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(54) **Process and installation for detecting a rail break**

(57) Process for monitoring the integrity of at least one section of railway track (10), the said section being constituted by two parallel rails (1 and 2), between which there are arranged, on the one hand, a generator (3) or detector (7) present at one end and an impedance (4) present at the other end, and, on the other hand, a detector (7) or a generator (3) arranged in a common-mode link (6), comprising the following steps:

- generating a signal with the aid of the said generator at a certain frequency and injecting it into the said section,
- picking up and detecting the said signal at the said frequency with the aid of the detector,
- carrying out a processing of the said signal and proceeding to an integrity diagnosis of the said section.

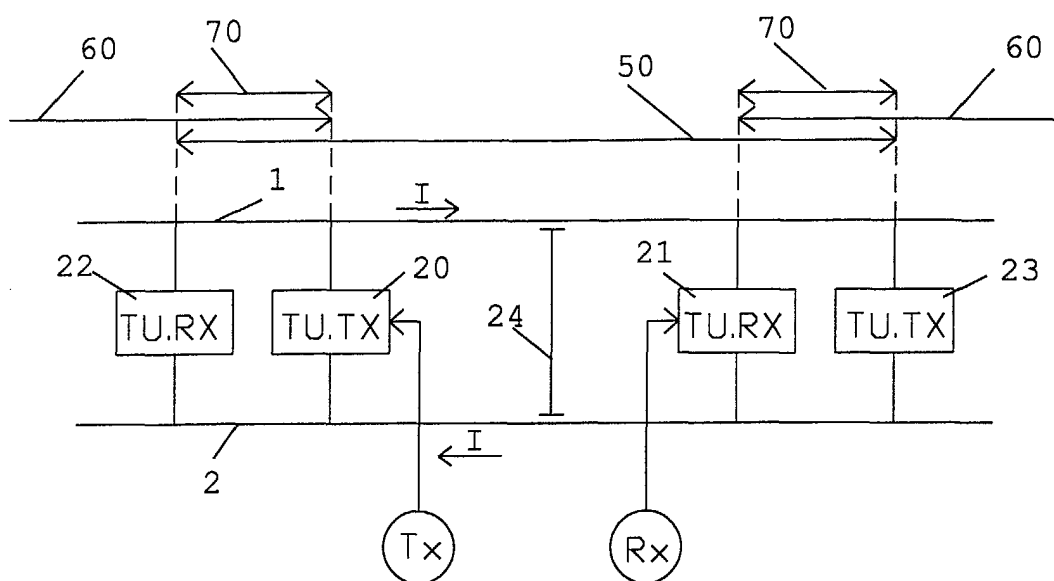


FIG. 3

Description

Subject matter of the invention

[0001] The present invention relates to a process for monitoring the integrity of a railway track, in particular to a process for detecting a rail break.

[0002] The invention likewise concerns the installation intended to implement the process.

State of the art

[0003] Certain rail transport operators and indeed all such operators for certain types of traffic such as passenger lines, lines for speeds above 160 km/h etc. require an autonomous real-time system on the ground for detecting rail breaks. In reality, the term "in real time" is understood to mean a delay in response of the order of at most a few minutes.

[0004] It is in fact imperative that a rail break can be detected in time because it could cause a significant failure, such as a derailment, especially in the case of curved track sections.

[0005] Moreover, the appearance of an initial rail break may be followed with a relatively high degree of probability by a second break in the immediate vicinity of the first. This then translates into the creation of a "gap" in detection or the "loss" of a train in the case of a detection system provided by a track circuit.

[0006] A track circuit is known as being a system which uses the two rails as transmission lines. A signal is injected in differential form at one point and received by a receiver at another point. The presence of an axle between these points is translated into a resistance which short-circuits the two rails, producing in this way an attenuation of the signal received. The system thus acts as a detection system capable of detecting with complete security the presence of an axle in a given section. The latter is defined as the length of the section delimited respectively by the two points of emission and reception.

[0007] One known practice is to limit this track circuit by introducing joints; either insulated joints (mechanical discontinuities) or electrical joints (without a mechanical discontinuity) - which is the currently preferred solution - obtained by the use of radio-frequency signals in tuned track circuits. The track will then be divided into sections, also called "block systems", separated by electrical joints.

[0008] According to the state of the art, it is customary to use electrical joints for large sections of track, that is to say of between 100 metres and 2 kilometres.

[0009] According to the very principle of the track circuit, an accidental electrical discontinuity in the rail should lead to the disappearance of the signal at the receiver but, in practice, this is not always the case: the earthing of the track and the returns for the traction current towards the substations constitute parasitic paths

that allow the track circuit current to avoid the rail break and thus prevent its detection.

[0010] Nevertheless, detection can be ensured with a certain probability by following a certain number of rules as regards the positioning of the earthing points and of the return for the traction current towards the substations.

[0011] Moreover, in order to compensate for the self-induction coil of the track per unit length, the trend is to "pupinize" the track, that is to say to place capacitors at regular intervals between the two rails. This makes it possible to achieve a relative increase in the power attenuation introduced by the parasitic path, which is not pupinized. This latter technique makes it possible to mitigate the disadvantages without for all that eliminating them.

