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(54) MONITORING WITH A LPWAN DATA LOGGER

(57) Method for monitoring a component of a rail or road, by using a with the component associated self-contained unit having an internal radio transmitter and an internal radio receiver of a radio signal; an internal battery, of not rechargeable type with a sufficient capacity to provide the unit at least 5 years of the required power supply; an internal memory and an internal microprocessor; a sensor; an internal analog-to-digital converter; an internal clock; an antenna, wherein the unit transmits the data to a remote receiver by radio. The data communication applies a network of LPWAN type via modulated and not modulated chirps in combination.

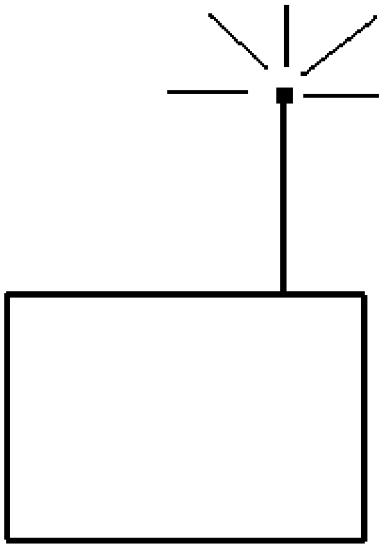

Fig. 1

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Description

[0001] This invention relates to the monitoring of a component belonging to a railway train for transport of persons and goods, or part of a highway. For example, the component is part of the overhead line for electrical power supply to the train, for example, the pole rail connection, or the return cable or minus cable or potential compensating cable, or other component of the catenary-return system. Another component is the switch heating or part thereof, or a switch actuator or part thereof, or a compensation or ES-joint (expansion joint respectively electric separation joint in a rail) or an access door, for example, of a relay box, relay house or fence. Yet another component may be a part in or along a tunnel for auto- or rail traffic, such as a tunnel wall or tunnel fan or a visibility meter, or hectometer pole or a lamppost or traffic sign or signage or railway sign.

[0002] "Railway" also means here "highway", and vice versa.

[0003] To this end, has been invented a self-contained unit with one or more of: a single radio transmitter and optionally an internal radio receiver of a radio signal; an internal battery, of preferably not rechargeable type which supplies galvanic current by chemical reaction, preferably with a sufficient capacity to provide the unit at least 5 years of the required power supply; an internal memory and an internal microprocessor; a sensor; an internal analog-to-digital converter; an internal clock; an internal or external antenna; one or more keys for data input by a user; a display unit such as a monitor or display; an internal digital-to-chirp and / or chirp-to-digital converter.

[0004] The unit preferably comprises a radio communication system operating with the digital data and one or more of chirp signals, chirp modulation and conjugate chirps. In this context, refer to EP2449690, US6549562, EP0952713, US6940893, US6614853 and EP2763321, the contents of each of which is herein included. Preferably, radio communication takes place via modulated and not modulated chirps in combination. For example, a narrow-band or ultra-narrowband radio technology is used, preferably with the application of "Binary phase-shift keying (BPSK)".

[0005] The communication is done via a network, preferably of LPWAN (Low Power Wide Area Network) type.

[0006] For the purpose of radio communication, the unit is at preferably equipped with a transmitter and / or receiver as claimed in one of the claims 1 - 18 of EP2763321.

[0007] Preferably, the unit is configured so that at the side of the transmitter the via radio to be transferred digital transmission data is converted into chirps which are transmitted by the antenna and are converted, after receipt at the side of the receiver in digital reception data which is substantially equal to the digital transmission data.

