The invention describes an electronic processing apparatus (10) for determining railroad information, comprising a sensor adapted to provide a sensor signal representing a railroad property or a railroad event, a gateway adapted to communicate with the sensor and with a remote processing unit, and a mounting base (12) adapted to be fixedly mounted to a crosstie (14) of the railroad, wherein the mounting base (12) carries at least one electronic device (8) of the electronic processing apparatus (10).
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Electronic processing apparatus and method for mounting an electric processing apparatus

Description

The present invention relates to an electronic processing apparatus for determining railroad information, comprising a sensor adapted to provide a sensor signal representing a railroad property or a railroad event and a gateway adapted to communicate with the sensor and with a remote processing unit.

Railroad information is conventionally gathered by human track checkers walking along a section of the railroad and looking for damage or wear. In order to reduce maintenance costs, several surveillance devices have been developed which are to be moved along the track and which comprise detectors to detect physical and mechanical characteristics of the railroad. For example, a mechanized surveillance device is disclosed in FR 2 895 424 and comprises a hammer that creates shocks in a crosstie, wherein a response of the shock is detected by a sensor unit allowing determination as to a damage in the metal connection of the crosstie.

The use of conventional surveillance devices such as the device disclosed in FR 2 895 424 is limited to a condition when the railroad is not in use. The mobile platform of the known device needs to be moved to and from the place of the measurement which requires high workload and thus results in high maintenance costs.

It has therefore been an object of the present invention to provide an electronic processing apparatus for determining railroad information which reduces costs and workload for inspection and maintenance of railroads.
According to a first aspect of the present invention, this object is achieved by an electronic processing apparatus for determining railroad information, comprising: a sensor adapted to provide a sensor signal representing a railroad property or a railroad event and a gateway adapted to communicate with the sensor and with a remote processing unit, characterized by a mounting base adapted to be fixedly mounted to a crosstie of the railroad, wherein the mounting base carries at least one electronic device of the electronic processing apparatus. According to an important feature of the present invention, the mounting base which carries at least one electronic device is fixedly mounted to a crosstie of the railroad with the effect that the apparatus can be mounted to one of the most stable and solid parts of the railroad as well as at a position that avoids any interference with a passing train. Furthermore, the crosstie usually has an upper flat surface that allows both convenient and firm installation of the mounting base. At the same time, the crosstie is in close mechanical connection with the rails, such that, for example, movement or vibration of the rail is transmitted to the crosstie and can be detected by an acceleration sensor of the apparatus. Other sensor concepts are likewise conceivable. The gateway allows the transmission of sensor signals to a remote processing unit and/or the receipt of operation signals from the remote processing unit. Accordingly, by means of one or more electronic processing apparatuses according to the present invention, it will be possible to detect or monitor railway conditions such as increased wear or damage of the railroad. Therefore, cost and time necessary for maintenance of the railroad can be reduced.

The electronic processing apparatus preferably comprises at least one anchor element having a first portion connected to or adapted to be connected to the mounting base and a second portion adapted to be inserted into a hole of the crosstie such as to be fixedly mounted to the crosstie. Anchor elements allow a fixation of a mounting base with increased rigidity and stability. The electronic processing apparatus can therefore remain fixed
to the crosstie for a long period of time such as to allow continuous monitoring of the railroad. Furthermore, vibrations and other mechanical stress can be accommodated by such anchor elements with high reliability.

5 More preferably, the electronic processing apparatus further comprises a curing material adapted to establish a material bonded connection between the anchor element and the crosstie and/or between the mounting base and the crosstie. The use of an additional curing material results in an extremely rigid and firm connection between the electronic processing apparatus and the crosstie with the particular advantage that vibrations and other mechanical stresses will not lead to anchor elements becoming loose, in particular even if the electronic processing apparatus has a higher weight. For example, if the electronic processing apparatus includes a power source or an energy harvesting device and other electronic components to obtain a self-sustaining and independent apparatus, the weight of the apparatus can increase such that the forces acting at the connection between the mounting base and the crosstie increase as well. The use of anchor elements and, preferably the additional use of a curing material, allows such a complex and heavier apparatus to be fixedly and reliably mounted as a compact unit to the crosstie.

