SYSTEM FOR THE REMOTE MEASURING OF THE PROTECTION GROUND

In a system for the remote measuring of the protection ground, comprising a centralized ground measuring device (1), a line selector (2) and remote controlled actuators (3) located near the region in which the measurement is required, said ground resistance measurement is performed in such a way that the measurement point is very distant from the reference grounds, so that in this way the deepest layers of the soil are involved in the measurement, which must be considered to be at a constant potential.
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SYSTEM FOR THE REMOTE MEASURING OF THE PROTECTION GROUND

Technical Field
The present invention generally relates to a system for the remote measuring of the protection ground associated to any kind of electric system, for civil or industrial use, and in particular it refers to a remote detecting system of the protection ground which employs a telephone line as support for the transmission of the control signals and of the quantities associated to this measurement.

Background Art
The protection ground electric system is used in order to bring part of a metallic structure of an electric/electronic device as much as possible to a value corresponding to the ground potential, when for some unusual reasons (anomalous contacts, failure, atmospheric discharges, etc.), a potential is applied to the metallic structure that can cause damage to the safety of a person.

The lower the value of the ground resistance, the safer is the protection.
Since often it may be very difficult and expensive to obtain low values of the resistance, the law requires values of the ground resistance depending on the use and the possible discharge currents.
Since the ground resistance is used only during certain
periods and since its value may vary also considerably due to the aging of the electric system or to changes in environmental conditions, a periodic control of the ground resistance is necessary in order to guarantee, in every condition, a value which is always lower than that established by the law.

The measurement of the ground resistance is performed by means of portable instruments, using stakes driven into the ground, in different ways, but usually relying on the volt-ammeter method.

In order to perform this operation, one has to reach the region of measure and drive the stakes into the ground by following appropriate rules.

The above described practice often implies also noticeable difficulties which render problematic a measurement which is already expensive, and which must be carried out anyway respecting maturities provided by the law.

Moreover, the ground measurements performed according to the conventional technique using the volt-ammeter method employ detection stakes located at a distance of 20/40 m from each other. In this manner, the electric current which is involved in the measurement in part flows through the surface layer of the ground and does not involve the equipotential region which lies in the deeper layers.

Therefore, the measurement is influenced by the detection of a ground surface resistance which
apparently is very low and does not correspond to the actual one, and since said apparent ground resistance is lower than the actual ground resistance, a safety coefficient will be deduced, according to the ground resistance, which is fictitious and overestimated; but this is extremely dangerous.

Disclosure of Invention

The object of the present invention is that of providing a system which allows the remote measuring of the ground resistance without forcing an operator to move and in extremely short times.

A further object of the present invention is that of providing a remote measuring system of the protection ground, which allows to operate at very deep soil layers, thereby increasing the precision of the measurement.

Finally, an object of the present invention is to provide a remote measuring system of the protection ground, which is easy to use and which has a limited cost.

These objects and other ones which will result as the description proceeds, are achieved through a remote measuring system of the protection ground comprising a centralized ground measuring device, a line selector and remote controlled actuators located near the region where said ground measurement is required, whereby said ground resistance measurement, is done in a measurement
region which is very distant from the reference grounds, so that in this way the deepest layers of the soil which can be considered to be at a constant potential are involved in the measurement.

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Brief description of Drawings
The features of the invention will be more clearly understood from the following description of a practical configuration of the invention, to be considered together with the annexed drawings, in which:

Fig. 1 is a block diagram of the whole remote detection system;

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Fig. 2 is a representation of the actual ground measuring device corresponding to an exploded view of the block 1 of Fig. 1;

Fig. 3 is a representation of the possible line connections of the remote controlled actuator indicated by the reference number 3 in Fig. 1;

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Fig. 4 is a schematical representation of the parts making up the remote controlled actuator indicated by reference 3 of Fig. 1; and

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Fig. 5 is a block diagram of a portable device corresponding to a different configuration of the
present invention.

Best Mode of Carrying out the Invention

In Fig. 1, which shows the block diagram of the entire system, a centralized ground measurement device 1 is connected to two reference grounds 11 and 12 and in order to enlarge the measuring possibilities, a line selector 2 permits to choose among different measuring lines. On each line there are disposed remote controlled actuators 3 which following a control, connect the ground to be measured with the centralized measuring device. As transmission means it it possible to use any kind of double wire, and in the following we refer to a telephone line only because it is already diffused in a capillary way and already implemented. The measured data may be treated by a computer 4 and possibly sent to a supervisory center by means of a modem 5.

In Fig. 2 there is shown a block diagram corresponding to the centralized measuring device 1 of Fig. 1, and while A indicates in dotted line the centralized measuring device on its own, the dotted line B indicates the soil on which the measurement is performed.

