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(54) METHOD AND APPARATUS FOR TESTING THE INSULATION OF A TRACK CIRCUIT

VERFAHREN UND VORRICHTUNG ZUM TESTEN DER ISOLIERUNG EINES
GLEISSTROMKREISES

METHODE ET APPAREIL POUR TESTER L'ISOLATION D'UN CIRCUIT DE VOIE

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(56) References cited:
EP-A- 0 952 065 EP-A- 0 958 986
WO-A-2006/127066 FR-A- 2 758 301
GB-A- 2 063 539 US-A- 4 619 425
US-A1- 2006 155 433

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Description

[0001] The present invention refers to a method and apparatus for testing the insulation of a direct current track circuit.

[0002] In the railway industry language, a direct current track circuit is a section of a railway track of variable length (ranging from a few metres to several kilometres) electrically insulated from the adjacent track sections and having a low voltage applied on the set of two tracks. Application of voltage onto the electrified tracks occurs at an end of the track section, while a voltage detector is applied parallel at the end opposite to such power supply point. When there are no vehicles on that track section, the detector extracts a non-zero voltage given that the electrified tracks are not short-circuited by the presence of the train axes, while should any railway vehicle reach that track section it short-circuits the tracks with each other through its axes, and causes current circulation between the axes and thus lower voltage, ideally zero-voltage, which is calculated by the detector.

[0003] Thus, such technology allows continuously generating information regarding the presence in a track section for vehicles (standstill or mobile), and used as it is for automating the control of a railway line.

[0004] The information received from the direct current track circuit is reliable if electrically insulated from the earth, or from an adjacent direct current track circuit, in that should such insulation deteriorate, the sensor could detect a voltage signal, due to dispersion towards the earth or due to the influence of another direct current track circuit connected, and transmit false circuit unoccupied information.

[0005] The object of such solution is to allow measuring the insulation resistance of the joints (made up of an electrically insulating material) present between two adjacent direct current track circuits and uniquely identify the joint (or joints) revealing dispersions, in such a manner to be able to intervene through suitable actions and repairs.

[0006] The measurement environment is extremely noisy - just imagine the traction noise of electric locomotives - and the measurement method must be practically immune to noise signals even of high levels.

[0007] Document US20060155433 proposes a method and a system for detecting a train on a direct current track circuit wherein an unambiguous code is added to the signal transmitted to the circuit. In particular, added to the voltage signal at the carrier frequency sent on the direct current track circuit is a preset number of information bits which - if identified in the reception step - signal the absence of the train in that direct current track circuit. It is obvious that in a noisy environment like the one described above even this system could fail to signal the correct information in that the added word could erroneously not be received. The present invention overcomes the abovementioned drawbacks by providing a system in which in each of the adjacent direct current track circuits part of the railway line, the alternating low voltage

signal is modulated in amplitude and/or in phase with an unambiguous digital code word. Each circuit shall have its own unique digital word.

[0008] Such encoding is currently used for encoding signals in mobile phones and it is substantially a technique for access, by several sources of information, to the same transmission channel, by using the same frequency band, which consists in associating - to the information transmitted by each of these sources - a code capable of identifying it in an unambiguous manner with respect to the rest and capable of allowing a receiver, to selectively extract information associated to each of them.

[0009] In such manner, it is possible to monitor whether the insulation level of a predetermined direct current track circuit is satisfactory. Only its unambiguous digital word shall be detected in such case, otherwise if there is deterioration in the insulation, traces of other digital words associated to adjacent circuits shall be detected. By evaluating and calculating the degree of presence of such digital words of other circuits it is possible to estimate the degree of insulation of the circuit in question.

[0010] An aspect of the present invention regards an apparatus for testing the insulation of a direct current track circuit according to the characteristics of claim 1.

[0011] A further aspect of the present invention regards a method for testing the insulation of a direct current track circuit according to the characteristics of claim 3.

[0012] Characteristics and advantages of the method and apparatus according to the present invention shall be more clear and apparent from the following exemplifying and non-limiting description of an embodiment provided with reference to the attached figure which represents a block diagram of the apparatus according to the present invention.

[0013] With reference to the abovementioned figure the apparatus according to the invention is applied on a direct current track circuit 1 which essentially comprises a pair of tracks R made of parallel metal sections usually T-shaped, mounted transversely with respect to a bearing structure made up of crosspieces made of wood, steel or cement. Each direct current track circuit is separated from the adjacent one through electrically insulating joints G. In a railway line there is a plurality of direct current track circuits adjacent and insulated from each other.

