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(54) **Monitoring system for detection of rails breakages and method of detection**

(57) Device for monitoring failures of rails and method for the detection of such failures, wherein the rails K are provided with sensors S_1, S_2 to S_{2n-1}, S_{2n} placed thereon and having associated preamplifiers PZ_1 and PZ_2 to PZ_{2n-1}, PZ_{2n} installed as close as possible to the sensors S_1 and S_2 to S_{2n-1}, S_{2n}, the preamplifiers being arranged in series with sequential amplifiers Z_1 and Z_2 to Z_{2n-1}, Z_{2n} connected to a busbar (NI) that is incorporated into a computer (PC).

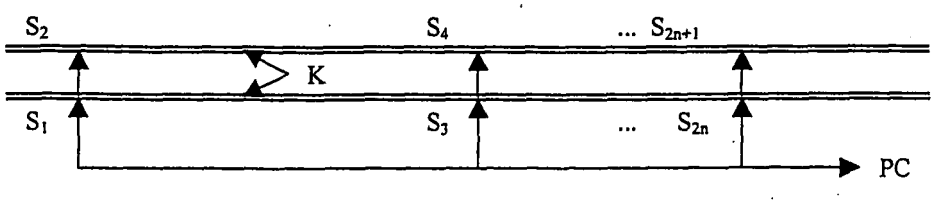

Fig.4

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Description

Technical background

[0001] The present invention relates to a monitoring device for the detection of failures in rails using the principle of mechanical energy transfer. The invention also relates to a method for the detection of failures.

State of the art

[0002] Railway tracks are subject to mechanical and thermal stresses when used in a common manner. In addition, frequent attacks on the part of criminal elements occur who attempt to dismantle the railway track or parts of it for various reasons. Mechanical and thermal loads of the rails under operation as well as deliberate damages to the railway tracks often result in endangering the safe railway traffic.

[0003] In the past, railway tracks were regularly inspected by trackmen. Nowadays, however, the inspections are carried out in prolonged time intervals. Increasing speeds of railway vehicles in combination with possible tampers on the railway tracks may have fatal consequences for passengers, railway staff and other affected individuals.

[0004] When a rail is broken, cut away or dismantled, the resulting mechanical energy is emitted into the rail. Such energy is then radiated into the rails, that form e.g. a contact less track, as if it would be transferred through a waveguide. Similarly, various other defects of the railway track, such as loose fasteners, cause an acoustic emission when being in contact with a moving railway vehicle.

[0005] Acoustic emissions originating as a result of a sudden event (such as fracture or cut), and especially acoustic emissions, that are associated with a non-linear acoustic spectroscopy in case of a gradually developing defect (such as fasteners becoming loose), are able to prevent considerable casualties, personal injuries and damages to the property when employed in combination with appropriate devices.

[0006] DE 199 54 760 discloses a method and device for monitoring rails, wherein several magnitudes characterizing the propagation of acoustic signals in the rails, that are in contact with the wheels of a moving vehicle, are captured by the sensors installed in multiple points and evaluated in a measuring station. These sound sensors are arranged on the web of the respective rail. If the rail is partly cracked or otherwise damaged, the wheel passing through generates a non-characteristic sound propagated into the surrounding area of the rail. Such sound is then compared with the characteristic sounds stored in the memory of the evaluation unit. By means of a sensor installed in a known position, the failure of the rail can be localized and the identified location can be inspected. The above method is, however, based on the necessary interaction of a wheel and thus it is not utilizable for monitoring the rail itself.

[0007] DE 198 58 937 discloses a similar method and device for monitoring railway traffic, wherein recurring failures in the system wheel-rail are captured and analyzed, the magnitudes characterizing the propagation of acoustic signals in the rails being again captured by the sensors installed in multiple points and evaluated in a measuring station. This method is also based on the interaction of a wheel and thus it is not utilizable for monitoring the rail itself.

[0008] EP 1000833 discloses an arrangement for the detection of a split rail. The solution consists in that an optical fibre is arranged underneath the head of the rail so that the fibre is cut across when the rail gets interrupted and the event is indicated in a collection site. However, such installation of optical fibres along extensive railway tracks is expensive.

[0009] The aim of the present invention is to provide a diagnostic device that records possible failures of the railway track by scanning the signal of an acoustic emission induced by the release of mechanical energy within the rail, which release may be caused by a fracture or lateral deflection of the rail or by dismantling or cutting of the railway track or by spontaneous gradual loosening of the fasteners or other parts of the superstructure.

Disclosure of the invention

[0010] The above disadvantages are largely eliminated by the device for monitoring defects in rails according to the invention, wherein the rails are provided with sensors placed thereon and having associated preamplifiers installed as close as possible to the sensors, the preamplifiers being arranged in series with sequential amplifiers connected to a busbar that is a part of a computer. The diagnostic method is based on the principle of acoustic emission and the device using this principle enables to detect and evaluate abrupt as well as gradually developing failures, employing the non-linear acoustic spectroscopy in case of gradually developing failures. For an acoustic emission to be generated no interaction of the rail and a moving wheel is necessary because the acoustic emission originates from the release of mechanical energy inside the rail.