For this measuring device the operation phases and the features of the single blocks comprise:

I) a multiplexer 16 which sends a synchronism and recognition signal and at the same time supplies the line 14, 14'.

II) The remote controlled actuator 3 is supplied, and if
it recognizes the transmitted address, it closes the contacts 13 for a time which exceeds the measuring time.

III) A constant current I which is generated by an appropriate generator 17 flows in the resistance RX and then closes itself passing through the measuring device and a current probe 18.

When the probe 18 detects the current, it moves the change-over switch 10 from position 10⁰ to position 10⁰. From this time on, the actual measuring is carried out; the selective voltmeter 19, because of its high impedance, may be practically considered to be connected to the ends of RX, so that:

\[ RX = \frac{VX}{I} \]

since I is constant the measured value of VX is directly proportional to the value of RX.

It must be noted that the value of the two reference grounds 11 and 12 and the length of the line does not influence the measurement, so that these quantities may also be unknown.

The generator 17 generates an alternate current with a very low frequency of the order of Hz (in the experimented prototypes it has been preferred a frequency between about 1.5 Hz and 110 Hz). The use of a low frequency is justified by the fact that otherwise the capacities and the inductances of the line would produce errors in the measurements proportional to the frequency value.

The generator 17 generates simultaneously also a
continuous current (which is superimposed to the alternate current) and which has the task of depolarizing some layers of the soil behaving like electrolytic cells which cause noticeable difficulties for the flow of electric current. The voltmeter 19 is provided with a filter which is centered on the frequency of the current generator but is also provided with a synchronism circuit with the emitted frequency, in order to allow an improved signal to noise ratio and to render disregardable the "ripple" in the measuring stability, which would be otherwise impossible to obtain, in view of the low frequencies employed.

The multiplexer block 16 comprises a direct current power supply which has the possibility of re-positioning the polarity on the wire lines as will be described afterwards. Said transmitter may be employed according to usual specifications, as for example the emission type CCITT V21 with a transmission rate of 256 or 512 BPS, provided by the telephone service managing companies.

Fig. 3 shows the ways of connecting the remote controlled actuator 3 along the line. In the first case, according to Fig. 3', the remote controlled actuator 3a is simply connected in parallel to the line without sectioning it altogether, whereas in the second case of Fig. 3" a sectioning is necessary.

The references used for the terminals are:
ae, be = entering line
au, bu = outgoing line
at, bt = they are connected separately to the ground
to be measured, in this manner the ground resistance
measure is not increased by the line resistance.
The two systems are equivalent under the operation point
of view and in both cases the ground resistance is to be
connected to "at" and "bt". The switch K may be an
electromechanical relay or a solid state relay.

A type of control message that can be sent from the
centralized measurer 1 affording a good efficiency and
reliability in synchronism is that which provides two 8-
bite words to be iteratively repeated until the called
actuator closes the contacts 13. The first word is
formed by 8 bits all set to 1, whereas the second one is
formed by a first and last bit always set to 0, and the
other six ones which vary according to the transmitted
address. With this message it is possible to have sixty-
four different addresses per line, but this number may
be simply varied by varying the length of the words.

In Fig. 4 there is shown the block diagram of the device
related to the remote controlled actuator, interfaced to
the line by means of a contact 22 already illustrated.
By means of a switch 23, whose functionality will be
explained later, the signal emitted by the multiplexer
reaches the modem 24 and the voltage supplied by the
line power supply reaches the general power supply 25
which stabilizes it for all circuits.
The signal is decoded and sent to the logic circuits 27 to which the two outputs R and M are associated. The output R controls the switch 23 which performs an "autoreverse" function. This function is justified by the fact that the remote controlled actuator is usually installed on a telephone line which is supplied by an exchange. In this condition (inactivity condition) the remote controlled actuator has not to be supplied, in order that the line is not unnecessarily loaded, and this supply is in fact forbidden by the diode 30. When a ground measure has to be performed, the line is switched from the exchange to the centralized measuring device 1, which, through the multiplexer 16 sends an opposite supply (with respect to the exchange) which is transmitted correctly through the diode 30 in order to supply the remote controlled actuator.

It may happen however that because of an incorrect installation or because of a subsequent line inversion caused by a repairer (inversion of the wires "a" and "b") a remote controlled actuator is erroneously supplied. If the remote controlled actuator is correctly supplied without control signal for a predetermined time, the switch 23 will position itself in the absorption condition 0, this is the "AUTOREVERSE" function.

The output M is activated when the transmitted address and the one set by the proper circuit 26 are equal. The signal which exits from M is essentially a square wave
whose period is equal to the length of the received message. During the "off" period of said square wave, the switch M is open and the current of the generator 28 can charge the condenser 31 by means of the diode 32.

