consequent losses are minimized in spite of the entire arrangement being grounded at both ends.

[007] BRIEF SUMMARY OF THE INVENTION

[008] In underground network, electrical cable link apparatus are the only points accessible by operators for detecting physical/electric parameters on the network by employing electronic sensing devices. Sometimes, these points are positioned in impervious environments (e.g. deserts areas) where power sockets for supplying electric power to these devices are not available.

[009] The Applicant observes that the use of an electrical cable link apparatus to obtain diagnostics information by employing electronic sensing devices finds problems due to the need of providing suitable electric power supply to such sensing devices.

[0010] The Applicant has found that the electrical power to be supplied to the electronic sensing device installed in an electrical cable link apparatus can be obtained by inductive coupling with the current flowing in the screen conductors connected to the electrical link apparatus. In this way, it is also possible to have electric power supply even if the network line is disconnected from a load because screen current is always present, despite in this configuration no current circulates in the cable.

[0011] According to a first aspect, the present invention relates to an electrical cable link apparatus comprising:

a first electrical conductor structured to conduct a first electrical current from a first screen portion of a first external electrical cable;

an electrical linking module connected to the first electrical conductor and structured to implement a cross-bonding/earthing link;

a first inductor device inductively coupled to the first electrical conductor and able to generate a supply voltage.

[0012] Particularly, the first inductor device includes a conductive coil. In accordance with an embodiment, the first inductor device is a toroidal inductor and includes a magnetic core surrounding the first electrical conductor and around which

accommodate the electrical linking module, the first inductor device and the voltage source. Preferably, the electrical cable link apparatus further comprises at least one electrical cable connector mounted on a wall of the housing to connect the first electrical conductor with an external screen cable connectable to the first screen portion of the first external electrical cable.

[0019] According to a second aspect, the present invention relates to an electrical cable system comprising:

- a first screen cable connectable to a first cable screen portion and structured to conduct a first electrical current;
- a second screen cable connectable to a second cable screen portion structured to conduct a second electrical current; and
- an electrical cable link apparatus, comprising:
  - a first electrical conductor connected to the first screen cable;
  - a second electrical conductor connected to the second screen cable;
  - a first inductor device inductively coupled to at least the first electrical conductor to provide and able to generate a supply voltage;
  - an electrical linking module connected to the first and second electrical conductors and structured to implement a cross-bonding/earthing link.

[0020] Particularly, said electrical cable system further comprises a sensor module electrical arranged to receive the supply voltage; the sensor module being configured to detect physical/electric parameters from the electrical linking module.

[0021] BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Further characteristics and advantages will be more apparent from the following description of a preferred embodiment and of its alternatives given as a way of an example with reference to the enclosed drawings in which:

[0023] - Figure 1 shows schematically a first embodiment of an electrical cable system comprising an AC electrical power transmission line, a screen conductor line and an electrical cable link apparatus configured to perform a cross-bonding link;

[0024] - Figure 2 shows schematically a second embodiment of the electrical cable system comprising an electrical cable link apparatus configured to perform an a earthing link;

[0025] - Figure 3 and 4 show a lateral section view and a top view of an electrical cable link apparatus employable in the embodiment of figure 1.

[0026] DETAILED DESCRIPTION

[0027] In the following description, same alphanumeric references are used for analogous exemplary elements when they are depicted in different drawings. Figure 1 shows schematically a first embodiment of an electrical cable system 1000 comprising an AC (Alternate Current) electrical power transmission line 1, a screen conductor line 2 and an electrical cable link apparatus 3.

[0028] In accordance with the first embodiment, the electrical power transmission line 1 shows a three-phase configuration and comprises a first electrical cable L1, a second electrical cable L2 and a third electrical cable L3 which can be, as an example, of the high voltage type, each corresponding to a different phase of the system 1000. Particularly, each cable L1-L3 of the electrical power transmission line 1 includes a central conductor element 4 surrounded by an insulation body (not shown) and a metallic screen 5. The screen 5 can have a cross section of 35-50 mm^2 and has a conductivity of about 0.017.

[0029] The screen is generally made of copper but can also comprise a conductive sheath. Each electrical cable L1-L3 of the electrical power transmission line 1 can also include further conductors or insulating layers. The first embodiment illustrated in figure 1 refers to an electrical power transmission line 1 for which a so-called “cross-bonding” of cable screens is performed.

[0030] In accordance with the example of figure 1, the electrical transmission line 1 is provided with a cable joint assembly comprising a first cable joint J1, a second cable joint J2 and a third cable joint J3. Particularly, each cable joint J1-J3 is structured to join the conductor elements 4 of the respective cable L1-L3. As shown in figure 1, in the first joint J1 the screen 5 is separated in a first screen portion L11 and a second screen portion L12 of the first cable L1. In the second cable joint J2 the screen 5 is separated into a first screen portion L21 and a second screen portion L22

The powering and managing module 20 and the sensor module 19 are schematically shown in figure 1 as assembled in an electronic sensing apparatus 12. It is observed that the logging and monitoring module 26 can be internal or external to the housing 30.

[0048] Figure 2 refers to a second embodiment of the electrical cable system 1000 which is configured to perform a earthing link. Particularly, the screens 5 of the first cable L1, the second cable L2 and the third cable L3 are connected, by a first screen conductor W1, a second screen conductor W2 and a third screen conductor W3, respectively, to the pass-through ports 15 of the electrical cable link apparatus 3. The screen conductors W1-W3 are particularly made with electrical cables having a non-coaxial structure. In the electrical cable link apparatus 3 of figure 2, the second inner conductors 14, which are portions of, or are connected to, the screen conductors W1-W3, are inductively coupled with the inductor device 11. The inductor device 11 can be made in a manner analogous to the one described with reference to figure 1.