[0008] This unit is preferably adapted for one or more of:

transmitting (circuit- or packet-switched) of a status signal at on a transmission frequency, for example, between 860 and 1000 MHz (for example at least 860 or 865 and / or up to 870 or 900 MHz) at a transmit power of preferably 25 mW, or less and a data rate, for example, between 0.3 and 50 kbps; the at intervals of at least 10 minutes or 1 hour or 10 hours or one day or one week or one month, and / or up to one day or one week or one month or one year for, preferably, a maximum of 1 second broadcasting (Uplink) of a message, with a size, preferably at most 3 bytes (e.g., 8 or 16 bits per byte), and possibly only immediately after sending waiting for a response from the server, with a size, preferably at a maximum of 3 bytes (e.g., 8 or 16 bits per byte), for a maximum of, preferably, 1 second (downlink receive window) after which the transmitting / receiving procedure is concluded and remains closed during the interval to be reactivated to the end of the interval;
transmitting for a maximum of 1% or 10% of the available time; sampling with a regularity at least 10 or 50 or 100 times more than the frequency of transmitting, for example, every minute sampling and every hour transmitting; immediately transmitting as soon as a particular result is obtained from sampling.

[0009] During the interval, the CPU will preferably at least one time do the sampling of the sensor data, to reduce energy consumption sampling is done preferably up to three times per interval or a maximum of once every 10 minutes or every day.

[0010] The relevant monitoring data is preferably broadcast in association with a unique identification data of the unit.

[0011] The unit preferably belongs to a group of identical units having a mutual distance of, preferably, at least 1 or 5 or 10 or 100, and / or up to 100 or 200 or 1000 meters and this group is included in a wireless radio network for simplex or duplex communication and each individual unit is, preferably, located at a distance of at least 1 or 2 or 5 or 10 kilometers from the nearest radio transmit / receive mast of the terrestrial network of such masts that are, preferably, arranged according to the cellular network principle, which masts are, preferably, via a wired network connected to the server computer, which is supplied by the from the group of units derived data and optionally in turn provides data to this group.

[0012] The units transmit independently of each other and the moment of sending is, for example, triggered by the unit's own clock. By duplex communication transmission by the unit preferably triggers the sending of the reply by the server computer, during which duplex communication preferably the corresponding unit communicates with the same mast both for the upload and the download part.

[0013] The group of units is preferably located along

the railroad or highway, for example, of a length portion of the track each pole of the catenary, or of a motorway every hectometer pole or lamppost is equipped with a unit. Optionally, the maximum unit spacing is 1000 or 2000 meters. For units that are associated with return cables or minus cables or potential equalization cables, preferably per such cable a single unit is applied and preferably all such cables of a length portion of the railway track are equipped with a unit. For units that are associated with switch heating a single switch is preferably equipped with a large number of units. Preferably, each heat source, for example, burner pipe, is equipped with its own unit. Because burner pipes can have a short distance from each other, in this case, the units preferably are located at a mutual distance between 50 centimeters and 3 meters. If associated with a compensation joint, ES joint or obstruction, such as door, of an access opening, any joint or door is equipped with its own unit and this unit is located at preferably a distance of less than 1 meter of this joint or door and / or at a distance of at least 10 meters from other with this group affiliated units (because these joints or doors themselves as a rule are at least 10 meters from each other) . If associated with a switch actuator, 1, 2 or more units are associated with the same switch actuator and these units keep a mutual distance of preferably at least 50 cm or 1 m.

[0014] The antenna is located preferably at least 0.25 or 1 or 3 meters above the level of the local ground level or top face of the rail or road, for reliable wireless radio signal transmission with the associated network mast over the large distance of, for example, at least 2 kilometers.

[0015] The sensor is adapted for registering preferably of a galvanic voltage (for example, near the post rail connection) or current (for example at the return cable) or magnetic field (for example, to detect a galvanic current) or a temperature (for example, at the switch heating) or a displacement (for example at the compensation joint), or a vibration or the air humidity. The sensor may be combined with a door contact or reed contact or micro switch to e.g. check the closure of a door.

[0016] For example, the unit is integrated with a voltage security of, for example, a pole rail connection. In another example, the unit is integrated into a hollow profile, for example of an entrance gate, and the antenna preferably penetrates a to the surrounding open hole in the profile wall.