During the "on" period, M is closed and the charge of the condenser 31 is transferred on the condenser 34 by means of the diode 33.

Repeating various times this procedure, the potential difference at the two sides of the condenser 34 will switch the relay 29, which will change over "ae" and "be" on "at" and "bt", so as to allow measuring the ground resistance. At the same time, the remote controlled actuator is no more supplied due to this change over, and the relay 29 will remain attracted until the condenser 34 will be discharged.

Fig. 5 relates to a variation in the inventions embodiment, and it shows the block diagram of a portable device which essentially comprises two remote controlled actuators 3A and 3B which respond to two different addresses which are recognized by the modem 20. By means of the logic circuits 36, the first address activates 3A which allows the measurement of the ground resistance as already disclosed. The second address allows, by means of 3B, the connection to the line of a "normal generator" 21 of sample signals in order to perform the equivalent measure, the block 21 may however be replaced by any line test. The phonic and supply circuit 35 allows to the operator, along the line, to exchange
phonic messages with the exchange in order to receive information and for coordinating the measurements (an usual telephone may be employed). The use of such instrument may be very useful and cheap, because of the fact that it can replace a great number of fixed remote controlled actuators.

The description of the invention in its preferred embodiments has been given only for an exemplificative purpose and by no way as a limitation of the principle based on a system of remote measure of protection grounds.
Claims

1. A system for the remote measuring of the protection ground, characterized in that it comprises a centralized ground measuring device (1), a line selector (2) and remote controlled actuators (3) interfaced with said line selector, located near the region where said ground measurement is required, whereby said ground resistance measurement is done in a measurement region which is very distant from the reference grounds, so that in this way the deepest layers of the soil which can be considered to be at a constant potential are involved in the measurement.

2. A system for the remote measuring of the protection ground, according to claim 1, characterized in that the centralized ground measuring device comprises a multiplexer (16), a direct current generator (17), a current probe (18), a selective voltmeter (19) and a change-over switch (10).

3. A method for the remote measuring of the protection ground, according to claims 1 and 2, characterized in that during the measurement of the protection ground the interaction between the various blocks is such that:
I) the multiplexer (16) emits a synchronism and recognition signal and simultaneously the line is supplied.
II) The remote controlled actuator (3) is supplied and following the recognition of the transmitted address it closes the contacts (13) which are provided for closing the circuit.

III) A direct current generated by a suitable generator (17) flows into the ground resistance and closes itself inside the measuring device, passing through the current probe (18) which is suited to detect the closing of the measurement circuit.

IV) The actual measurement of the ground resistance following the change-over of the switch (10), is performed on the basis of the detection by means of the selective voltmeter (19) of a voltage which is directly proportional to the ground resistance.

4. A system for the remote measuring of the protection ground according to claims 1, 2 and 3, characterized in that the current generator (17) generates an alternate current at a frequency of the order of Hz.

5. A system for the remote measuring of the protection ground according to claims 1, 2, and 3, characterized in that the current generator (17) generates a direct current superimposed to the alternate one.

6. A system for the remote measuring of the protection ground according to claims 1, 2 and 3, characterized in that the voltmeter (19) is selective for the frequency
of the current generator (17) and performs a demodulation which is synchronous with the emitted frequency.

7. A system for remote measuring of the protection ground, according to claims 1, 2 and 3, characterized in that the remote controlled actuator block (3) comprises, besides the line contacts (22), a switch (23), a general power supply (25), a direct current generator (28), a blocking diode (30), a modem (24) and a circuit for setting the address (26), and a logic circuit interfaced with a network comprising the condensers (31 and 34) and the diodes (33 and 32), for actuating a relay (29), according to the charge of the condenser (34) passing through the diode (33), when the transmitted address and the set address are equal, said circuit being an intrinsically safe device, since it is guaranteed that the relay (29) is not actuated in presence of any kind of failure.

8. A system for remote measuring of the protection ground according to claims 1, 2, 3 and 7, characterized in that the remote controlled actuator has a configuration such that the line is not loaded through the diode (30), when the line is supplied at a normal polarity, and in such a way that this diode (30), on the contrary, is directly polarized for a supply which is opposite to that of the exchange, employed for
activating the ground measurement, which is effectively completely performed only if the transmitted and the set address are equal, whereby the switch (23) is otherwise disposed differently in a condition of zero absorption, which is also called autoreverse condition, when the actuator is supplied for a well defined period of time without receiving the signal transmitted by the multiplexer (16).
FIG. 4

FIG. 5
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC | G01R27/18 | G01R27/20 |

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)

| IPC | G01R |

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

Electronic database consulted during the international search (name of database and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

27 July 1995

**Date of mailing of the international search report**

07.08.95

**Name and mailing address of the ISA**

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