[0012] It should be pointed out that this faculty for detection using a track circuit is highly dependent on external parameters such as the type of earthing, the state of the ballast, the geometry of the track (of the catenary type or of the type with a third rail etc).

[0013] Moreover, these techniques do not make it possible to distinguish between the two events of track occupation and the rail break. In fact, both these events lead to a fall in voltage in the track circuit. Furthermore, it is of course important to be able to detect the presence of the train in security while at the same time distinguishing between the two types of information, namely a rail fracture and occupation of the track.

[0014] Moreover, at the moment the various solutions proposed in the state of the art can only be used in the case of a line equipped with track circuits that have electrical or mechanical joints, which is generally not the case with lines carrying light traffic or lines with signalling of the ERTMS level-3 type (European Railway Train Management System).

[0015] To date, there is no device for detecting a rail break for this type of track.

Aims of the invention

[0016] The present invention aims to propose a solution which does not have the disadvantages of the state of the art by providing a process and installation for secure detection, in the railway engineering sense of the term, of a rail break.

[0017] The present invention thus aims to provide a solution which makes it possible to detect a rail break, either by using a system involving detection with a track circuit or by using a system that does not involve a track circuit.

[0018] An additional aim of the invention is to be able to apply the process and the installation of the invention to a relatively long section of track, e.g. of several tens of kilometres used, in particular in the case of lines for which detection of the trains is not ensured by track circuits.

[0019] An additional aim of the invention is to provide

a low-cost solution which minimizes the amount of equipment.

Main characteristic elements of the invention

[0020] The present invention relates to a process for monitoring the integrity of at least one section of railway track, the said section being constituted by two parallel rails, between which there are arranged, on the one hand, a generator or detector present at one end and an impedance present at the other end, and, on the other hand, a detector or a generator arranged in a common-mode link, comprising the following steps:

- generating a signal with the aid of the said generator at a certain frequency and injecting it into the said section,
- picking up and detecting the said signal at the said frequency with the aid of the detector,
- carrying out a processing of the said signal and proceeding to an integrity diagnosis of the said section.

[0021] According to a first embodiment of the process of the invention:

- a signal at a certain frequency corresponding to a current in a first circuit corresponding to the said section is generated with the aid of an AC voltage source placed between the rails,
- the said current at the said frequency is picked up and detected, with the aid of the detector placed in the common-mode link, in an additional circuit constituted by at least one common-mode connection linked to the said first circuit.

[0022] According to a second embodiment:

- a signal is generated from a current source in an additional circuit at a certain frequency, the said current source being arranged in the common-mode connection,
- the said signal at the said frequency is picked up and detected in a first circuit corresponding to the said section in the form of a differential voltage between the two rails with the aid of the said detector.

[0023] In the process of the invention, the signal may be coded.

[0024] In the process of the invention, the common-mode link may be an earthing connection in the case the traction current is an AC current. Alternatively, the common-mode link may be a connection serving as a return for the traction current towards the substations in the case the traction current is a DC current.

[0025] The invention is further related to an installation for monitoring the integrity of a section of railway track, preferably for detecting rail breaks, comprising - according to a first embodiment - at least:

- a means for generating a signal, arranged between the two rails of the said railway track,
- an impedance connected between the rails at a predetermined distance from said generating means,
- appliances with mid-points, which are arranged between the rails and the mid-points of which are linked, at least by conductors in such a way as to form a common-mode connection,
- a means for detecting said signal, arranged on the said common-mode connection, and
- means for carrying out a processing of the said signal and proceeding to an integrity diagnosis of the said section.

[0026] In the installation according to this first embodiment, said means for generating a signal, may consist of an AC voltage source and said means for detecting said signal may consist of an AC current detector.

[0027] The invention is further related to an installation for monitoring the integrity of a section of railway track, preferably for detecting rail breaks, comprising - according to a second embodiment - at least:

- a means for detecting a signal, arranged between the two rails of said railway track,
- an impedance connected between the said rails at a certain predetermined distance from said detecting means,
- appliances with mid-points, which are arranged between the said rails and the mid-points of which are linked, at least by conductors, in such a way as to form a common-mode connection,
- a means for generating said signal, arranged on said common-mode connection,
- means for carrying out the processing of said signal and proceeding to the integrity diagnosis of said section.

[0028] In an installation according to said second embodiment, said means for detecting a signal may consist of an AC voltage detector, and said means for generating a signal may consist of an AC current source.

[0029] In an installation according to the invention, said common-mode connection may comprise an earth connection via earthing points. Alternatively, said common-mode connection may comprise a conductor which effects the return of the traction current towards substations.

[0030] In an installation according to the invention, said appliances with a mid-point may be windings with a mid-point.

[0031] In an installation according to the first embodiment, said voltage source may play the part of transmitter (Tx) of a track circuit for the detection of trains, and said impedance may play the part of a tuning unit in connection with the receiver (Rx) of a track circuit for the detection of trains. Said track circuits may be separated from adjacent track circuits either by insulated

joints or electrical joints.

[0032] In an installation according to the second embodiment, differential voltage detector may play the part of receiver (Rx) of a track circuit for the detection of trains, and the impedance may play the part of a tuning unit in connection with the transmitter (Tx) of a track circuit for the detection of trains. Said track circuits may be separated from adjacent track circuits either by insulated joints or electrical joints.

