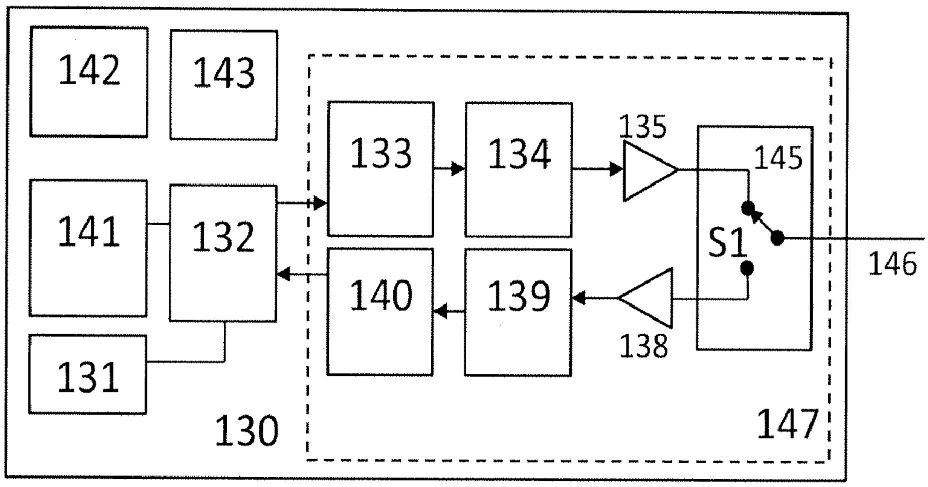


Figure 4b

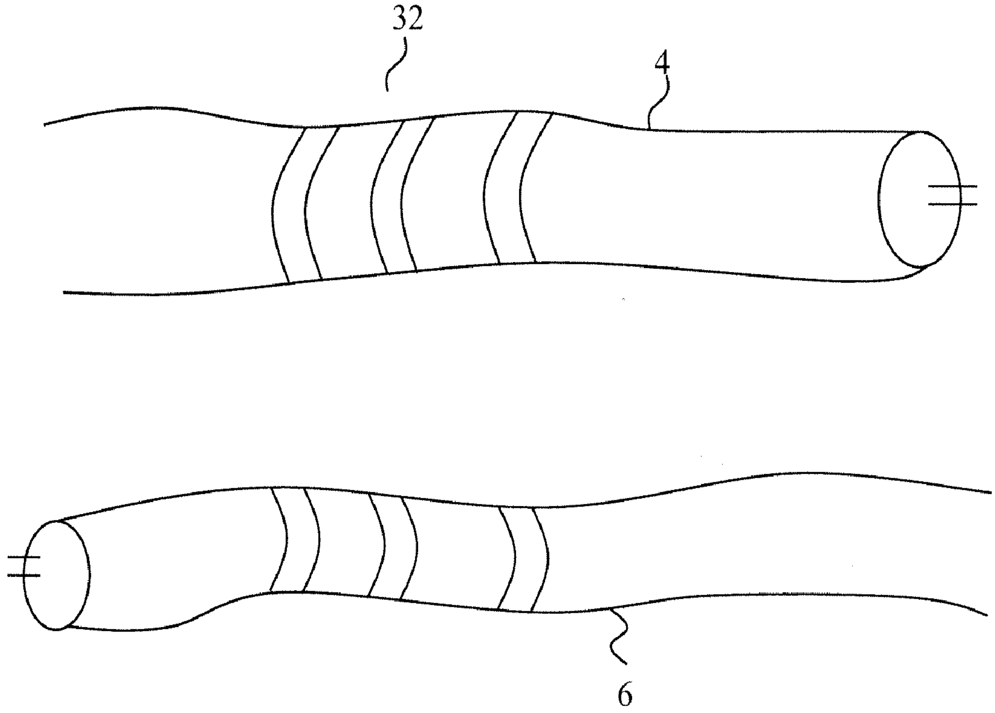


Figure 5

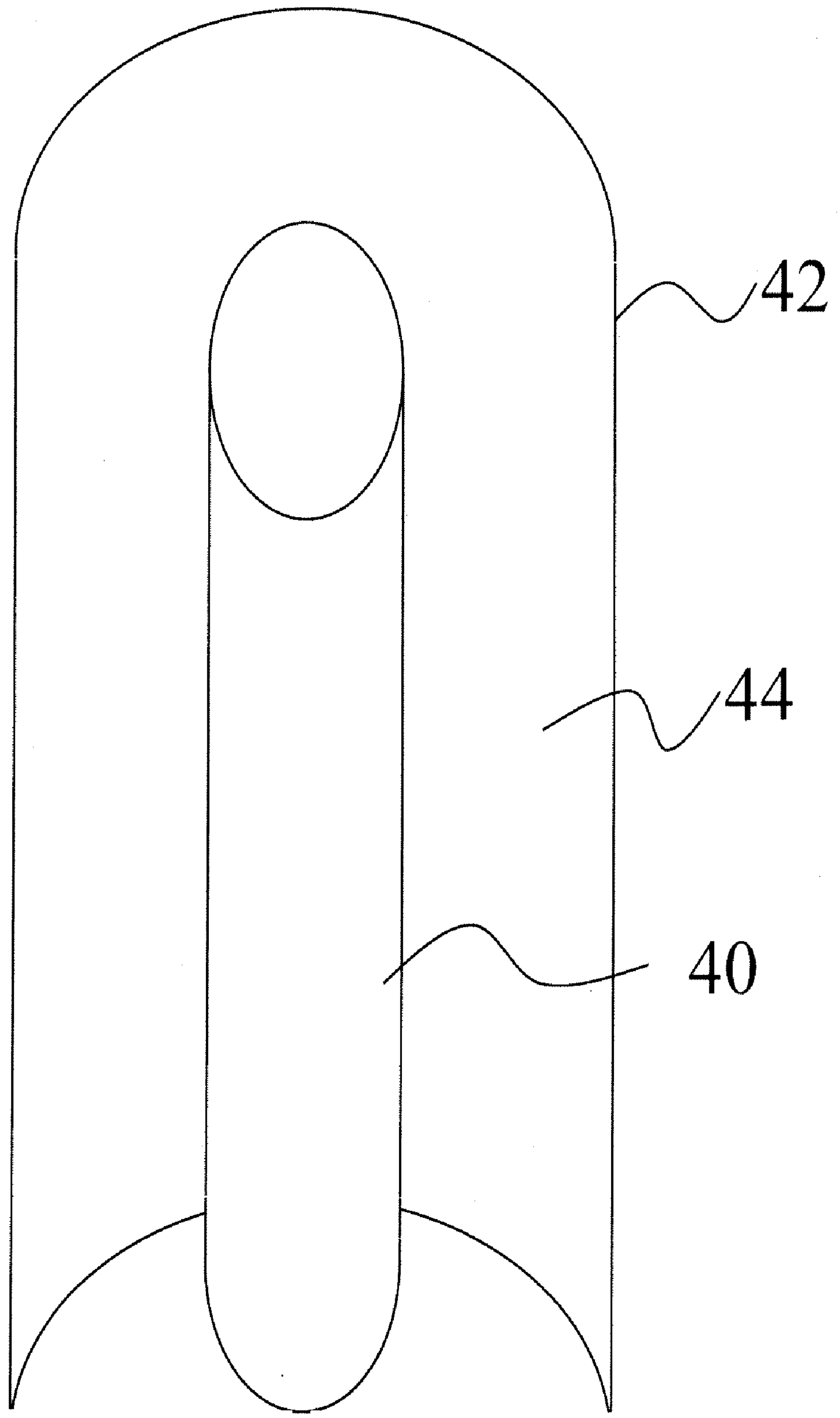


Figure 6

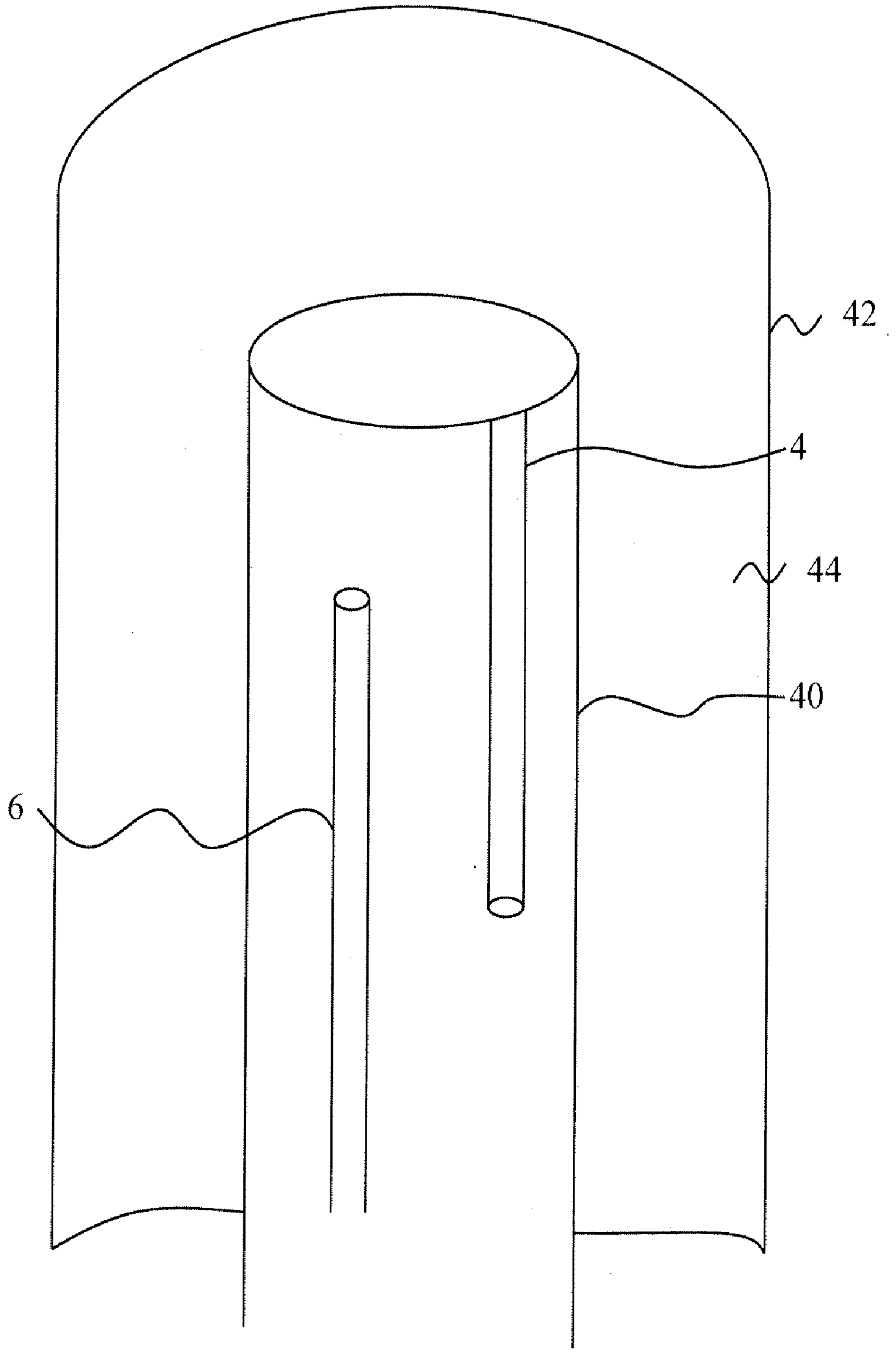


Figure 7

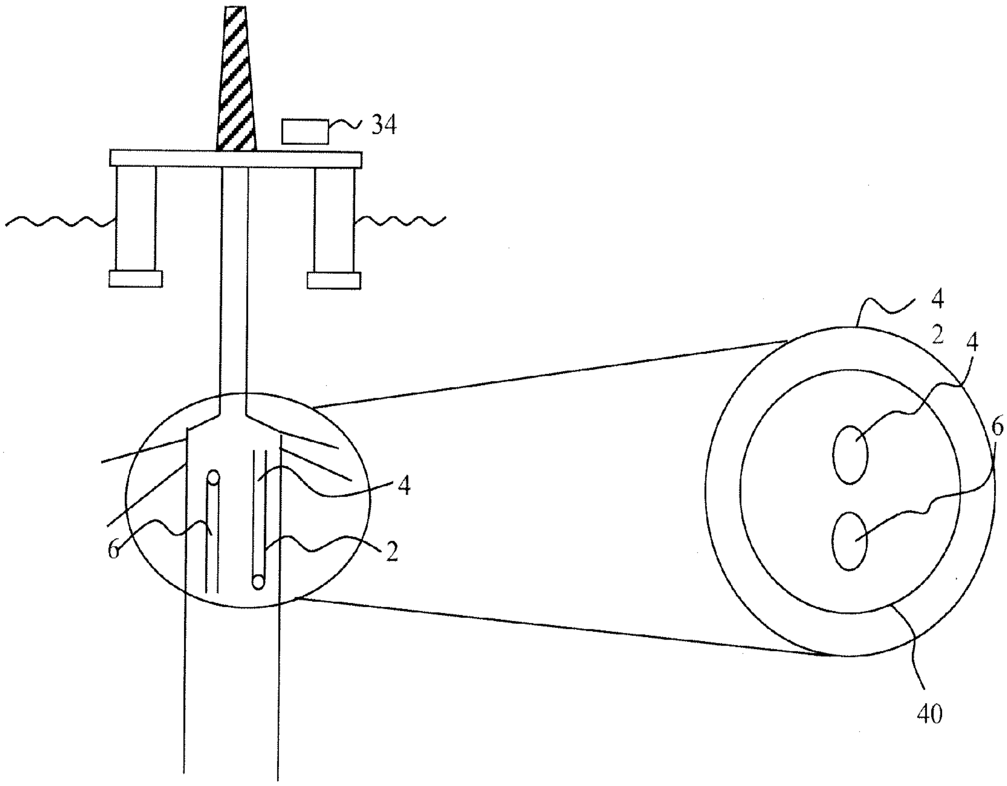


Figure 8

PIPELINE INSTRUMENTATION AND CONTROL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of GB 1010095.6 filed Jun. 16, 2010, which application is fully incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a radiating cable for the transfer of data signals in a confined space. More particularly, the present invention relates to a leaky radiating cable for the transfer of signals within a pipe structure. Further, the invention relates to a method for providing signal coupling between a first transmission line and a second transmission line e.g. for a hydrocarbon extraction facility.

BACKGROUND OF THE INVENTION

[0003] In some industrial applications communications may be required between two pieces of equipment deployed inside a pipe structure. One example of such an application is found in the oil and gas industry. The extraction of hydrocarbons from a well system is a very challenging task with such systems typically comprising a complex network of metallic pipes through which oil or gas is supplied from an underground reservoir to a production platform. In the most complex installations the reservoir may be located within the ground beneath the sea where a production pipe system is utilized to carry extracted hydrocarbon from the seabed through a riser to a production platform located at the surface of the sea.