[0017] The invention also relates to a method to determine which to a railroad or highway belonging component of a group of identical components which are with mutual spacing located along a railroad or highway, must be visited by a service man, which components are fitted with their own unit according to the invention and these units are within a radio communication network through which the units transmit measurement data to a server computer, said server computer is configured to, in dependence of these measuring data, to select the to be visited component and presents it to a user and then the service man goes to the selected component.

[0018] For example, a tunnel will be equipped with a group of units with mutual spacing, e.g. mounted in or on the tunnel wall. Advantageous applications inside a tunnel for car or train traffic are as follows:

Monitoring of the condition of the tunnel wall, e.g. deterioration of the light reflection of the tunnel walls by pollution. To this end, each unit of the group is equipped with a means for measuring the light reflection of an associated part of the tunnel wall. Preferably, the centrally collected measurement data is used to compare with a threshold, passage of which triggers the decision to wash the tunnel wall. As a result, the road safety is increased, and lower maintenance costs arise.

[0019] Monitoring of the condition of the part of the tunnel fans, for example, by a vibration and / or galvanic current measurement. These fans generate an artificial air flow through the tunnel for the purpose of ventilation. To this end, preferably each fan is associated with its own unit which is equipped with a means for the vibration and / or current measurement to measure vibration of the fan or power supply current of the fan, respectively. From the obtained measurement data a trend can be determined that allow a prediction about the time of necessary repairs.

[0020] Monitoring of the condition of visibility meters, in the particularly the lens or the viewing window with which smoke is monitored in the tunnel. To this end, preferably each visibility meter is associated with its own unit which is equipped with a means for measuring the light transmittance of the lens or the viewport. From the obtained measurement data a trend can be derived to predict the time of necessary cleaning the lens or window.

[0021] By equipping a unit with an inclinometer it can be detected whether the object associated with it, for example, post, is indeed or not standing upright. If the unit is equiped with a light or temperature sensor it can be detected of its associated object, for example, street lighting or switch heating, works (indicating, for example, light or heat). If the unit is provided with a position determination, for example GPS or triangulation (positioning by distance measurement to a minimum of two or three associated masts of the radio network), the location of the object associated with it, for example, rail sign or road sign, can be determined and thus controlled remotely, if the object is present at the desired location.

[0022] The following is an explanation of the in the drawing shown example.

Fig. 1 schematically shows a unit of the invention;
Fig. 2 shows in perspective a part of a railway track;
Fig. 3 shows in perspective view an against freezing heated switch of a railway;
Fig. 4 shows in a graph the variation in time of the frequency of a base chirp and a modulated chirp;

Fig. 5 shows a graph of the phase of the in fig. 4 shown signals;
Fig. 6 shows in a graph the real and the complex component of the base chirp, in the time domain.

[0023] Fig. 1 shows of the unit the housing that contains all of the components so that the unit can operate independently, and protruding out of the housing is the antenna.

[0024] Fig. 2 shows the five poles that carry the overhead catenary. Every pole is equipped with a pole-rail connection, and thereafter is connected to a unit so that each post 5 is equipped with own unit.

[0025] The switch of FIG. 3 is equipped with gas-fired burner tubes and each burner tube is equipped with its own unit. Thus each burner pipe can remotely be checked for correct functioning. For example, located in the II area along the switch tongue a burner pipe is located.

[0026] Fig. 4-6 show examples of chirps which are used in the radio communication.

[0027] Many alternative embodiments belong to the invention, also whereby an alternative is applied for chirps.

[0028] Thus, the invention, for example, relates to the application of a self-contained unit with on-board energy power supply during monitoring of a component which belongs to a railway, wherein the unit is arranged for radio communication, and preferably the means of the unit for the radio communication are designed for transmission and generating chirps from the to be transferred digital data.