[0011] In a preferred embodiment, the location of the components including the sensors, preamplifiers and amplifiers is combined with the location of an automatic block signal device.

[0012] The subject of the invention also comprises the method for detecting failures of rails which method is carried out in that the rails are provided with sensors installed on them, then preamplifiers are installed as close to the sensors as possible and subsequent amplifiers are installed in series with the preamplifiers and finally the amplifiers are connected to a busbar that is a part of a computer.

Overview of the figures

[0013] The invention will be further explained by means of the accompanying drawing wherein Fig. 1 shows the graphical representation of an acoustic emission originating from an abrupt event, such as a fracture of the rail, Fig. 2 shows the graphical representation of the progression of a gradually developing failure within the frequency spectrum, Fig. 3 shows the monitoring device according to the invention in a schematic view, and Fig. 4 presents the method for positioning sensors on the track.

Preferred embodiment of the invention

[0014] An abrupt event, such as a fracture of the rail, cutting the rail and dismantling or lateral deflection of the railway track, will manifest itself in form of an acoustic emission that may have its graphical record represented in a manner similar to that shown in Fig. 1. If a gradually developing failure occurs, the event manifests itself in form of the corresponding changes to the frequency spectrum, as illustrated in Fig. 2 in an exemplary way.

[0015] The device for monitoring abrupt and gradually developing failures is schematically illustrated in Fig. 3. It is evident that the device comprises the sensors S_1, S_2 to S_{2n-1}, S_{2n} located along the section of the monitored track that may be as long as several tens of kilometers. The sensors are connected with associated preamplifiers PZ. The wiring scheme of the entire measuring system including the sensors S_1 a S_2 is evident from Fig. 3 that clearly illustrates that the preamplifiers PZ_1 and PZ_2 must be located as close to the sensors S_1 and S_2 as possible. The preamplifiers are connected to subsequent serial amplifiers Z_1 and Z_2 that are in turn connected to the busbar NI incorporated into a computer.

[0016] Fig. 4 presents the method for positioning the components of the monitoring device on the track. Be supposed that the sensors having odd numbers are placed on the right-hand stretch of rails, while the sensors having even numbers are placed on the left-hand one. The locations of the components including the sensors, preamplifiers and amplifiers can be preferably combined with those of a automatic block signal system (identified as N_1, N_3, N_{2n-1} in Fig. 4) if the track is equipped with the latter.

[0017] An automatic block is a device securing the service of consecutive trains wherein a series of subsequent signal devices are interconnected, the spacing between them being typically 1,000 meters. If there is a train in a section, the signal device at the beginning of that section is in the "stop" position (red light) while the signal device of the preceding section shows the "caution" signal (amber light). The localization of the signal devices of an automatic block system can be also utilized for the parallel operation of the monitoring device according to the invention, i.e. for the parallel location of the elements of the same.

[0018] The monitoring system may be set up either in the continuous monitoring mode or in the standby mode. When being operated the latter mode, the system is switched on if the signal strength of an acoustic emission exceeds the preset detection threshold, see Fig. 1, and switched off after the signal level of the acoustic emission drops below the preset limit. After being captured, the signal is processed by means of the Fourier transformation in order to obtain a frequency spectrum, such as that illustrated in Fig. 2. The frequency spectrum obtained in the above described way is then compared with the database stored in a PC and containing characteristic spectrums. This enables to determine the type of the failure detected.

[0019] Many types of failures, especially those gradually developing, manifest themselves by producing different frequency spectrums depending on the actual loads induced by railway vehicles. For this reason, the complete monitoring process requires using an evaluation software based on the principle of non-linear acoustic spectroscopy.

[0020] An acoustic event arising between two consecutive odd or even sensors is usually detected by both the sensors. When the distance between the two sensors is known, the time period, within which the signal characterizing that acoustic event reaches either sensor, can be used for the calculation enabling the point of the failure to be localized.

Claims

1. Device for monitoring failures of rails, **characterized in that** the rails (K) are provided with sensors (S_1, S_2 to S_{2n-1}, S_{2n}) placed thereon and having associated preamplifiers (PZ_1 and PZ_2 to PZ_{2n-1}, PZ_{2n}) installed as close as possible to the sensors (S_1 and S_2 to S_{2n-1}, S_{2n}), the preamplifiers being arranged in series with sequential amplifiers (Z_1 and Z_2 to Z_{2n-1}, Z_{2n}) connected to a busbar (NI) that is incorporated into a computer (PC).

2. Monitoring device according to claim 1, **characterized in that** the location of the sensors, preamplifiers and amplifiers is combined with the location of an automatic block signal device.