[0014] The apparatus according to the present invention for each direct current track circuit comprises a transmission block 2 capable of transmitting to the circuit an alternating voltage signal to which an unambiguous code word is associated. Such code word consists in providing a preset number of positive and negative half-waves of such alternating current according to a predetermined sequence. In particular, a so-called spread word S, for example made up of 16 chips, wherein each chip is equivalent to a sinusoidal cycle at the considered frequency, wherein the chip with value "1" provides for the sinusoidal cycle at the considered frequency with zero-phase, while the chip with value "0" provides for the sinusoidal cycle

with phase 180°.

[0015] Advantageously, an unambiguous digital word of a specific direct current track circuit is orthogonal to the unambiguous code words of the adjacent direct current track circuits.

[0016] According to the present invention, the term "orthogonal" is used to indicate that the scalar product between two orthogonal words is zero.

[0017] Such voltage signal on which the code word is overlapped or associated may be the traditional 50 Hz or 83.3 Hz voltage signal which is used for detecting the passage of the train on that direct current track circuit or it may be a specific voltage signal generated for such purpose.

[0018] Exploiting such property, the apparatus of the present invention further comprises a block 3 for extracting or detecting such voltage signal and a block 4 for processing such signal.

[0019] Under normal conditions, such signal must contain the unambiguous word regarding its direct current track circuit or it may contain more than one unambiguous word (in case of deterioration of the insulation of the joints G).

[0020] By carrying out the scalar product between such signal and the various unambiguous words (the unambiguous word of the circuit in question and those of the adjacent circuits), the presence of a correct unambiguous word may be verified and - in addition - other power supply signals may be detected, verifying the presence of other unambiguous words hence signalling, identifying and assessing the deterioration of the electric insulation between adjacent direct current track circuits.

[0021] The extracted voltage signal is sent to the processing block which comprises a microprocessor and at least one analogue/digital converter for such extracted signal. Comparison between the extracted signal and the previously memorised unambiguous codes is carried out in such processing block 4, verifying the presence of the unambiguous word/s received emitting a signal for identifying the words themselves.

Claims

1. Apparatus for testing the insulation of a direct current track circuit in a railway line provided with a plurality of direct current track circuits adjacent to each other, such circuit comprising a pair of tracks (R) made up of parallel metal sections between which it is possible to apply an electric voltage, each direct current track circuit being separated from the adjacent one through electrically insulating joints (G),
characterised in that it comprises a transmission block (2) capable of transmitting to the direct current track circuit an alternating current signal, associated to which is an unambiguous code word which consists in providing a preset number of

positive and negative half-waves of such alternating current according to a predetermined sequence, the unambiguous code word associated to each direct current track circuit being orthogonal to the one associated to an adjacent circuit,

at least one block (3) for detecting the alternating current signal delivered to the direct current track circuit and at least one processing block (4) adapted to compare such predetermined unambiguous code word with the extracted signals, such processing block performs the comparison between the detected voltage signal and the previously stored unambiguous code words, checking for the presence of the unambiguous code words received emitting a signal for identifying the words themselves.

2. Apparatus according to claim 1, wherein the processing block comprises a microprocessor and at least one analogue/digital converter of such extracted signal.
3. Method for testing the insulation of a direct current track circuit in a railway line provided with a plurality of direct current track circuits adjacent to each other, such circuit comprising a pair of tracks (R) made up of parallel metal sections between which it is possible to apply an electric voltage,
characterised in that it comprises the following steps:

transmitting an alternating current signal on each of such direct current track circuits, associating an unambiguous code word to each signal providing a preset number of positive and negative half-waves of such alternating current according to a predetermined sequence, the unambiguous code word associated to each direct current track circuit being orthogonal to the one associated to an adjacent circuit, detecting the alternating current signal from the circuit whose degree of insulation is to be measured, comparing such signal with the previously stored unambiguous code words by calculating the scalar product between such signal and the previously stored unambiguous code words, detecting the presence of one or more unambiguous code words in the signal when the result of the scalar product is different from zero, emitting a signal for identifying the unambiguous code words detected in the signal.

Patentansprüche

1. Vorrichtung zum Testen der Isolierung eines Gleichstrom-Schienenstromkreises in einem Eisenbahngleis, die mit einer Vielzahl von zueinander benach-

barten Gleichstrom-Schienenstromkreisen versehen ist, diese Schaltung weist ein Paar Schienen (R) auf, die aus parallelen Metallabschnitten bestehen, zwischen denen es möglich ist eine elektrische Spannung anzulegen,

jeder Gleichstrom-Schienenstromkreis ist von dem benachbarten durch elektrisch isolierende Verbindungen (G) getrennt, **dadurch gekennzeichnet, dass** es aufweist

einen Übertragungsblock (2), der in der Lage ist, an den Gleichstrom-Schienenstromkreis ein Wechselstromsignal zu übertragen, dem ein eindeutiges Codewort zugeordnet ist, das darin besteht, eine vorgegebene Anzahl von positiven und negativen Halbwellen eines solchen Wechselstroms gemäß einer vorbestimmten Sequenz bereitzustellen, das eindeutige Codewort, das jedem Gleichstrom-Schienenstromkreis zugeordnet ist, ist orthogonal zu demjenigen, welches einem benachbarten Stromkreis zugeordnet ist,