[0029] Thus, the invention concerns a device and / or method for monitoring of a component or group of substantially identical components, preferably each component is associated with its own wireless communicating data logger of a group of substantially identical data loggers.

[0030] The present invention also includes an embodiment obtained by a disclosed feature separately, optionally combined with one or more other disclosed features separately.

Claims

1. Method for monitoring a component of a rail or road, by using a with the component associated self-contained unit having an internal radio transmitter and an internal radio receiver of a radio signal; an internal battery, of not rechargeable type with a sufficient capacity to provide the unit at least 5 years of the required power supply; an internal memory and an internal microprocessor; a sensor; an internal analog-to-digital converter; an internal clock; an antenna, wherein the unit transmits the data to a remote receiver by radio.

2. Method as claimed in claim 1, the data Communications occurs through a network of LPWAN (Low Power Wide Area Network) type.

3. Method according to claim 1 or 2, there is radio communication via modulated and not modulated chirps in combination.

4. Method according to any one of claims 1-3, there is used a narrowband or ultra narrowband radio technology, preferably with the application of "binary phase-shift keying (BPSK) ".

5. Method according to any one of claims 1-4, the component is a voltage surge safety of the post-rail connection of the supporting mast of the train catenary or a heating with a rail associated heating element, such as burner pipe, of a switch heating.

6. Method according to any one of claims 1-5, the component is present in a tunnel through which the road extends, for example, a light reflection detector or fan or sight sensor.

7. Method according to any of claims 1-6, wherein the unit transmits a message, in association with a unique identification data of the unit, at a transmission frequency between 860 and 870 MHz at a transmit power of 25 mW and a data rate between 0.3 and 50 kbps at intervals of at least one day and up to one week for a maximum of 1 second with a size at most 3 bytes and only immediately after sending waits for a response from the server for a maximum of 1 second after which the transmitting / receiving procedure is concluded and remains closed during the interval to be timely reactivated to the end of the interval wherein sampling takes place with a regularity at least 50 times more than the frequency of transmitting.

8. Method according to any one of claims 1-7, the unit belongs to a group of identical units having a mutual distance of at least 10 and up to 1000 meters and this group is included in a wireless radio network for duplex communication and each individual unit is located at a distance of at least 1 kilometers from the nearest radio transmit / receive mast of the terrestrial network of such masts that are arranged according to the cellular network principle, which masts are via a wired network connected to the server computer, which is supplied by the from the group of units derived data and in turn provides data to this Group, wherein the units transmit independently of each other, and the units are each associated with a relevant component of a group of identical components, for example, catenary masts (5) at the side of the road.

9. Method according to any one of claims 1-8, the antenna is situated at least 0.25 meters above the top face of the rail.

10. Method according to any one of claims 1-9, the sensor is adapted for the registration of one or more of: a galvanic voltage or current or magnetic field or a temperature or a movement or a vibration or air humidity or light or inclination or position determination.

11. Method according to any one of claims 1-10, wherein a group of identical units with mutual spacing is mounted in or to the tunnel wall, and each unit of the Group is equipped with a means for measuring the light reflection of an associated part of the tunnel wall and associated data is transmitted.

12. Method according to any one of claims 1-11, wherein a group of identical units with mutual spacing is mounted in or to the tunnel wall, and each unit of the group is equipped with a means for the vibration and / or current measurement of an associated fan in the tunnel.

13. Method according to any one of claims 1-12, wherein a group of identical units with mutual spacing is mounted in or to the tunnel wall, and each unit of the group is equipped with a means for measuring the light transmittance of the lens or the viewing window of a associated visibility sensor in the tunnel.

14. Method according to any one of claims 1-13, on the side of the transmitter the via radio to be transferred digital transmission data is converted into chirps which are transmitted by the antenna and after reception are converted at the side of the receiver in digital reception data which is substantially equal to the digital transmission data.