[0004] Typically, production operations require a great quantity of command and control information relating to parameters and conditions 'downhole'. Such information typically includes characteristics of pressure, temperature, flow rate, flow composition, flow direction and so on, along with data relating to the size and configuration of the borehole itself. The requirement to provide such information is extremely challenging due to the very constrained nature of the pipe structure. The pipe structure is the most accessible route for any data signaling mechanism. Generally, such command and control of production activities are performed from a surface based control station on the surface production platform. In general, valves and drilling mechanisms are remotely controlled from the surface based control stations which rely on analysis of sensor data often from critical locations within the borehole pipe structure. Remote data gathering sensors and control devices also require electrical power and this must also be supplied from the surface based control stations.

[0005] Methods for remote signaling from downhole locations in a well production system are well known in the art. For example 'mud pulsing' is a widely used telemetry system generating characteristic data whilst drilling, and this is commonly referred to as 'measurement whilst drilling'. In general, the mud pulse system uses variations in pressure in the mud fluid used in production to transfer data to a control station. Pressure variations are used to represent modulated data. However, these systems suffer from interference from the acoustic noise generated by drilling operations. Acoustic signaling within the pipe walls and through the fluid carried by production pipes suffers from similar limitations. Alternative techniques have been proposed such as hard wired conductive cable systems which provide data and power to remote locations within the pipe structure. This technique has also been found to be unreliable in an extreme environment such as in a well system. Furthermore, the production tubing and casing are assembled in sections and this complicates deployment of a wired system which has to be threaded through the centre of the pipe as each section is deployed. The fluids which flow in the production tubing and casing contain abrasive materials, are often chemically reactive, and at high temperature and pressure. In this environment electrically conductive cables and electrically conductive connectors provide very low reliability. Moreover, hard wired cables are permanently interfaced to control devices and sensors and should one part of the system fail then this often results in failure of the whole command and control network. Such single point failure is highly undesirable in a well based production facility.

[0006] In summary, the communication systems described above are disadvantageous in that they are complicated in use, unreliable due to the harsh environment in which they are exposed, and expensive to install.

[0007] There is a need for a flexible system for reliably providing data communications to remote equipment within a pipe structure, for example within the casing of a sub-surface hydrocarbon production system.

SUMMARY OF THE INVENTION

[0008] It is an object of the present invention to provide a radiating cable system for the transfer of signals, for example data signals, in a hostile environment such as a well system in which signals are transferred in a simple manner.

[0009] In this description the term "radiating cable" is used to describe a cable arrangement which electromagnetically couples part of the electrical signal it carries into the surrounding media. This coupling will, in practice, be bi-directional and a cable that couples its signal with the surrounding media not only radiates signals into the surrounding media but also couples external electromagnetic signals that are present in the surrounding media to generate a signal carried by the radiating cable. In this description the term radiating cable is used as a concise description of a general elongate insulated electrical conductor system which provides radiation of electromagnetic signals into its surrounding media and also generates an internal electrical signal in response to external electromagnetic signals that are present in the surrounding media.

[0010] It is another object of the present invention to provide a radiating cable system for a hydrocarbon extraction well that recognizes the constraints of production tubing arrangement and provides an efficient communication link.

[0011] It is another object of the present invention to provide a radiating cable system for the transfer of signals in which such signals are transferred in a well system in a reliable manner.

[0012] It is a further object of the present invention to provide a radiating cable system in which fluids and solids within pipes of a well system do not adversely affect the system of the present invention, thus providing the possibility of a continuous communication link between data gathering sensors of a production well pipe and a control station.

[0013] According to a first aspect of the present invention there is provided a

[0014] pipeline instrumentation and control system for the transfer of data in tubing, comprising;

[0015] first and second radiating cables being electrically insulated radiating cables for controlled radiation and reception of electromagnetic signals;

[0016] said radiating cables being disposed in said tubing and arranged parallel to a longitudinal axis of said tubing;

[0017] a first end section of said first radiating cable being arranged in parallel to a second end section of said second radiating cable so that said first and second end sections overlap along said longitudinal axis of said tubing to facilitate the transfer of electromagnetic radiation therebetween.

[0018] In this way, by overlapping two cables the transfer of signals, for example data signals, in a hostile environment such as a well system is achieved in a simple and reliable manner. Further as the cables do not require a physical connection, the system is suitable for a hydrocarbon extraction well that recognizes the constraints of production tubing arrangements and provides an efficient communication link. As the cables are radiating cables, fluids and solids within pipes of a well system do not adversely affect the system, thus providing the possibility of a continuous communication link between data gathering sensors of a production well pipe and a control station.

[0019] Preferably, said first and second end sections are aligned in close proximity. In this way, the cables require only to be near each other to transfer the data.

[0020] Preferably, said first radiating cable is connected to a first transceiver and said second radiating cable is connected to a second transceiver to facilitate bi-directional signaling between said first and second end sections. In this way, a bi-directional communication link is provided.

[0021] Preferably, said first and second end sections overlap over a length of approximately 5 m. In this way, a relatively short overlapping distance is all that is required to provide reliable data transfer.

[0022] Preferably, said first and second ends are separated by a distance in the range 1 to 30 mm. In this way, data is reliably transferred inside tubing as the ends are confined within the tubing.

[0023] Preferably, said first radiating cable is connected to a command control center and said second radiating cable is connected to one of group of devices comprising: a sensor, gauge, data logger, electrical device and electro-mechanical device. In this way, a downhole data communication system is provided to transfer data to devices located in the pipeline.