[0049] The electrical linking module 10 of figure 2 is configured to implement a earthing link and comprises a first connecting element 27, a second connecting element 28 and a third connecting element 29 (e.g. made by conductive rails) which connect a corresponding second inner conductor 14 to a ground terminal GND. The electronic sensing apparatus 12 and its powering method can be analogous to the ones described with reference to figure 1.

[0050] A particular embodiment of the electrical linking module 10 of figure 1, implementing a cross-bonding link, will be now described with reference to figure 3 and figure 4. The housing 30 of the electrical linking module 10 is a box made, as an example, of metal and is provided with a removable top cover 31, a base 49 and four lateral walls 32. The removable top cover 31 can be fixed to the walls 32 by one or more nut-and-bolt assemblies 33.

[0051] One of the lateral walls 32 is provided with the coaxial cable connectors 15 structured to connect the screen cables SC1-SC3 with the internal cable C1-C3. As an example, one of the coaxial cable connectors 15 is structured to connect the first tubular conductor 6 and the first inner conductor 7 (figure 1) of the first screen cable SC1 to the second tubular conductor 13 and second inner conductor 14 of the first internal cable C1, respectively. Figures 3 and 4 also show an outer sheet 34 of the screen cables SC1-SC3 and a further outer sheet 35 of the internal cables C1-C3.

CLAIMS

1. An electrical cable link apparatus (3), comprising:

a coaxial cable comprising: a first electrical conductor (C1, 13), structured to conduct a first electrical current from a first screen portion (5, L11) of a first external electrical cable (L1), and a second electrical conductor (C1, 14), structured to conduct a second electrical current from a second screen portion (5, L12) of the first external electrical cable (L1);

an electrical linking module (10) connected to the coaxial cable (C1) and structured to implement a cross-bonding link;

a first inductor device (T1) inductively coupled to the first electrical conductor (C1, 13) and the second electrical conductor (C1, 14), the first inductor device (T1) being able to generate a supply voltage (Vcc).

2. The apparatus (3) of claim 1, wherein the first inductor device (T1) includes a conductive coil.

3. The apparatus (3) of claim 2, wherein the first inductor device (T1) is a toroidal inductor and includes a magnetic core surrounding the first electrical conductor (C1, 13) and the second electrical conductor (14) and around which the conductive coil is wound.

4. The apparatus (3) of claim 1, comprising a voltage source (24) connected to the first inductor device (T1) to receive a first induced electrical current and provide a corresponding supply voltage, the voltage source (24) comprising a voltage regulator (24) including an AC/DC converter.

5. The apparatus (3) of claim 1, further comprising a sensor module (19) arranged to receive the supply voltage (Vcc), the sensor module (19) being configured to detect physical/electric parameters from the electrical linking module (10).

6. The apparatus of claim 5, wherein the sensor module (19) comprises at least one of the following sensor devices: current sensor, partial discharge sensor, voltage sensor and temperature sensor.

7. The apparatus of claim 6, wherein the partial discharge sensor is one of the following

devices: high frequency current transformer HFCT, capacitive coupler, electromagnetic antenna.

8. The apparatus (3) of claim 5, further comprising: an electronic managing module (26) arranged to receive the supply voltage (Vcc) and structured to exchange data/commands with the sensor module (19).

9. The apparatus of claim 1, further comprising:

at least one electrical conductor (C2, 13) structured to conduct an electrical current from a screen portion (5, L21) of a second external electrical cable (L2);

at least one second inductor device (T2) inductively coupled to the at least one electrical conductor (C2, 13) to provide an induced electrical current from the electrical current and connected to the first inductor device (T1).

10. The apparatus of claim 9, wherein the first inductor device (T1) and the at least one second inductor device (T2) are connected in accordance with one of the following electrical configurations: series configuration, parallel configuration.

11. The apparatus of claim 4, further comprising:

a housing (30) having a plurality of walls (32) and a removable cover (31) and structured to accommodate the electrical linking module (10), the first inductor device (T1) and the voltage source (24).

12. The apparatus of claim 11, further comprising at least one electrical cable connector (15) mounted on a wall (32) of the housing (30) to connect the first electrical conductor (C1, 13) with an external screen cable (SC1) connectable to the first screen portion (5, L11) of the first external electrical cable (L1).

13. An electrical cable system (1000), comprising:- a first coaxial screen cable (SC1) connectable to a first cable screen portion L11) to conduct a first electrical current and to a second cable screen portion (L12) to conduct a second electrical current;

- a second coaxial screen cable (SC2) connectable to a third cable screen portion (L21) to conduct a third electrical current and to a fourth cable screen portion (L22) to conduct a

second electrical current; and

- an electrical cable link apparatus (3), comprising:

a coaxial cable (C1) comprising: a first electrical conductor (13) connected to the first cable screen portion (L11) and a second electrical conductor (14) connected to the second cable screen portion (L12);;

a further coaxial cable (C2) comprising: a third electrical conductor (13) connected to the third cable screen portion (L21) and a fourth electrical conductor (14) connected to the fourth cable screen portion (L22);

a first inductor device (T1) inductively coupled to at least the coaxial cable (C1) and able to generate a supply voltage (Vcc);

an electrical linking module (10) connected to the coaxial cable and the further coaxial cable and structured to implement a cross-bonding link.

14. The system (1000) of claim 13, further comprising:

a sensor module (19) arranged to receive the supply voltage (Vcc), the sensor module (19) being configured to detect physical/electric parameters from the electrical linking module (10).