3. Method for detecting failures of rails, **characterized in that** the rails (K) are provided with sensors (S_1, S_2 to S_{2n-1}, S_{2n}) placed thereon, the sensors are associated preamplifiers (PZ_1 and PZ_2 to PZ_{2n-1}, PZ_{2n}) installed as close as possible to the sensors (S_1 and S_2 to S_{2n-1}, S_{2n}) and the preamplifiers are connected in series with sequential amplifiers (Z_1 and Z_2 to Z_{2n-1}, Z_{2n}) that are then connected to a busbar (NI) that is incorporated into a computer (PC).

4. Method for detecting failures according to claim 3,

characterized in that the elements including are installed in combination with the signal devices comprising an automatic block system.

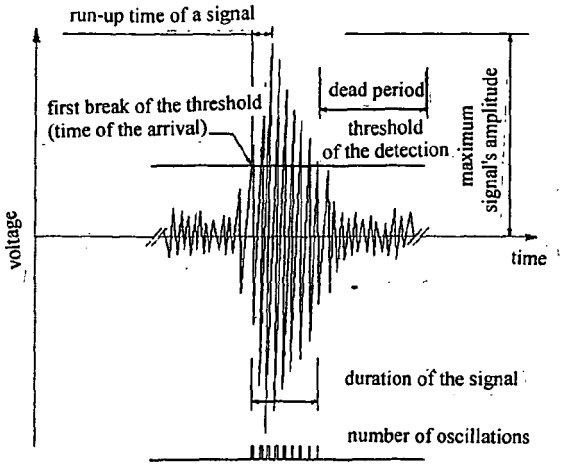

Fig.1

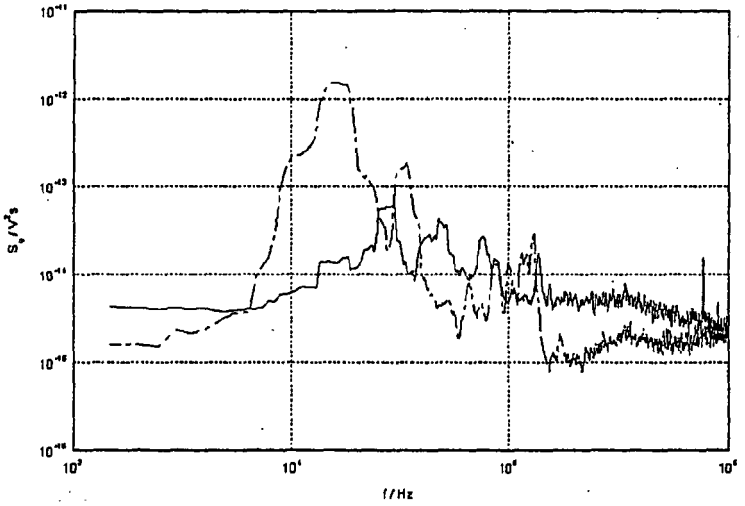

Fig.2

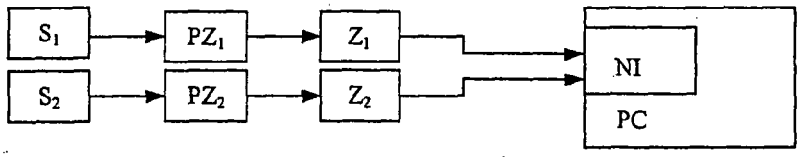

Fig.3

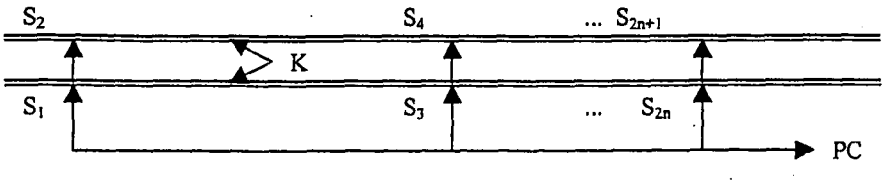

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 09 00 9648

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CA 2 242 723 A1 (STEPHENS ROBERT DOUGLAS [CA]) 28 February 1999 (1999-02-28) * page 10, line 11 - page 15, line 7; figure 1 *	1-4	INV. B61L23/04
X	DE 199 54 760 A1 (CLAUSS MANFRED [DE]) 3 August 2000 (2000-08-03) * column 1, line 55 - column 2, line 10; claims 1-5 *	1-4	
X	EP 0 514 702 A1 (TELEFUNKEN SYSTEMTECHNIK [DE]) 25 November 1992 (1992-11-25) * column 3, line 47 - column 4, line 11; figure 2 *	1,3	
A	WO 2005/025962 A2 (ANALOGIC ENGINEERING INC [US]; TURNER STEVEN [US]) 24 March 2005 (2005-03-24) * page 9, paragraph 1 - page 13, paragraph 2; figure 1 *	1-4	

TECHNICAL FIELDS SEARCHED (IPC)

B61L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 December 2009	Janhsen, Axel

CATEGORY OF CITED DOCUMENTS

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04-12-2009

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- DE 19858937 **[0007]**
- EP 1000833 A **[0008]**