In a further embodiment of the invention, the mounting base may comprise a mounting plate, wherein a lower side of the mounting plate is adapted to be fixedly mounted onto an upper surface of the crosstie and an upper side of the mounting plate is carrying the at least one electronic device. By virtue of such a mounting plate, firm area contact can be realized between the apparatus and the crosstie in order to further improve the support of the apparatus on the crosstie. In addition, in cases where accelerator sensors are used, such sensors can be mounted to the crosstie via the mounting plate in order to ensure a reliable transmission of vibrations of the crosstie to the sensor. Therefore, the accuracy of the detected signal will be improved.
Furthermore, it is preferred that the electronic processing apparatus comprises a casing mounted to or provided at the mounting base, wherein the at least one electronic device is accommodate within the casing. A casing achieves protection of the electronic device from the surroundings to prevent damage or manipulation of the electronic device. The casing may be provided with a striking or noticeable color or marking such as to make an identification of the apparatus along the railroad easier.

In a further embodiment of the present invention the electronic processing apparatus may include a plurality of sensors each being adapted to provide a sensor signal representing a railroad property or a railroad event, wherein all sensors are adapted to communicate with the same gateway. In such a configuration, the accuracy of determination of railroad information can be increased by using the output signals of multiple sensors, wherein sensor signals from multiple sensors can be communicated through the same gateway in order to more effectively utilize hardware of the electronic processing apparatus. Preferably, the sensors are all accommodated within the same housing resulting in a compact apparatus which is easy to install and mount to the crosstie.

In a further embodiment of the invention the sensor may be adapted to detect a motion state of the railroad, in particular a motion state of the crosstie. Preferably, the motion state is an acceleration of the crosstie such as to detect vibrations of the crosstie with regard to its intensity, amplitude, frequency, etc. The motion state can be correlated to a certain railroad information, for example a certain condition of wear or damage based on calibration data or based on a change of the motion state over time.

When the sensor is adapted to detect a motion state, it is preferred that the sensor is rigidly mounted to the mounting base or to a sensor mounting body rigidly mounted to the mounting base, such that vibrations of the mounting base are transmitted to the sensor substantially without loss. Thereby, even
vibrations of small amplitude or high frequency can be detected by the sensor with high reliability and accuracy. On the other hand, a sensor may also be rigidly mounted, directly or via a sensor mounting body, to another railroad element, preferably a rail, such that vibrations of the other railroad element are transmitted to the sensor substantially without loss. Such a sensor may then be connected to the at least one electronic device at the mounting base, for example to the gateway, by means of a cable or wireless communication.

Preferably, the electronic processing apparatus is adapted to detect a time series of sensor signals, in particular a time series of motion states of the crosstie or a time series of motion states of another railroad element, which allows continuous or at least repeated monitoring of railroad information in order to detect changes due to wear or damage or even allow real-time monitoring of the railway.

In a preferred embodiment, the electronic processing apparatus may further comprise a wake-up/send-to-sleep unit adapted to switch the electronic processing apparatus between a ready state and lower-power consumption state according to predetermined conditions. This provides a concept to temporarily set the apparatus to a low-power consumption state in order to reduce the overall power consumption and to increase battery lifetime, for example. The wake-up/send-to-sleep unit may comprise a wake-up/send-to-sleep sensor for detecting a wake-up/send-to-sleep sensor signal, preferably representing a motion state of the crosstie, wherein the wake-up/send-to-sleep unit is adapted to switch the electronic processing apparatus between the ready state and the low-power consumption state based on a detected wake-up/send-to-sleep sensor signal. Thus, the electronic processing apparatus can switch from the low-power consumption state to the ready state as soon as vibration is detected indicating that a train passes. When the vibration decays indicating that the train has actually passed the sensor, the
wake-up/send-to-sleep unit may switch the electronic processing apparatus back to the low-power consumption state.

Furthermore, the wake-up/send-to-sleep unit may be adapted to switch the electronic processing apparatus between the ready state and the low-power consumption state based on a wake-up/send-to-sleep sensor signal received from a clock or from a remote processing unit, for example from another electronic processing apparatus.