wenigstens einen Block (3) zum Erfassen des Wechselstromsignals, welches an den Gleichstrom-Schienenstromkreis geliefert wurde, und wenigstens einen Steuerblock (4), der geeignet ist, ein solches vorgegebenes eindeutiges Codewort mit den extrahierten Signalen zu vergleichen, ein solcher Steuerblock führt durch den Vergleich zwischen dem detektierten Spannungssignal und den zuvor gespeicherten eindeutigen Codewörtern, prüfen auf das Vorhandensein der empfangenen eindeutigen Codewörter, Aussenden eines Signals zur Identifizierung der Wörter selbst.

2. Vorrichtung gemäß Anspruch 1, wobei der Steuerblock einen Mikroprozessor und wenigstens einen Analog/Digital-Wandler für ein solches extrahiertes Signal umfasst.

3. Verfahren zum Testen der Isolierung eines Gleichstrom-Schienenstromkreises in einem Eisenbahngleis, die mit einer Vielzahl von zueinander benachbarten Gleichstrom-Schienenstromkreisen versehen ist, diese Schaltung weist ein Paar Schienen (R) auf, die aus parallelen Metallabschnitten bestehen, zwischen denen es möglich ist eine elektrische Spannung anzulegen, **dadurch gekennzeichnet, dass** es die folgenden Schritte aufweist:

Übertragen eines Wechselstromsignals auf jede dieser Gleichstrom-Schienenstromkreise, Zuordnen eines eindeutigen Codewortes zu jedem Signal, das eine voreingestellte Anzahl von positiven und negativen Halbwellen eines solchen Wechselstroms gemäß einer vorbestimmten Sequenz bereitstellt, das eindeutige Codewort, das jedem Gleichstrom-Schienenstromkreis zugeordnet ist, ist orthogonal zu demjeni-

gen, welches einem benachbarten Schaltkreis zugeordnet ist,

Erfassen des Wechselstromsignals des Stromkreises, dessen Isolationsgrad gemessen werden soll,

Vergleichen dieses Signals mit den zuvor gespeicherten eindeutigen Codewörtern durch Berechnen des Skalarprodukts zwischen diesem Signal und den zuvor gespeicherten eindeutigen Codewörtern,

Erfassen des Vorhandenseins eines oder mehrerer eindeutiger Codewörter in dem Signal, wenn das Ergebnis des Skalarprodukts verschieden von Null ist,

Aussenden eines Signals zur Identifizierung der im Signal erfassten eindeutigen Codewörter.

Revendications

1. Appareil pour tester l'isolation d'un circuit de voie à courant continu sur une ligne de chemin de fer comprenant une pluralité de circuits de voie à courant continu adjacents les uns aux autres, ledit circuit comprenant une paire de rails (R) constitués de sections métalliques parallèles entre lesquelles il est possible d'appliquer une tension électrique, chaque circuit de voie à courant continu étant séparé du circuit de voie à courant continu adjacent par des joints d'isolation électrique (G), **caractérisé en ce qu'il comprend** un bloc de transmission (2) capable de transmettre au circuit de voie à courant continu un signal de courant alternatif, auquel est associé un mot de code sans équivoque qui consiste à fournir un nombre prédéfini de demi-ondes positives et négatives dudit courant alternatif selon une séquence prédéterminée, le mot de code sans équivoque associé à chaque circuit de voie à courant continu étant orthogonal par rapport à celui qui est associé à un circuit adjacent, au moins un bloc (3) pour détecter le signal de courant alternatif délivré au circuit de voie à courant continu et au moins un bloc de traitement (4) conçu pour comparer ledit mot de code sans équivoque avec les signaux extraits, ledit bloc de traitement effectue la comparaison entre le signal de tension détecté et les mots de code sans équivoque précédemment stockés, en vérifiant la présence des mots de code sans équivoque reçus en émettant un signal pour identifier les mots eux-mêmes.
2. Appareil selon la revendication 1, dans lequel le bloc de traitement comprend un microprocesseur et au moins un convertisseur analogique/numérique de ce signal extrait.