[0033] According to the invention, said detecting means may comprise an instrument transformer comprising a first winding serving as a primary, a second winding serving as a secondary, and at least one receiver.

[0034] According to one embodiment of the invention, said first winding connects the mid-points of two appliances with a mid-point belonging to two different tracks (A and B), and said at least one receiver is capable of detecting a current at a first frequency (F1), corresponding to a first track circuit present on the first track (A), and of detecting a current at a second frequency (F2), corresponding to a second track circuit present on the second track (B).

Brief description of the figures

[0035] Figures 1a and 1b show schematically the use of a track circuit fitted with a device for detecting rail breaks in common mode, according to the invention.

[0036] Figures 2a to 2d represent schematically four versions of a device for detecting rail breaks according to the invention.

[0037] Figure 3 represents schematically a track circuit for detecting the presence of a train between two electrical joints, with their emitter and their receiver.

[0038] Figure 4 represents schematically a track circuit for detecting a train, fitted with a device according to the invention for detecting rail breaks.

[0039] Figure 5 represents schematically a track section comprising two parallel tracks fitted with a device for detecting rail breaks, according to a preferred embodiment of the invention.

Description of a number of preferred embodiments of the invention

[0040] The present invention consists in the presence of a signal generator, especially a voltage source or a current source, placed either between the two rails of a railway track or on a common-mode link, and in the detection of the said signal indicating a rail fracture or break. Any combination of type of source (voltage or current) and type of detector (measurement of current or of voltage) can be included within the scope of the present invention.

[0041] The term "common mode" is understood to signify a means that allows two rails to be joined. These common-mode means are usually constituted by appli-

ances with mid-points, which are either themselves interconnected with the aid of connections or the mid-points of which are directed to earth.

[0042] Figures 1 and 2 describe schematically the principle of detection for a process and a device implemented according to a preferred embodiment. More detailed explanations can be found by reference to Figure 3.

[0043] According to these Figures 1 and 2, use has been made of the embodiment according to which a voltage source arranged between the two rails is provided and according to which the presence of a common-mode current is detected. Of course, exactly the same analysis could be effected with the opposite configuration, that is to say if a source of current arranged in a common-mode connection were used and a differential voltage between the two rails were detected.

[0044] In this first scenario, a track circuit is constituted by rails 1 and 2, between which are arranged a source of AC voltage 3 at a frequency F1 and an impedance 4 equivalent to a given impedance at the said frequency of the source 3.

[0045] This source generates a current which is preferably coded at a frequency that is lower the longer the section.

[0046] The process according to the invention advantageously uses a system of coded signals to distinguish the traction current from the current for detecting rail breaks.

[0047] There are also appliances 5 (impedance) with mid-points that allow earthing in the case of traction with alternating voltage or the return of the said current towards substations in the case of traction with direct current. These appliances make it possible to achieve the common-mode link.

[0048] In reality, such appliances 5 are already fitted to track circuits and are, by virtue of this fact, used for the purpose of the invention.

[0049] In the case of a traction current at alternating voltage, e.g. an AC voltage of 25 kV at 50 Hz, such appliances 5 with mid-points allow some of the traction current to return via conductors 8, leading towards earthing points 13 (Fig. 2a). Between two mid-points of appliances 5, there is then a common-mode connection 6.

[0050] Such appliances 5 likewise exist in the case of a DC traction current, in order to ensure insulation of the track with respect to earth. In this case, the traction current is redirected via conductors 8 and from the mid-points of the said appliances 5 and a conductor 14 towards substations 15 (Fig. 2b). The electrical path formed by two conductors 8, and part of conductor 14 represent a common-mode connection 6. This connection 6 (Fig. 2a or 2b) will be used, according to the invention, to detect a rail break in the portion of track between the appliances 5.

[0051] In order to detect the presence of a common-mode current, a device 7 capable of measuring the said current is arranged preferably in the connection 6 be-

tween an appliance 5 and either the conductor 14 or the earthing point 13, depending on the circumstances.

[0052] This device 7 can be constituted by any instrument for measuring current known from the state of the art. It is, of course, configured to distinguish between the passage of a traction current and a current for detecting rail breaks at a frequency F1.

[0053] In the normal condition, that is to say without rail breaks between the source 3 and the impedance 4, a current I passes through the track circuit 10 (Figure 1a). A limited portion of the said current will pass via the connection 6 owing to the inherent dissymmetries of the track.

[0054] In the case of a rail break 11, the current I will pass via the circuit 12 (Figure 1b) and will cause an increase in the current (traction current + current due to the common mode) detected by the device 7. It is thus sufficient to detect this increase in current to be able to determine that a discontinuity in the rail 1 or the rail 2 has taken place and thus to detect a rail break in the section of track concerned.

[0055] The tuning of the detection process should take account of the environment of the track (earthing, catenary etc.). The limitations on use depend on the type of traction, on the presence of an earthing or of a return to the substations and on the characteristics of the track.

[0056] As shown in Figure 2, the connection 6 can be made in various forms, depending on the characteristics of the track. There are essentially two possibilities, which are linked to the return of the traction current (AC or DC). The traction current can be drained by means of earthing points 13 for the rails of the track, in the case of a 25 kV, at 50 Hz AC traction voltage (Fig. 2a) (at regular distance), or through the presence of a conductor 14 which links a plurality of points along a track to a substation 15, which is essentially a common track insulation point for a number of points on the track in the case of a direct traction voltage (Fig. 2b).