In a further preferred embodiment of the invention, the electronic processing apparatus may comprise a power source adapted for self-sustaining operation of the electronic processing apparatus such that the apparatus can be operated independent from a power supply network, and installation as well as maintenance costs can be reduced.

In a further embodiment, it is preferred that the electronic processing apparatus further comprises an energy harvesting device adapted to generate electric power by collecting ambient energy from the surroundings, wherein the energy harvesting device is arranged to supply power to the gateway and/or the sensor. In this embodiment, maintenance of the electronic processing apparatus itself is reduced to a minimum, because even the exchange of batteries or recharging of batteries can be omitted.

The gateway of an electric processing apparatus of the present invention may comprise a wireless communication module adapted to send sensor data based on the sensor signal via a wireless communication, preferably via a mobile phone network or a Low-Power Network, to the remote processing unit, in particular to a remote server or to another electronic processing apparatus. A mobile phone network or a Low-Power Network is particular advantageous for transmitting data over larger distances and at the same time allows operation at a minimum power consumption.
According to a second aspect of the present invention, the above object is achieved by a system comprising a plurality of electronic processing apparatuses according to the first aspect of the invention, a plurality of crossties, each of which having at least one of the plurality of electronic processing apparatuses fixedly mounted thereto, and a remote processing unit adapted to communicate with the plurality of electronic processing apparatuses to transmit sensor data and to derive railroad information from the sensor signals. With a system having a plurality of electronic processing apparatuses, centralized monitoring of railroad conditions of a longer part of a railroad becomes possible or even the centralized monitoring of a railroad network.

According to a third aspect of the present invention, the above object is achieved by a method for mounting an electronic processing apparatus according to the first aspect of the present invention to a crosstie of a railroad comprising the steps of drilling at least one hole in the crosstie, introducing a curing material into the hole, inserting an anchor element into the hole, wherein said anchor element is connected to the mounting base and/or the method further includes a step of connecting the mounting base to the anchor element. By a method according to the third aspect of the present invention, it becomes possible to mount an electronic processing apparatus of the first aspect of the invention or a number of electronic processing apparatuses according to the system of the second aspect of the present invention to a crosstie in such a manner that the connection is, on the one hand, very rigid and solid to guarantee a long lifetime in the field and enhanced transmission of vibrations and, on the other hand, can be carried out using standard tooling and without specific expert knowledge. Installation time and maintenance costs are therefore reduced.

Preferably, the method of the third aspect of the invention may further include a step of applying a curing material to a lower surface of the mounting base and/or to an upper surface of the crosstie and establishing material bonded
surface contact between the two surfaces via said curing material. Not only can the solidity and strength of the fixation of the apparatus be enhanced to avoid that the apparatus becomes loose over a longer period of time in the field, but furthermore the additional curing material between a lower surface of the mounting base and an upper surface of the crosstie can also enhance the transmission of vibrations from the crosstie to the electronic processing apparatus which can be particularly advantageous if the sensor includes a motion sensor, for example an acceleration sensor. Even vibrations of smaller amplitude and/or higher frequency will be transmitted reliably from the crosstie to the sensor and sensor signals can be obtained with high accuracy.

A specific embodiment of the present invention will be described below with reference to the attached drawings in which

Fig. 1A shows a schematic cross-sectional view of an electronic processing apparatus according to the embodiment as attached to a crosstie,

Fig. 1B shows a schematic top view of an electronic circuit of the electronic processing apparatus according to the embodiment of the invention,

Fig. 2 shows a perspective view of the crosstie in a first step of a method for mounting an electronic processing apparatus according to an embodiment of the present invention,

Figs. 3-6 show further steps of the method for mounting the electronic processing apparatus by means of cross-sectional views of the crosstie,
Fig. 7 shows a perspective view as well as two partial views of a mounting base of the electronic processing apparatus during a later step of the method for mounting an electronic processing apparatus, and

Fig. 8 shows a perspective view of the crosstie and the electronic processing apparatus in a final step of the method for mounting the electronic processing apparatus.