[0024] Preferably, said device is located in a wellbore. More preferably, said tubing is production tubing located in a wellbore. In this way, downhole gauges in a producing well can be operated with the system of the present invention.

[0025] According to a second aspect of the present invention there is provided a method of data transfer in a wellbore, comprising the steps of:

[0026] (a) locating a device in said wellbore;

[0027] (b) providing a pipeline instrumentation and control system according to the first aspect in tubing of said wellbore;

[0028] (c) connecting said second radiating cable to said device;

[0029] (d) running said first radiating cable into the wellbore;

[0030] (e) overlapping said first and second end sections in the wellbore and thereby providing electromagnetic coupling;

[0031] (f) transmitting data from the sensor between said radiating cables and up said first radiating cable to a control command centre.

[0032] In this way, downhole permanent devices can be accessed by intervention of a single cable into the production tubing. A downhole connection is not required and the overlap will be known to have been achieved by the reception of transferred data at a surface of the tubing.

BRIEF DESCRIPTION OF DRAWINGS

[0033] A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments by way of example only, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0034] FIG. **1** shows a simplified view of a radiating cable system of present invention arranged within a production tubing of a hydrocarbon extraction well according to an embodiment of the present invention;

[0035] FIG. **2** shows a simplified view of a conventional co-axial cable having a continuous outer shield to minimize transmission line loss.

[0036] FIG. **3** shows a simplified view of a radiating co-axial cable showing a shield formed by winding a conductive tape in a helical arrangement with slots between turns to allow controlled leakage of a signal (not shown) as it propagates along the cable according to an embodiment of the present invention;

[0037] FIG. **4***a* shows a simplified view of a hydrocarbon production pipe comprising first and second transceivers for communicating with command center according to an embodiment of the present invention;

[0038] FIG. **4***b* shows a simplified block diagram of the transceivers and associated circuitry in block diagram for communicating between command center and sensor and/or data logger and/or electrical device and/or electro-mechanical device arranged within production well tubing according to an embodiment of the present invention;

[0039] FIG. **5** shows a simplified view of the radiating cable system of the present invention comprising a first radiating cable arranged in close proximity to a second radiating cable for facilitating the transfer of signals between according to an embodiment of the present invention;

[0040] FIG. **6** shows a simplified production tube within a casing of a well production system;

[0041] FIG. **7** shows a simplified view of the radiating cable system of the present invention comprising a first radiating cable arranged in close proximity to a second radiating cable for facilitating the transfer of signals between and arranged in a production tube within a casing of a well production system according to an embodiment of the present invention;

[0042] FIG. **8** shows a simplified overview of an example hydrocarbon well production system incorporating the radiating cable system of the present invention and depicting the advantages of the cylindrical shape of the first radiating cable and second radiating cable complementing the general design of production tubing or annular space of a production tubing of a hydrocarbon extraction well.

DETAILED DESCRIPTION OF THE INVENTION

[0043] FIG. **1** shows a simplified view of a radiating cable system of the present invention arranged within a production tubing of a hydrocarbon extraction facility. The radiating cable system **2** comprises a first radiating cable **4** and a second radiating cable **6** made generally of a first and second elongated radiating co-axial axially extending cable. First and second radiating cables **4**, **6** are generally flexible in nature and as will described later for allowing general manipulation during insertion and removal into and out of hydrocarbon production tubing. In the current application, a radiating cable is defined as controlled radiation of a signal passed along the length of a cable. In one example embodiment a first elongated radiating cable for coupling signals to a second radiating cable has its shield formed by winding a conductive tape in a helical arrangement with slots between turns to allow controlled leakage of signals as it propagates along the cable.

[0044] Similarly, second radiating cable for the coupling signals to first radiating cable has its shield formed by winding a conductive tape in a helical arrangement. Slots between turns are formed to allow controlled leakage of signals as they propagate along the cable. Typically, coupling signals between first and second co-axial cable is for the bi-directional signaling to/from at least one sensor (e.g. for sensing characteristics pressure, temperature, flow rate, flow composition, flow direction and so on) to first or second transceiver. First and second radiating cable have a continuous electrically protective shielding such as a resilient material best suited to protect the cables from the deleterious effects of production well environment. As will be described later in detail, first and second radiating cables are aligned in closed proximity to create a radiating cable system and substantially aligned (as will be described later) with the axis of the production tubing.

[0045] FIG. **2** shows a simplified view of a conventional co-axial cable **10** having a continuous outer shield **12** which is provided to minimize transmission line loss. Conventional co-axial cable is generally shown having an electrical cable with an inner conductor **14** surrounded by a flexible, tubular insulating layer **16**, surrounded by a tubular conducting shield **12**. Co-axial cables provide protection of the transmission signal from external electromagnetic interference. Co-axial cables are widely known in the art and a full description is not disclosed herein.

[0046] Twisted pair transmission lines are often used to reduce radiation and pick-up of transmitted data compared to single unbalanced wire line. The twisted wires are held in close contact and a balanced signal is carried by the wires. The magnetic field generated by the outgoing current is almost exactly cancelled by the field generated by the return current flowing in the opposite direction. However, if a twisted pair of wires is terminated in a reactive circuit it may be designed to be imbalanced. In this mode the outgoing current is designed to be out of phase with the return current in the twisted pair to a controlled degree so that the magnetic fields generated by the currents flowing in opposite directions do not completely cancel and a field is generated in the surrounding media which can be used to stimulate an electric current in a similar near-by radiating cable.