[0057] Figure 2a in fact describes the first embodiment (AC voltage), which profits from the earthing points 13 which link the mid-points of the appliances 5. The appliances 5 of the invention are advantageously inductive impedances (windings) which exhibit a given value at the frequency F1 of the track circuit while at the same time forming a low impedance at low frequency. In the case appliances are already present on the track, serving as a return path for the traction current, these windings can be used in the process of the invention.

[0058] Figure 2b represents the second embodiment in the case of a DC voltage: the conductor 14 is there essentially to drain the traction current towards the substation 15, but likewise serves as a connection 6 for implementing the process of the invention.

[0059] The principle of the invention thus consists in using the connection to detect the presence of a common-mode current, the connection being either an earthing link (Fig. 2a) or a link redirected towards the

substations (Fig. 2b).

[0060] A known method is then used to measure the current between a point, for example the mid-point of a winding of the appliance 5, and a point of the connection 6, which is, for example, the earthing or a point on a return path for the traction current towards the substations. The signal detected at the frequency F1 at a specific detector 7 present on this connection 6 signifies that a rail fracture has occurred on the section (block system) under consideration.

[0061] Figures 2c and 2d show an embodiment wherein a current source 40 and a differential voltage detector 41 are placed between the rails on the common-mode connection 6. This system equally allows to detect the rail break 11, by detecting the influence that said rail break has on the voltage measured by the detector 41.

[0062] According to a preferred embodiment, the process of the invention employs track circuits that are already present, such as the track circuits used to locate trains, which are separated by electrical joints.

[0063] Traditionally, an electrical joint (referred to as an RX/TX joint) of the type shown in Figure 3 comprises two tuning units, TU.RX ("Tuning Unit - Receiver") and TU.TX ("Tuning Unit - Transmitter") respectively, which are arranged between two rails 1 and 2, which connect the two rails and which are arranged at a distance of between 15 and 30 m from one another. The distance between the two adjacent joints can vary between a few hundred metres and one or two kilometres. Each joint thus separates the track into two sections 50 and 60, called "block systems", with an overlap zone 70, corresponding to the distance between the two units. Detection of the presence of a train is effected by means of electrical signals present in the circuits corresponding to the said block systems, at frequencies typical of each block system, this allowing electrical separation of two adjacent circuits.

[0064] Figure 3 shows two electrical joints forming the limits of a track circuit. The unit 20 of the left-hand joint and the unit 21 of the right-hand joint are equivalent to capacitances at a first frequency F1. At this frequency, an AC source (Tx) emits a signal into the track circuit delimited by the two joints. The source Tx is in fact in series with the unit 20, while the unit 21 is provided with a receiver Rx in parallel, which essentially comprises a device for measuring the current in the track circuit. The track circuit corresponding to block system 50 is separated from the adjacent circuits 60 by virtue of the fact that the outer units 22 and 23 are equivalent to short circuits at the frequency F1. At a different frequency F3, these units are by contrast equivalent to capacitances, in this way allowing detection of the presence of a train in the adjacent block system 60 by currents at this frequency F3.

[0065] Detection of a train on the block system 50, for example, is due to the fact that the axle 24 of this train forms in itself a short circuit between the rails 1 and 2.

In reality, the axle exhibits a low impedance which can be likened to a short circuit, which will cause a drop in voltage in the receiver linked to unit 21, which is deactivated in this way. This deactivation thus corresponds to the detection of a train between units 20 and 21.

[0066] This situation is clearly similar to that described in Figure 1. By using appliances 5 with a mid-point and the common-mode connection 6 provided with the current-measuring device 7, it is possible to securely detect a rail break in each block system, as shown in Figure 4. The appliances 5 with a mid-point, which are inductive impedances, do not necessarily have to be situated between the tuning units of an electrical joint.

[0067] It is furthermore possible for a section of track monitored in accordance with the process of the invention to include several detecting track circuits. This allows the installation of appliances 5 with a mid-point close to a limited number of joints along the track, rather than close to each electrical joint.

[0068] Thus it will be observed that, when there is a train on a track circuit 50, the current will pass via the axle of the train and not via the connection 6. As for the traction current, it is measured by the device 7 at the moment when the train passes.

[0069] Thus there is no confusion between detection of rail breaks and the presence of a train on the section of track corresponding to the track circuit 50, provided that adequate coding of the signals allows the traction current to be distinguished from the common-mode signals used to detect rail breaks.

[0070] A preferred mode of embodiment of the invention is shown in Figure 5. The measurement of current is performed on two essentially parallel pairs A and B of rails 1,2 and 1',2'. The two tracks A and B are equipped with track circuits for detecting trains, the said circuits being separated by electrical joints (20,22) and (21,23). In this specific case, the current-measuring device 7 is in the form of an instrument transformer (18,19,32), which allows a rail break to be detected in either of two block systems (30,31) belonging to either of the two parallel tracks. The detection of trains in the block systems 30 and 31 is performed by means of differential signals at different frequencies referred to as F1 and F2. Appliances 5,5' with a mid-point are present between the tuning units of the electrical joints.