An electronic processing apparatus 10 is shown in Figs. 1A and 1B as comprising a mounting base 12 for fixing the apparatus 10 to a crosstie 14 of a railroad, and a casing 16 mounted on the mounting base 12. Casing 16 accommodates an electronic circuit 18 having at least one electronic device. In the present embodiment, the electronic circuit 18, as illustrated in more detail in Fig. 1B, is implemented by a circuit board carrying circuitry and electronic devices such as a sensor 22 adapted to provide a sensor signal representing a railroad property or a railroad event, a gateway 24 adapted to communicate with the sensor and with a remote processing unit 26, a power source 28 such as a battery adapted for self-sustaining operation of the electronic processing apparatus 10, a wake-up/send-to-sleep unit 30 adapted to switch the electronic processing apparatus 10 between a ready state and a low-power consumption state, a storage unit 32 for storing data and/or signals, and a processing unit 34 such as a CPU.

The mounting base is preferably formed by a solid plate having a lower side 36 adapted to establish surface contact with an upper side 38 of the crosstie 14, wherein an upper side of the mounting base 12 carries circuit board 20 and housing 16. A plurality of anchor elements 42 are provided to fix the mounting base 12 to the crosstie 14. Furthermore, housing 16 may be fixed to the mounting base by means of a plurality of screws 43 or any other suitable connection.
A method for mounting the electronic processing apparatus according to the embodiment of the invention is now described in more detail with reference to Figs. 2 to 8.

At the start of the mounting method a suitable crosstie is chosen on which the apparatus 10 is to be mounted. It is preferred to mount the apparatus 10 on a crosstie that is subject to large vertical forces or vibrations of relatively high amplitude, because wear and damage are expected to occur first at such crossties. Preferably, at least one electronic processing apparatus is mounted on a crosstie of a turnout (track switch), for example near a crossing nose of a turnout. Not only is this part of the railroad especially prone to wear and damage, but also the function of a turnout may additionally be monitored by the electronic processing apparatus. Most preferably, an electronic processing apparatus is mounted in a region of up to three crossties before or after the tip of a crossing nose of a turnout.

In a further step shown in Figs. 2 and 3, holes 44 are drilled into the crosstie 14 in a vertical direction from the upper side 38, for example by using a drill hammer. Preferably, the holes 44 have a diameter between 6 mm and 14 mm and a depth between 50 mm and 100 mm. Best results have been achieved by using holes with a diameter of 10 mm and a depth of 75 to 80 mm. To assist the drilling procedure, a drilling rig 45 may be used that positively fits to the upper side of the crosstie and allows an easy finding of the right position of the at least one holes 44.

In a further step of the mounting method, illustrated in Fig. 4, a curing material 46 is inserted into hole 44. The curing material 46 may be a suitable glue that can be inserted into hole 44 in a liquid, semi-liquid or granular condition.

In a further preferred embodiment, the curing material 46 is included in a cartridge 48 that has a cylindrical shape adapted to be partially or completely
inserted into the hole 44. The advantage of using such a cartridge 48 is that it may contain the exact amount of curing material 46 that is required for the hole. Furthermore it ensures that the worker will not come into contact with the curing material 46.

The cartridge 48 can be made of a breakable material such as glass or a breakable plastic material. The cartridge can then be destroyed by the worker after having been inserted into the hole 44. For example, the cartridge 48 can be of such size that it slightly stands out of the hole 44 making it easier for the worker to break the top of the cartridge 48 by any suitable tool or by an anchor element to be placed into the hole 44.

In a further step of the mounting method an anchor element 42 is inserted into hole 44 such that a first portion 50 of anchor element 42 stands out of the hole 44 and a second portion 52 of anchor element 42 is placed inside the hole 44. The insertion of the anchor element 42 can be done by using a suitable tool such as a setting tool or a drill hammer, and the first portion 50 may have any suitable tool engagement portion such as a thread 54 in order to allow engagement of the tool for inserting the anchor element 42. As the anchor element 42 penetrates the hole 44, the curing material may slightly ooze out of the hole 44 as can be seen at reference signs 56 in Fig. 6. This may indicate that hole 44 is sufficiently filled with curing material 46. Excessive curing material may be removed from the crosstie 14.