[0047] FIG. **3** shows a simplified view of a first radiating co-axial cable which is adapted for the transmission of signals such as data signals to a second transceiver (not shown) according to an embodiment of the present invention. First radiating cable or is constructed by means of a central conductor **24** separated from a conducting shield **28** by an insulating dielectric **26**. A shield **30** is formed by winding a conductive tape in a helical arrangement. Slots **32** which are provided between turns allow controlled leakage of a signal (not shown) as it propagates along the cable according to an embodiment of the present invention. Partly removed for the purpose of clarity is the electrically insulating protective shielding **30** which protects inner cable from the deleterious effects of the production well environment.

[0048] The dielectric permittivity and diameter of an insulating dielectric are designed to form a controlled impedance waveguide between the conductor and shield. Shielding is covered by a protective electrically insulating sleeve. Further, shield **30** is formed by winding a conductive tape in a helical arrangement with slots **32** between turns to allow controlled leakage of a signal as it propagates along the cable. In one embodiment of the present invention, slots **32** are formed along the entire length of first and second radiating cable. In an alternative embodiment, slots are formed at predetermined distances along first and second radiating cable to aid in control of leakage of signal at predetermined distance from surface based control station. As will be described later, the radiating cable is terminated in its characteristic impedance to prevent signal reflections. In an alternative embodiment, the far end of the radiating cable could be connected to a second impedance matched receive terminal. Preferably, the radiating cable is driven by an amplifier matched to its characteristic impedance. Although not depicted in the current figure, radiating cables **4**, **6** are connected to a transceiver that is operable to transmit and receive electromagnetic signal to and from a surface based control station **34**.

[0049] In an example embodiment and as shown in FIG. **4***a* a hydrocarbon production pipe is 1000 m long. A temperature sensing instrument **67** is provided 950 m from the top side of the pipe. Communications interface **60** is provided in a top side control centre to provide an interface with pipe command and control system **68**. Transmission line **61** is used to carry a data signal that requests a measurement from temperature sensor **67**. Transmission line **61** is around 930 m long. This signal travels to transceiver **62** which generates a signal in radiating cable **63**.

[0050] Radiating cable **63** is 20 m long and is positioned within the pipe so that it overlaps radiating cable **64** over a 5 m section. Transceiver **65** receives the coupled signal and generates a signal on transmission line **66** suitable for interfacing with sensor **67**. In response sensor **67** generates a modulated signal in transmission line **66** that represents the measured temperature. This modulated signal is received by transceiver **65** which generates a conditioned signal in radiating cable **64**. Radiating cable **63** receives the signal generated in radiating cable **64** and this signal is received by transceiver **62**. Transceiver **62** receives the coupled signal and generates a signal on transmission line **66** suitable for transmission over 930 m transmission line **61** back to communications interface **60**.

[0051] In another example embodiment of the present invention, the pipeline instrumentation and control system of the present invention may be used to control a valve inside the hydrocarbon production pipe. Such a valve may be utilized to release pressure within the drilled bore hole or may be used to seal a flow channel. In any case, such a valve would rely on data communications for operation. In such an example embodiment the valve is positioned a great distance from a communications interface **60** such that the control signal needs to be repeated prior to arriving at a top side control centre **68**. Transmission line **61** carries a data signal containing a command signal for opening and/or closing a valve that travels to transceiver **62**. Transceiver **62** generates a corresponding signal in radiating cable **63**. As can be seen in the current figure, first radiating cable is positioned within hydrocarbon production pipe such that it overlaps second radiating cable over a predetermined length. Due to the general conditions within such a pipe, the length may be in the order of 5 m thus ensuring even during fluid flow within the pipe that communication signal between first and second radiating cable occurs. Transceiver **65** receives the coupled signal and generates a control signal on transmission line **66** suitable for interfacing to valve interface **67**. Valve interface may be one part of a general valve module that may contain for example a processor, transceiver, data logger and optionally a power supply. Consequently, valve is operationally manipulated by received control signal. Such operational manipulation may be one of opening and/or closing of said valve with such manipulation being dependent on the requirements of the command centre. Optionally and preferably, transmitter part of transceiver forming part of general valve module sends a periodical acknowledgment signal to the command centre such that command centre personnel are aware of the current operational status of the valve. In such a scenario, the transmitter part of the transceiver generates a modulated signal being representative of the acknowledgement signal. As previously discussed, the valve module generates a modulated signal in transmission line **66** that represents the acknowledged signal. This modulated signal is received by transceiver **65** which generates a conditioned signal in radiating cable **64**. Radiating cable **63** receives the signal generated in radiating cable **64** and this signal is received by transceiver **62**. Transceiver **62** receives the coupled signal and generates a signal on transmission line **66** suitable for transmission to communications interface **60**.