3. Procédé pour tester l'isolation d'un circuit de voie à courant continu sur une ligne de chemin de fer comprenant une pluralité de circuits de voie à courant continu adjacents les uns aux autres, ledit circuit comprenant une paire de rails (R) constitués de sections métalliques parallèles entre lesquelles il est possible d'appliquer une tension électrique, 5
caractérisé en ce qu'il comprend les étapes suivantes : 10
- la transmission d'un signal de courant alternatif sur chacun des circuits de voie à courant continu, 15
 l'association d'un mot de code sans équivoque avec chaque signal en fournissant un nombre prédéfini de demi-ondes positives et négatives dudit courant alternatif selon une séquence prédéterminée, le mot de code sans équivoque associé à chaque circuit de voie à courant continu étant orthogonal par rapport à celui qui est associé à un circuit adjacent, 20
 la détection du signal de courant alternatif provenant du circuit dont le degré d'isolation doit être mesuré, 25
 la comparaison dudit signal avec les mots de code sans équivoque précédemment stockés, en calculant le produit scalaire entre ledit signal et les mots de code sans équivoque précédemment stockés, 30
 la détection de la présence d'un ou de plusieurs mot(s) de code sans équivoque dans le signal lorsque le résultat du produit scalaire est différent de zéro, 35
 l'émission d'un signal permettant d'identifier les mots de code sans équivoque détectés dans le signal.

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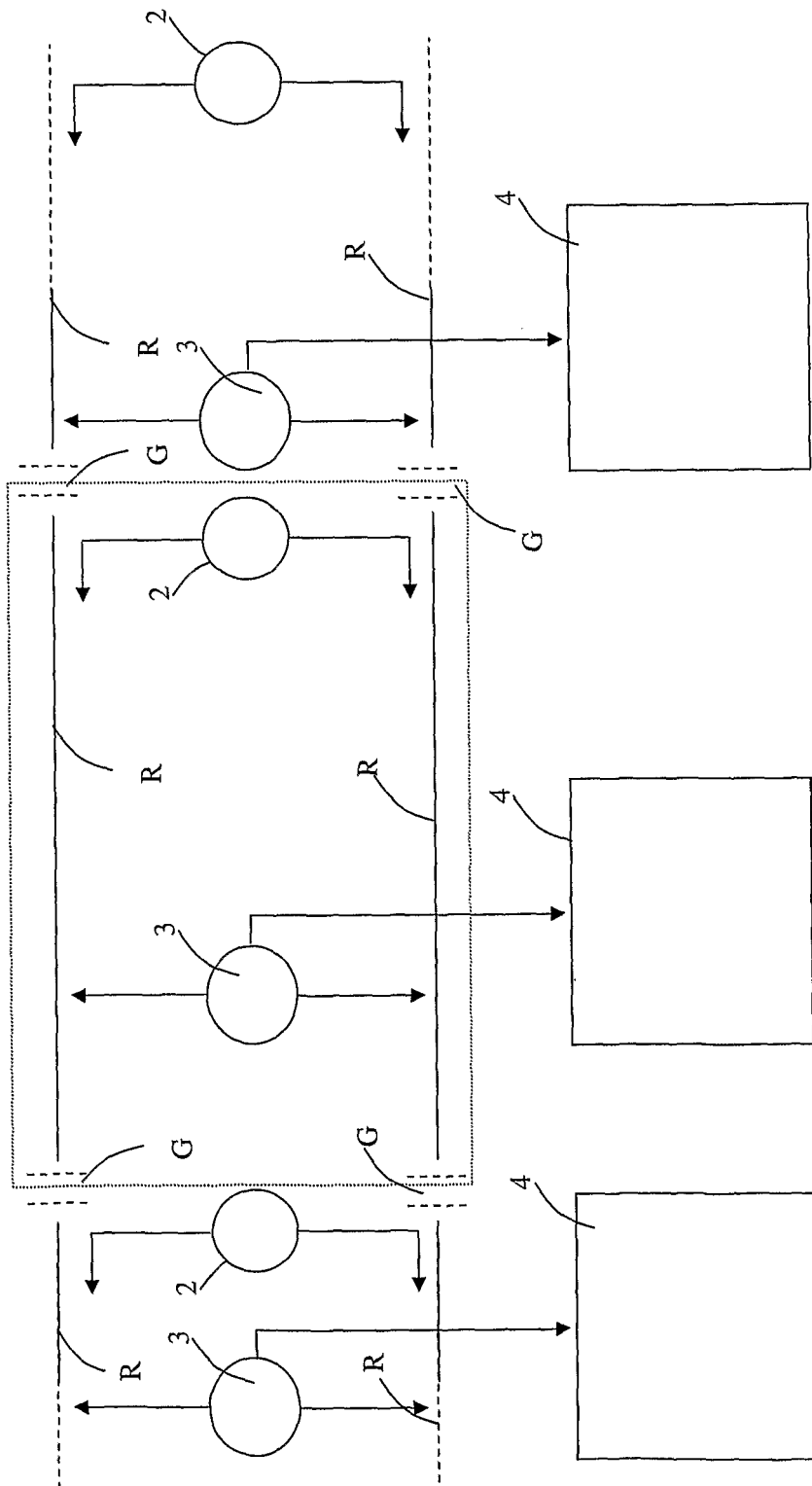


Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20060155433 A [0007]