The curing material 46 is then allowed to cure or dry. Depending on the material used as a curing material, this may take a time of a couple of minutes.

In a further step of the mounting method as depicted in Fig. 7, the plate-shaped mounting base 12 is placed at the upper side 38 of crosstie 14 such that through-holes 58 of the mounting base 12 are receive the first portions 50 of the anchor elements 42. Preferably, another curing material which may
be the same curing material 48 as used for anchor elements 42 or may be a different material, is applied to the lower side 36 of mounting base 12 and/or to the upper side 38 of crosstie 14 in order to establish additional material bonded surface contact between mounting base 12 and crosstie 14.

When approaching mounting base 12 to a crosstie 14 in a correct position, the first portion 50 of the anchor elements 42 will engage through-holes 58 of mounting base 12 and will stand out at an upper side 60 of mounting base 12. In the preferred embodiment, the first portion 50 is provided with threads 54 which allows to fix the mounting base 12 to the anchor element 42 by means of a suitable threaded nut 62. As can be seen in the example shown in Fig. 7, a connection can be made by using a washer 64 between nut 62 and mounting base 12 and by providing an additional lock nut 66 securing nut 62.

It should be noted that mounting base 12 further may include an indication such as an arrow 68 which ensures that the mounting base 12 is mounted in the correct position, for example such that arrow 68 is aligned with the main running direction of the railroad.

In a further step of the mounting method, housing 16 which includes the electronic circuit 18, is to be mounted to mounting base 12. In a preferred embodiment, the connection between housing 16 and mounting base 12 is established by an additional screw connection using a plurality of screws 43 engaging in corresponding holes of either housing 16 or mounting base 12.

As can be seen in the upper drawing of Fig. 7, a sealing lip 72 may be provided between mounting base 12 and housing 16 along an outer perimeter of the contact area between these two elements in order to avoid moisture or liquids to enter the gap between housing 16 and mounting base 12.

Furthermore, in a particular example of the invention, housing 16 comprises a lower housing part 74 and an upper housing part 76 attached and
connected to one another by means of housing screws 78 such as to form a sealed cavity therebetween, in which the electronic circuit 18 is arranged. Lower housing part 74 may be formed by a plate to achieve good surface contact with the plate shaped mounting base 12. Lower housing part 74 forms a sensor mounting body as mentioned in the claims. By using a sealed housing 16, the electronic circuit 18 can be protected even during the mounting procedure and the method of mounting the electronic processing apparatus 10 becomes easier and more reliable.

After fixing the housing 16 to the mounting base 12, the electronic processing apparatus 10 is firmly connected to the crosstie 14 and can be set into operation.

An example of a mode of operation of the sensor will be explained in the following. In this example it is assumed that a plurality of electronic processing apparatuses 10 have been installed at particular crossties along a railroad track. Each apparatus is powered by its power supply unit 28 which may be a battery, preferably a primary battery, but which may alternatively be formed by a rechargeable battery or an energy harvesting device adapted to generate electric power by collecting ambient energy from the surroundings.

Measurements and data communication are usually not desired continuously, but only at certain times. If no measurement or data communication is to be carried out, the electronic circuit 18 is switched to a low power consumption state. The wake-up/send-to-sleep unit 30 decides that the electronic processing apparatus 10 is to be switched to a ready state on the basis of, for example, a signal received from a clock or from remote processing unit 26. In such an embodiment, the ready state could be activated for a certain time of the day when certain train passing events are to be expected according to a train schedule. As a further example, the wake-up/send-to-sleep unit 30 could receive a signal from a wake-up/send-to-sleep sensor 31 which indicates a certain event or condition for which measurement or data
communication is desired. For example, the wake-up/send-to-sleep sensor 31 could be a vibration sensor or an acoustic sensor, and the wake-up/send-to-sleep unit 30 may switch to the ready mode if vibration or sound detected by sensor 31 exceeds a certain threshold value indicating a train passing event. Preferably, the wake-up/send-to-sleep sensor 31 is operable continuously under extremely low-power consumption. As a further option, sensor 31 may collect its energy from the surroundings (energy harvesting), which could be realized, for example, by using a Piezo-electric device.