[0052] Equally, the configuration of the pipeline instrumentation and control system of the present invention may be used for transmission of captured data from for example a data logger such that the control system allows captured data in bore well within a production pipe to be transmitted to a control centre. In such a scenario, data from a valve unit, a drilling unit, a senor unit e.g. for monitoring stability of pipe, and/or other device generating data required by a command centre may be stored on a data logger and transmitted periodically or constantly to the command center.

[0053] As shown in FIG. **4***b*, container within a single housing are first and second transceivers **62**, **65**. In practice, containment of first and second transceivers held within a single housing affords several advantages not least power supply considerations. Clearly, and as depicted in the current figure, both transmitter and receiver circuitry are powered from a single source **142** thus ensuring easier power budget considerations. Circuitry **143** ensures that power supply output is regulated prior to powering subsequent circuitry.

[0054] As further shown in the current figure is a processor module **132** which runs specialized software under the command of control center **68**. Further, processor module is connected to timing circuit **141** such to provide a timing clock cycle and further interacted to data interface **131**.

[0055] Modulator **133** is connected to line interface **147** and controlled by processor module **132**. Modulator modulates incoming signal from line interface **133** with its digital output converted to an output signal by means of converter **134**. To correct for signal amplitude variations, analogue signal is amplifies by means of amplifier **135** and then sent to radiating cable **146** as an outgoing signal to sensor and/or data logger and/or electrical device and/or electro-mechanical device within production well tubing by means of transceiver switch **51**.

[0056] Similarly, incoming signal (that is, incoming towards control center **68**) from sensor and/or data logger and/or electrical device and/or electro-mechanical device arranged within production well tubing is routed via switch S1 to receive amplifier. Output of receive amplifier is connected to analogue to digital converter **139** such that digital signal is demodulated at demodulator **140** and processed at module **132**.

[0057] As can be seen in the current figure, modulator **133**, digital to analogue converter **134**, amplifier **135**, receive amplifier **138**, analogue to digital converter **139**, demodulator **140** are all connected to module **132** for signal processing.

[0058] FIG. **5** shows a simplified view of the radiating cable system of the present invention comprising a first radiating cable **4** arranged in close proximity to a second radiating cable **6** for facilitating the transfer of signals between according to an embodiment of the present invention. Generally, length of radiating cable system **2** of the present invention extends from surface based control station **34** containing a transceiver **36** to sensors and transceiver located deep within production tubing (not shown). Transceivers are operable to transmit and receive electromagnetic signals travelling along length of radiating cable. In the current figure, first radiating cable is aligned in close proximity to second transmission thus facilitating the bi-directional coupling of electromagnetic signals leaking from slots **32** formed between turns of shield. As will be described later, first and second radiating cables forming radiating cable system **2** of the present invention, are arranged within the dimensionally limited production tubing, thus allowing close coupling between for the transfer of electromagnetic signals.

[0059] In some embodiments radiating cable can be used to carry the signal from the control center to the cable coupling region. In other applications, for example where the range is greater or the data rate is higher, a conventional transmission line may be used to carry the signals from the control center some way down the pipe to a local transceiver which interfaces with a radiating cable section.

[0060] FIG. **6** shows a simplified view of a production tube **40** within a casing **42** and shown in cross section. As illustrated, production tubing is positioned generally concentric to casing **42**. An annular space **44** is defined outside production tubing **40** and inside casing **42**. As will be shown later, the radiating cable system of the present invention may be deployed within production tubing or within annular space.

[0061] FIG. **7** shows a simplified view of the radiating cable system **2** of the present invention comprising a first radiating cable **4** in close proximity to a second radiating cable **6** for facilitating the transfer of signals therebetween and arranged in a production tube **40** within a casing **42** of a well production system according to an embodiment of the present invention. Generally, first radiating cable **4** is aligned in an overlapping and close proximity formation to a second radiating cable **6** for facilitating the transfer of signals therebetween. Preferably, gap between first and second radiating cables in the area of transfer of electromagnetic transmission area is between 1 to 30 mm. However, if the flow of extracted material disturbs such distance then transfer of electromagnetic transmission will continue albeit degraded. In any case, distance between first and second radiating cables **4**, **6** are limited by the inner diameter of the production tubing. Preferably, first and second radiating cables **4**, **6** are aligned axially within production tubing **40** thus minimizing the necessary length of radiating cable required to facilitate electromagnetic coupling.

[0062] FIG. **8** shows a simplified overview of an example hydrocarbon well production system incorporating the radiating cable system **2** of the present invention and depicting the advantages of the cylindrical shape of the first radiating cable and second radiating cable **4**, **6** complementing the general design of production tubing or annular space **44** of the production tubing **40** of a hydrocarbon extraction well.