[0071] The impedance 18 consists in a self-induction coil with a mid-point earthed, for example, in the case of an AC voltage and acting as a primary of the instrument transformer. In the case of a DC voltage, the mid-point can be connected to a cable which serves as a return connection towards the substations. In this case, detection of the two currents in the two circuits of the parallel tracks can be achieved with the aid of a single measurement appliance. The two windings 18 are used if an earthing is to be provided as shown in Figure 5.

[0072] At least one specific receiver 32 intended to detect the rail break is connected to the secondary 19 of the transformer.

[0073] Since the intention is to avoid the presence of a train being identified with an imaginary fracture, a coded track circuit signal is used.

[0074] Thus the use of a pre-programmed frequency-code pair makes it possible to determine (or more precisely to distinguish) the current coming from the track circuit and the traction current. The receiver 32 detects a signal above a certain threshold corresponding to the determined frequency (filtering) and to the coding. This detection makes it possible to determine the block system or track in which there is an anomaly.

[0075] It is possible to use a single receiver 32 per earthing point, provided that it is equipped with means (of decoding for example) for distinguishing between a signal at frequency F1 and a signal at frequency F2. Two receivers 32 per earthing point will advantageously be installed, that is to say one receiver per frequency F1, F2. These receivers will be installed in parallel on the secondary winding 19.

[0076] As illustrated in Figure 5, a rail break in one or the other of two block systems 30 and 31 is detected by a current-measuring device (18,19,32). The adjacent block systems will be monitored by similar devices (18', 19',32') linked to inductive connections 5' close to the adjacent joints. In fact, the presence of an earthing point in proximity to an electrical joint should participate in the common-mode conduction associated with a rail break in this section. It is consequently unnecessary to seek to detect this signal in the adjacent earthing points.

[0077] The current sensor 18,19 and the detector 32 will preferably be incorporated into a single housing, into which there passes, for example, a conductor carrying the common-mode current. Detection by the detector 32 can be effected either at the track or at a distance.

Claims

1. Process for monitoring the integrity of at least one section of railway track (10), the said section being constituted by two parallel rails (1 and 2), between which there are arranged, on the one hand, a generator (3) or detector (41) present at one end and an impedance (4) present at the other end, and, on the other hand, a detector (7) or a generator (40) arranged in a common-mode link (6), comprising the following steps:

- generating a signal with the aid of the said generator at a certain frequency and injecting it into the said section,
- picking up and detecting the said signal at the said frequency with the aid of the detector,
- carrying out a processing of the said signal and proceeding to an integrity diagnosis of the said section.

2. Process according to Claim 1, **characterized in**

that:

- a signal at a certain frequency corresponding to a current in a first circuit (10) corresponding to the said section is generated with the aid of an AC voltage source (3) placed between the rails (1 and 2),
- the said current at the said frequency is picked up and detected, with the aid of the detector (7) placed in the common-mode link (6), in an additional circuit (12) constituted by at least one common-mode connection (6) linked to the said first circuit.

3. Process according to Claim 1, **characterized in that**:

- a signal is generated from a current source (40) in an additional circuit (12) at a certain frequency, the said current source being arranged in the common-mode connection (6),
- the said signal at the said frequency is picked up and detected in a first circuit corresponding to the said section (10) in the form of a differential voltage between the two rails with the aid of the said detector (41).

4. Process according to any one of the preceding claims, **characterized in that** the signal is coded.

5. Process according to any one of the preceding claims, **characterized in that** the common-mode link (6) is an earthing connection in the case the traction current is an AC current.

6. Process according to any one of the preceding claims, **characterized in that** the common-mode link (6) is a connection serving as a return for the traction current towards the substations in the case the traction current is a DC current.

7. Installation for monitoring the integrity of a section of railway track, preferably for detecting rail breaks, comprising at least:

- a means (3) for generating a signal, arranged between the two rails (1 and 2) of the said railway track,
- an impedance (4) connected between the rails (1 and 2) at a predetermined distance from said generating means,
- appliances (5) with mid-points, which are arranged between the rails (1,2) and the mid-points of which are linked, at least by conductors (8) in such a way as to form a common-mode connection (6),
- a means (7) for detecting said signal, arranged on the said common-mode connection (6), and

- means for carrying out a processing of the said signal and proceeding to an integrity diagnosis of the said section.

8. Installation according to claim 7, wherein said means for generating a signal, consists of an AC voltage source (3) and said means for detecting said signal consists of an AC current detector (7).

9. Installation for monitoring the integrity of a section of railway track, preferably for detecting rail breaks, comprising at least:

- a means (41) for detecting a signal, arranged between the two rails (1 and 2) of said railway track,
- an impedance (4) connected between the said rails (1 and 2) at a certain predetermined distance from said detecting means,
- appliances (5) with mid-points, which are arranged between the said rails and the mid-points of which are linked, at least by conductors (8), in such a way as to form a common-mode connection (6),
- a means (40) for generating said signal, arranged on said common-mode connection (6),
- means for carrying out the processing of said signal and proceeding to the integrity diagnosis of said section.

10. Installation according to claim 9, wherein said means for detecting a signal consists of an AC voltage detector (41), and said means for generating a signal consists of an AC current source (40).