15. Method according to any one of claims 1-14, the unit comprises one or more keys for data input by a user; a display unit such as a monitor or display; an internal digital-to-chirp and chirp-to-digital converter.

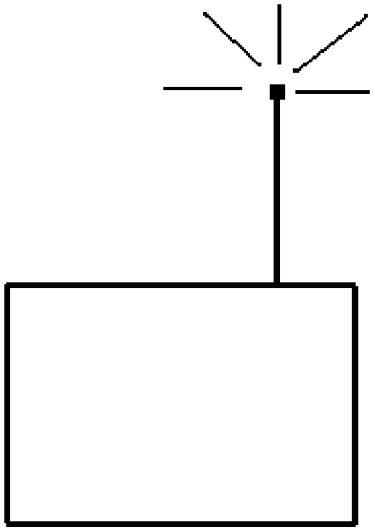

Fig. 1

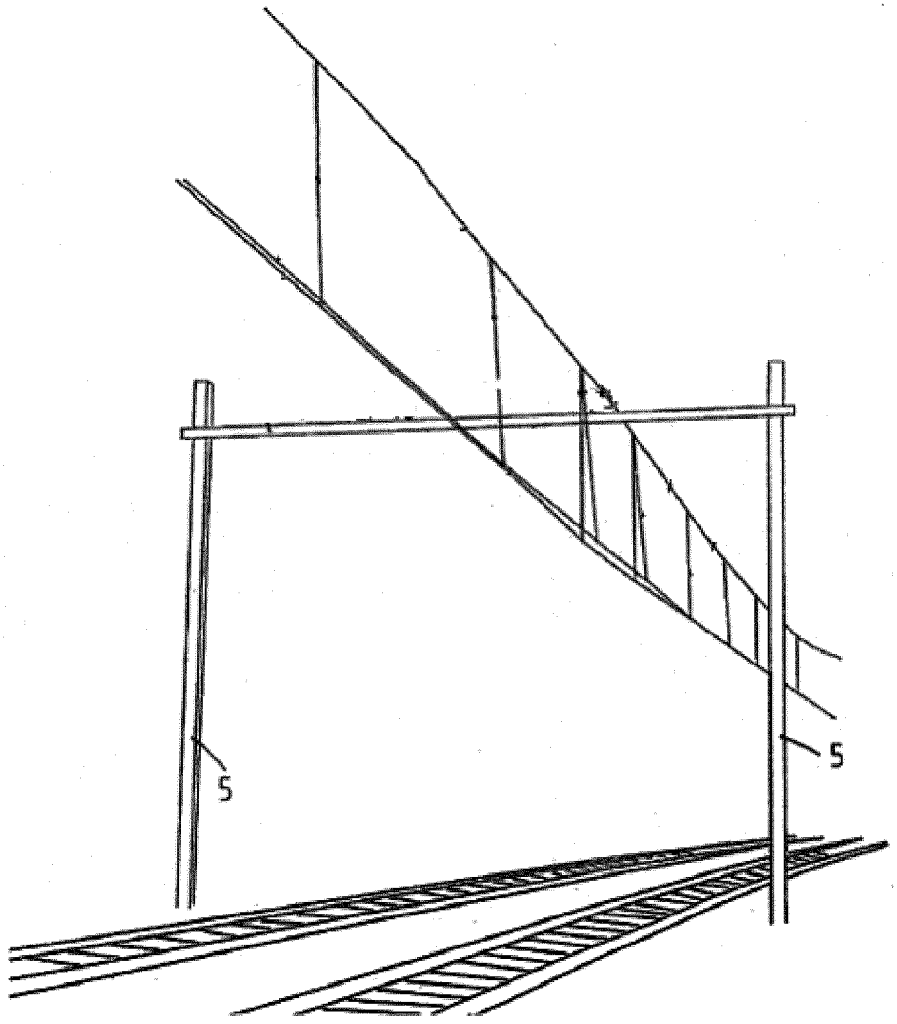

Fig. 2

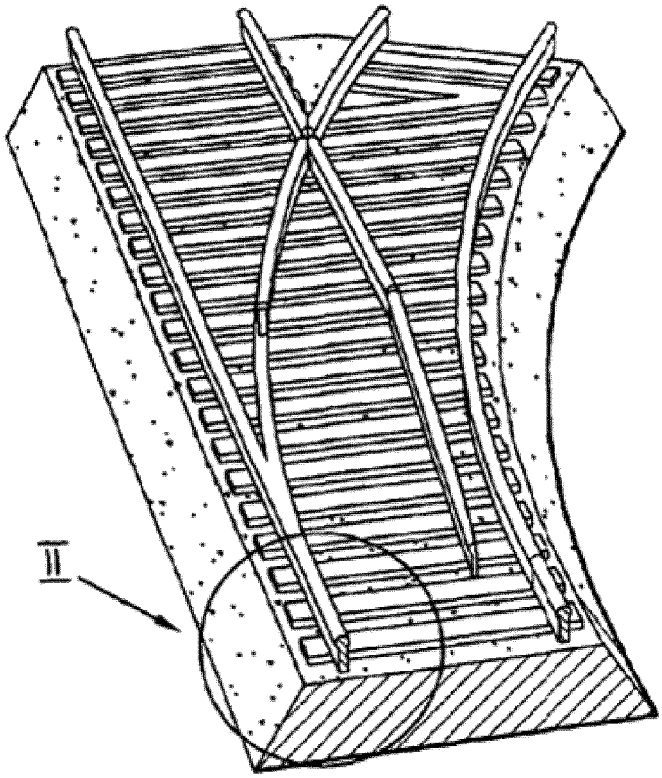

Fig. 3

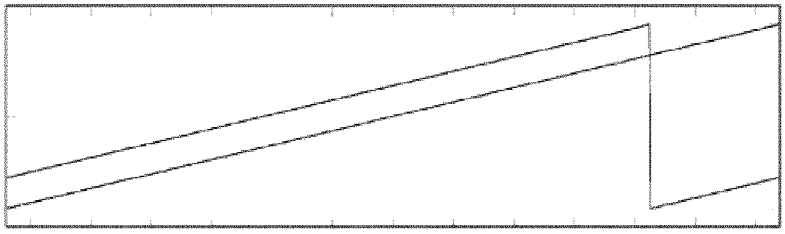

Fig. 4