[0063] As is depicted in the current figure, riser **50** links lower stack at the seabed with topside rig **48**. Control station **34** for the hydrocarbon production system is typically located within topside rig or platform and wellhead penetrates into seabed. Downhole sensors and downhole tools are located within the production string remotely from the control station **34**. First and second generally flexible transmission line are distributed throughout the production piping and provide the transfer of signals (e.g. data signals) between sensors deployed within the production tubing **40** and control station **34**. The cylindrical shape of the first radiating cable and second radiating cables **4**, **6** are generally arranged along the axial axis within the production tubing **40** (or annular space) and complement the cylindrical design of production tubing of a hydrocarbon extraction well. Furthermore, first radiating cable **4** of the radiating cable system is generally aligned to second radiating cable **6** and which is adapted to locally radiate a portion of the signal carried by the first transmission line **4**. Second radiating cable aligned with first radiating cable and further generally aligned with axis of production tubing **40** receives radiated signal from first radiating cable for facilitating the data communication therebetween. Typically, for an effective communication link, gap between first and second transmission lines is in the order of between 1 to 30 mm. In any case, distance between first and second transmission line is limited by the dimensions such as the inner diameter of the production tubing. First radiating cable **4** is connected to a first transceiver that is operable to transmit and receive electromagnetic signals and electromagnetically coupled to a second insulated radiating cable that is connected to a second transceiver that is operable to transmit and/or receive electromagnetic signals. When the first radiating **4** moves into close proximity to any part of radiating cable **6**, short range electromagnetic coupling is provided. That is to say, the connection for transmission between first and second radiating cable **4**, **6** is entirely based on electromagnetic coupling. The radiating cable system supports bi-directional data communications between surface based control station **34** and an array of sensors deployed in the production well facility. Since first and second radiating cables **4**, **6** complement the general shape of production tubing, the flow of extracted hydrocarbon material from the well is therefore not impeded during extraction thus allowing control signals from a control station **34** to sensors arranged within the production tubing to continue without interruption. Furthermore solid material flowing within the production tubing does not impact the radiating cable system since any material will flow upwards towards the topside rig by-passing the aligned radiating cable system.

[0064] Operational Deployment Method

[0065] In an example embodiment, the deployment of the pipeline instrumentation and control system maybe be deployed within a production well tubing according to the following example method:

[0066] In a first step, a second radiating cable having a proximal end and a distal end is located. Next, a sensor and/or data logger and/or electrical device and/or electro-mechanical device is connected to a distal end of second radiating cable. Next, a sensor and/or data logger and/or electrical device and/or electro-mechanical device connected to distal end of second radiating cable is inserted into production well tubing at a distal end of production well tubing. Next, sensor and/or data logger and/or electrical device and/or electro-mechanical device connected to distal end of second radiating cable is positioned at a distal end of production well tubing. Next, first radiating cable comprising a proximal end and a distal end and being of length Y which is greater than length of said second radiating cable is inserted into production well tubing. Next, distal end of first radiating cable is manipulated within production cable well tubing over proximal end of second radiating cable such that section of first radiating cable overlaps section of second radiating cable. Finally, proximal end of first radiating cable is connected to command control center.

[0067] The radiating cable system described in this application could alternatively be applied to a Floating Production, Storage, and Offloading (FPSO) based system or a land based subsurface production system.

[0068] Whilst the present invention may have particular applicability to hydrocarbon extraction wells, it is should be noted that the present invention is also applicable to other types of industries, for example where the transfer of signals between a control station and sensors and/or mechanical actuators inside piping is required.

[0069] Various embodiments of the invention have been described above. The descriptions are intended to be illustrative, not limitative. Thus, it will be apparent to one skilled in the art that certain modifications may be made to the invention as described without departing from the scope of the claims set out below.

1. A pipeline instrumentation and control system for the transfer of data in tubing, comprising;

first and second radiating cables being electrically insulated radiating cables for controlled radiation and reception of electromagnetic signals;

said radiating cables being disposed in said tubing and arranged parallel to a longitudinal axis of said tubing;

a first end section of said first radiating cable being arranged in parallel to a second end section of said second radiating cable so that said first and second end sections overlap along said longitudinal axis of said tubing to facilitate the transfer of electromagnetic radiation therebetween.

2. A pipeline instrumentation and control system according to claim **1** wherein said first and second end sections are aligned in close proximity.

3. A pipeline instrumentation and control system according to claim **1** wherein said first radiating cable is connected to a first transceiver and said second radiating cable is connected to a second transceiver to facilitate bi-directional signaling between said first and second end sections.

4. A pipeline instrumentation and control system according to claim **1** wherein said first and second end sections overlap over a length of approximately 5 m.

5. A pipeline instrumentation and control system according to claim **1** wherein said first and second ends are separated by a distance in the range 1 to 30 mm.

6. A pipeline instrumentation and control system according to claim **1**, wherein said first radiating cable is connected to a command control center and said second radiating cable is connected to one of group of devices comprising: a sensor, gauge, data logger, electrical device and electro-mechanical device.

7. A pipeline instrumentation and control system according to claim **6** wherein said device is located in a wellbore.

8. A pipeline instrumentation and control system according to claim **1** wherein said tubing is production tubing located in a wellbore.

9. A method of data transfer in a wellbore, comprising the steps of:

(a) locating a device in said wellbore;

(b) providing a pipeline instrumentation and control system in tubing of said wellbore, comprising first and second radiating cables being electrically insulated radiating cables for controlled radiation and reception of electromagnetic signals;

(c) connecting said second radiating cable to said device;

(d) running said first radiating cable into the wellbore;

(e) overlapping first and second end sections of said first and second cables, respectively, in the wellbore and thereby providing electromagnetic coupling;

(f) transmitting data from the sensor between said radiating cables and up said first radiating cable to a control command centre.

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