11. Installation according to Claim 7 to 10, **characterized in that** said common-mode connection (6) comprises an earth connection via earthing points (13).

12. Installation according to Claim 7 to 10, **characterized in that** said common-mode connection (6) comprises a conductor (14) which effects the return of the traction current towards substations (15).

13. Installation according to Claim 7 or 8, **characterized in that** said appliances (5) with a mid-point are windings with a mid-point.

14. Installation according to Claim 8, wherein said voltage source (3) plays the part of transmitter (Tx) of a track circuit for the detection of trains, the impedance (4) playing the part of a tuning unit (21) in connection with the receiver (Rx) of a track circuit for the detection of trains.

15. Installation according to claim 10, wherein said differential voltage detector (41) plays the part of re-

ceiver (Rx) of a track circuit for the detection of trains, the impedance (4) playing the part of a tuning unit (20) in connection with the transmitter (Tx) of a track circuit for the detection of trains.

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16. Installation according to claim 14 or 15, wherein said track circuits are separated from adjacent track circuits by insulated joints.

17. Installation according to claim 14 or 15, wherein said track circuits are separated from adjacent track circuits by electrical joints. 10

18. Installation according to Claim 7 or 9, **characterized in that** said detecting means (7, 41) comprises an instrument transformer comprising a first winding (18) serving as a primary, a second winding (19) serving as a secondary, and at least one receiver (32). 15

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19. Installation according to Claim 18, **characterized in that** the said first winding (18) connects the mid-points of two appliances (5) with a mid-point belonging to two different tracks (A and B), and in which the said at least one receiver (32) is capable of detecting a current at a first frequency (F1), corresponding to a first track circuit present on the first track (A), and of detecting a current at a second frequency (F2), corresponding to a second track circuit present on the second track (B). 25

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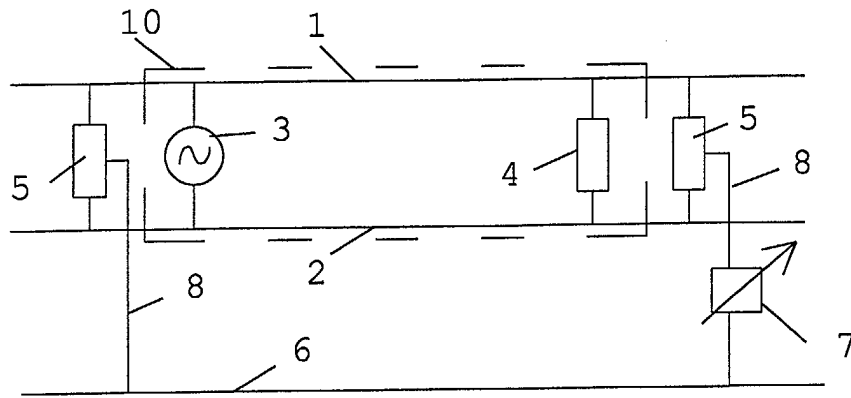