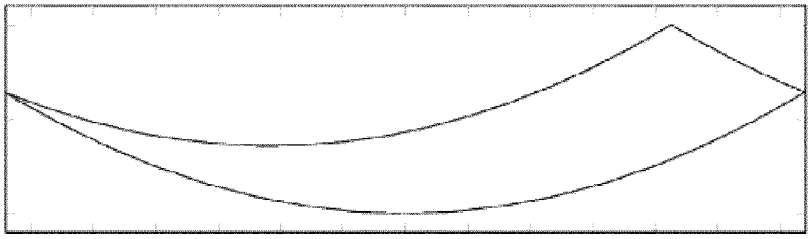

Fig. 5

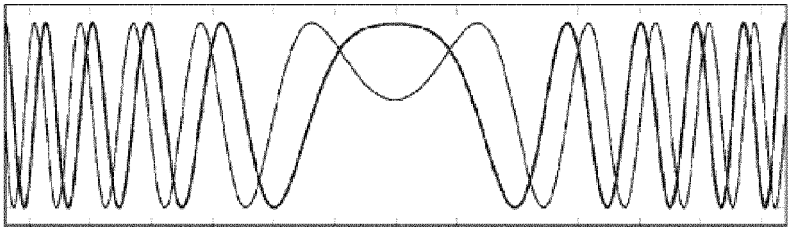

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 16 17 6071

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 October 2016	Robinson, Victoria

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

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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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