After setting the electronic processing apparatus 10 to a ready state, sensor 22 starts measuring, for example measuring an acceleration in the vertical direction, in order to detect vibration of the crosstie 14. The sensor signal of sensor 22 is transmitted to processing unit 34 for further processing, to storing unit 32 for storing the signal or to gateway 24 for further transmission of the signal to remote processing unit 26. Transmission of sensor signals 22 to gateway 24 or storing unit 32 are preferably carried out via processing unit 34, such that a certain algorithm run by processing unit 34 can be used to control the operation of the electronic processing apparatus 10. In a further embodiment, the gateway may also be adapted to receive data from remote processing unit 26 to allow the operation of electronic processing apparatus 10 to be controlled remotely.

In a preferred embodiment of the invention, sensor 22 detects a time series of sensor signals which are stored in storing unit 32. The gateway 24 is controlled to send packages of sensor signals or a time series stored in the storing unit 32, i.e. not continuously but only at predetermined times, for example either at the end of a measurement or a train passing event or at certain times according to a time table. Since operation of the gateway 24 involves relatively high power consumption, storing multiple sensor signals in storing unit 32 and transmitting packages of multiple sensor signals or data processed from such sensor signals by processing unit 34 through gateway 24 at only certain points in time will achieve an improved power management
and reduction in power consumption of the electronic processed apparatus 10.

Gateway 24 preferably uses a mobile phone network or a Low-Power Network which allows to send data over a large distance to the remote processing unit 26, preferably over a distance of more than 12 km, if necessary, while requiring only a minimum of electric energy.
Claims

1. Electronic processing apparatus (10) for determining railroad information, comprising:
   - a sensor (22) adapted to provide a sensor signal representing a railroad property or a railroad event and
   - a gateway (24) adapted to communicate with the sensor (22) and with a remote processing unit (26),
   characterized by
   a mounting base (12) adapted to be fixedly mounted to a crosstie (14) of the railroad, wherein the mounting base (12) carries at least one electronic device (20, 22, 24, 28, 30, 31, 32, 34) of the electronic processing apparatus (10).

2. Electronic processing apparatus (10) according to claim 1, characterized in that it further comprises at least one anchor element (42) having a first portion (50) connected to or adapted to be connected to the mounting base (12) and a second portion (52) adapted to be inserted into a hole (44) of a crosstie (14) such as to be fixedly mounted to the crosstie (14).

3. Electronic processing apparatus (10) according to claim 1 or claim 2, characterized in that it further comprises a curing material (46) adapted to establish a material bonded connection between the anchor element (42) and the crosstie (14) and/or between the mounting base (12) and the crosstie (14).

4. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the mounting base (12) comprises a mounting plate, wherein a lower side (36) of the mounting plate is adapted to be fixedly mounted onto an upper surface (38) of a crosstie (14) and an
upper side (60) of the mounting plate is carrying the at least one electronic device (20, 22, 24, 28, 30, 31, 32, 34).

5. Electronic processing apparatus (10) according to any of the preceding claims, characterized by a casing (16) mounted to the mounting base (12), wherein the at least one electronic device (20, 22, 24, 28, 30, 31, 32, 34) is accommodated within the casing (16).

6. Electronic processing apparatus according to any of the preceding claims, characterized in that it includes a plurality of sensors each being adapted to provide a sensor signal representing a railroad property or a railroad event, wherein all sensors are adapted to communicate with the same gateway.

7. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the sensor (22) is adapted to detect a motion state of the railroad, in particular a motion state of the crosstie (14).

8. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the sensor (22) is rigidly mounted to the mounting base or to a sensor mounting body (74) rigidly mounted to the mounting base (12), such that vibrations of the mounting base (12) are transmitted to the sensor (22) substantially without loss.