FIG. 1a

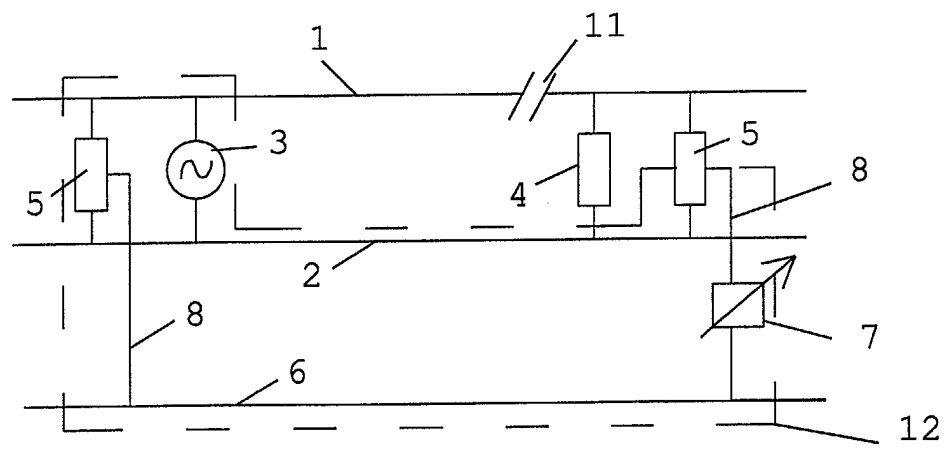


FIG. 1b

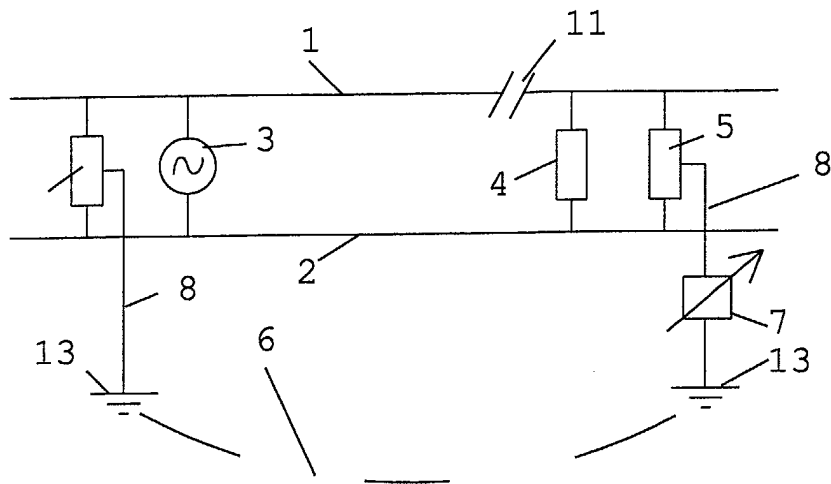


FIG. 2a

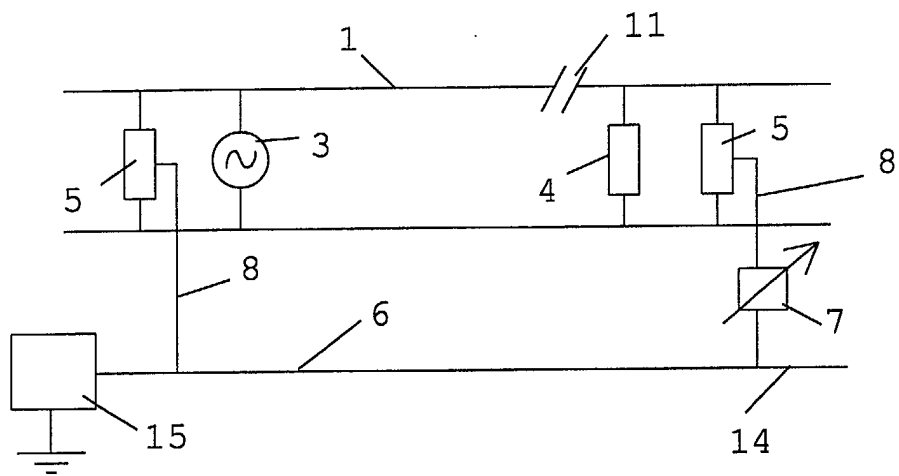


FIG. 2b

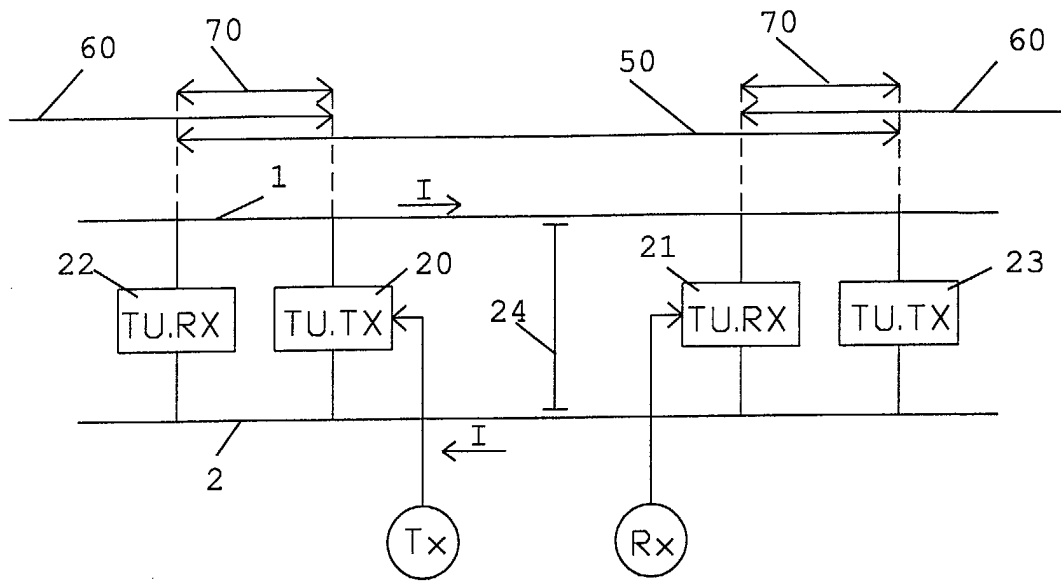


FIG. 3

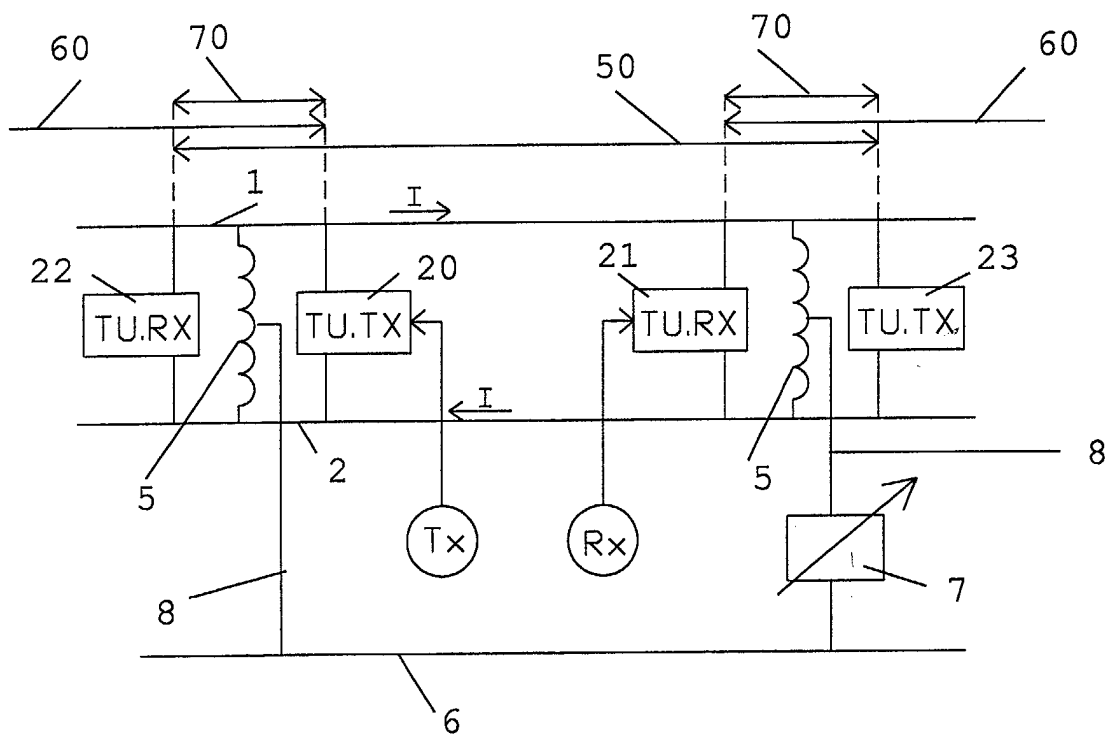


FIG. 4

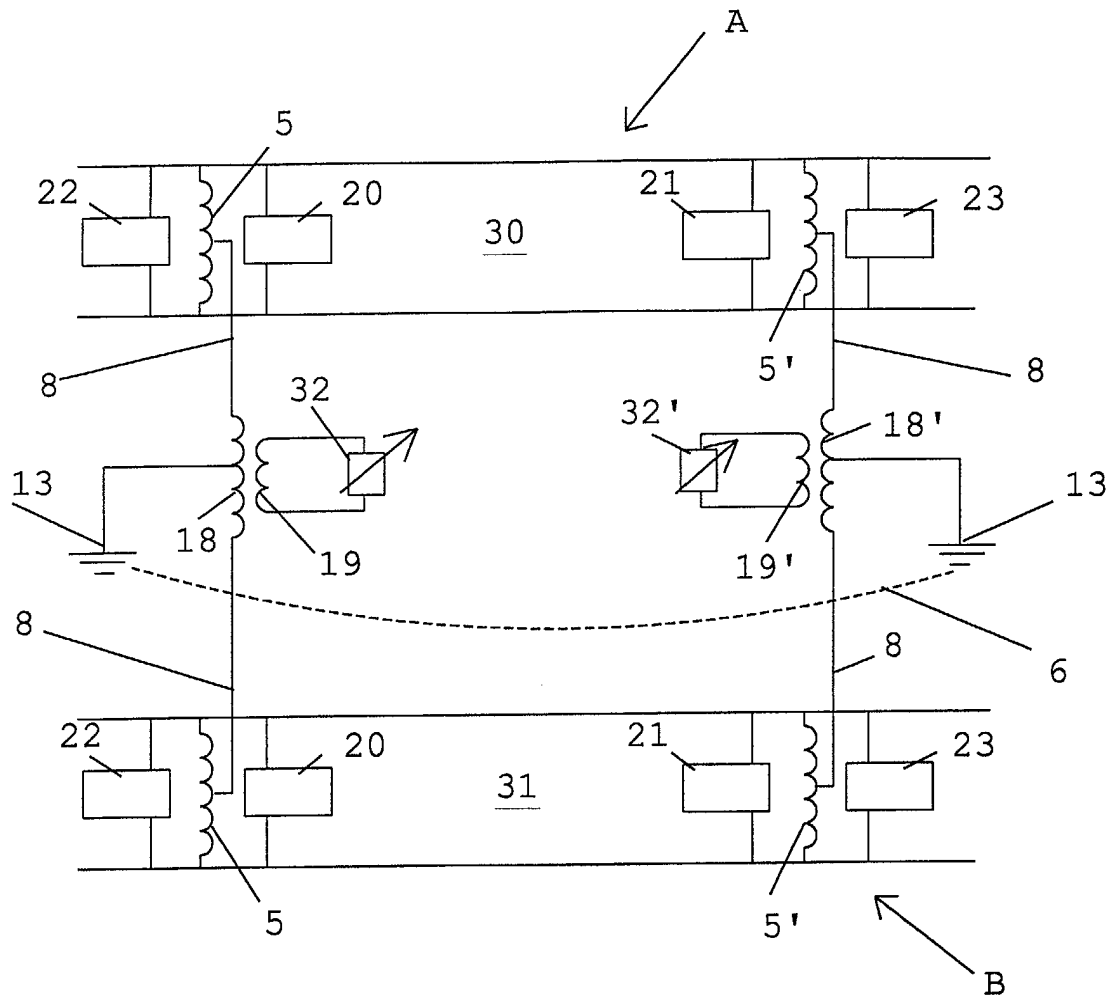


FIG. 5



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 03 44 7067

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