9. Electronic processing apparatus according to any of the preceding claims, characterized in that the sensor is rigidly mounted, directly or via a sensor mounting body, to another railroad element, preferably to a rail, such that vibrations of the other railroad element are transmitted to the sensor substantially without loss.

10. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the electronic processing apparatus
(10) is adapted to detect a time series of sensor signals, in particular a time series of motion states of the crosstie (14) or a time series of motion states of another railroad element.

11. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the electronic processing apparatus (10) further comprises a wake-up/send-to-sleep unit (30) adapted to switch the electronic processing apparatus (10) between a ready state and a low-power consumption state according to predetermined conditions.

12. Electronic processing apparatus (10) according to claim 11, characterized in that the wake-up/send-to-sleep unit (30) comprises a wake-up/send-to-sleep sensor (31) for detecting a wake-up/send-to-sleep sensor signal, preferably a motion state of the crosstie (14), and wherein the wake-up/send-to-sleep unit (30) is adapted to switch the electronic processing apparatus (10) between the ready state and the low-power-consumption state based on detected wake-up/send-to-sleep sensor signal.

13. Electronic processing apparatus (10) according to claim 11 or claim 12, characterized in that the wake-up/send-to-sleep unit (30) is adapted to switch the electronic processing apparatus (10) between the ready state and the low-power-consumption state based on a wake-up/send-to-sleep sensor signal received from a clock or from a remote processing unit (26) or from another electronic processing apparatus (10).

14. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the electronic processing apparatus (10) further comprises a power source (28) adapted for self-sustaining operation of the electronic processing apparatus (10).

15. Electronic processing apparatus according to any of the preceding claims, characterized in that it further comprises an energy harvesting device
adapted to generate electric power by collecting ambient energy from the surroundings, wherein the energy harvesting device is arranged to supply power to the gateway and/or the sensor.

16. Electronic processing apparatus (10) according to any of the preceding claims, characterized in that the gateway (24) comprises a wireless communication module adapted to send sensor data based on the sensor signal via a wireless communication, preferably via a mobile phone network or a Low-Power Network, to the remote processing unit (26), in particular to a remote server or to another electronic processing apparatus (10).

17. System comprising
   a plurality of electronic processing apparatuses (10) according to any of the preceding claims,
   a plurality of crossties (14), each of which having at least one of the plurality of electronic processing apparatuses (10) fixedly mounted thereto, and
   a remote processing unit (26) adapted to communicate with the plurality of electronic processing apparatuses (10) to transmit sensor data and to derive railroad information from the sensor signals.

18. Method for mounting an electronic processing apparatus (10) according to any of claims 1 to 16 to a crosstie (14) of a railroad, comprising the steps of:
   - drilling at least one hole (44) in the crosstie (14),
   - introducing a curing material (46) into the hole (44),
   - inserting an anchor element (42) into the hole,

wherein said anchor element (42) is connected to the mounting base (12) and/or the method further includes a step of connecting the mounting base (12) to the anchor element (42).
19. Method according to claim 18, characterized by further including a step of applying curing material (46) to a lower surface (36) of the mounting base (12) and/or to an upper surface (38) of the crosstie (14) and establishing material bonded surface contact between the two surfaces (36, 38) via said curing material (46).
A. CLASSIFICATION OF SUBJECT MATTER

INV. B61L23/04 B61L27/00

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61L

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

E. ELECTRONIC DATABASE CONSULTED DURING THE INTERNATIONAL SEARCH (NAME OF DATABASE AND, WHERE PRACTICAL, SEARCH TERMS USED)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>X</td>
<td>WO 2014/184253 A2 (SELEX ES LTD [GB]) 20 November 2014 (2014-11-20) abstract; figure 2 page 1, line 30 - page 4, line 5 page 5, lines 20-27</td>
<td>1,4-17</td>
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<td>Y</td>
<td>WO 2015/025188 A2 (AMSTED RAI L CO INC [US]) 26 February 2015 (2015-02-26) abstract; figures 1, 3 paragraphs [0002], [0012], [0015] paragraphs [0028] - [0029], [0034]</td>
<td>1-6,8, 10, 14-16</td>
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Date of the actual completion of the international search: 27 July 2018

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