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(54) **WAYSIDE TRAIN HOT BEARING DETECTION SYSTEM**

GLEISSEITIGES HEISSLÄUFER-DETEKTIONSSYSTEM

SYSTÈME DE DÉTECTION DE ROULEMENTS CHAUDS DE TRAINS SITUÉ EN BORDURE DE VOIE

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Description

Technical Field

[0001] This disclosure generally relates to the field of rail transportation, and to the field of infrared detectors for undercarriage components of trains. This disclosure relates, more particularly, to the rail vehicles diagnostics and the rail reliability by means of the temperature detection of train wheels or train wheel bearings, via infrared detectors.

Background

[0002] Reliable operation of a railway system may be dependent upon the integrity of the undercarriage components of rail vehicles. Worn or damaged undercarriage components, such as train wheels or train wheel bearings, may increase the rolling friction of an axle thereby leading to a potential damage.

[0003] In addition, worn or damaged undercarriage components, such as train wheel bearings, may cause excessive wear to the train axle and, in the case of failure of the bearing, may even cause the axle to lock up by preventing rotation of the wheel and thus resulting in a potential fire hazard due to the heat build-up, a potential sparking caused by friction of the locked wheel scraping along the rail, or at worst a potential derailment of the rail vehicle.

[0004] A hot bearing detection equipment measures and detects bearing temperatures thus making a diagnostic service to the rolling stock owners and to the rail infrastructure managers to increase the reliability of the train circulation.

[0005] Bearing temperatures may be detected by sensing a temperature of the wheel bearing indirectly through a bearing box surrounding the wheel bearing on the rail vehicle. For example, infrared radiation (IR) detectors may be mounted along a railway to detect IR energy emitted by an outer wheel bearing of passing rail vehicles. The emissions of IR energy may be indicative of a temperature of the wheel bearing.

[0006] Bearing temperatures may be measured by IR detectors that comprise sensing elements aimed at different parts of a target scanning area of the rail vehicle undercarriage component. The IR data obtained may be used to generate respective scanning signature waveform data corresponding to each different region. The IR detectors may be oriented so that at least one of the sensing elements receives unobstructed infrared emissions from the undercarriage component passing over the IR detector.

[0007] A control circuit for the IR detectors may cause an alarm to be raised if the IR data is indicative of temperature that is higher than a pre-set temperature threshold.

[0008] A prior art hot bearing detection system is known e.g. from document US 4,491,290, which includes

temperature IR detectors, two wheel detectors located close to the IR detectors and two further wheel detectors located respectively upstream and downstream thereof.

[0009] However, the known hot bearing detection equipment, built by IR detectors, electronic or hardware elements and software elements, is not reliable, intended as the CENELEC (European Committee for Electrotechnical Standardization) standards refer, in particular standards EN50126, EN50128 and EN50129.

[0010] CENELEC standards EN50126, EN50128 and EN50129 provide guidance on RAMS (Reliability, Availability, Maintainability and Safety) for the rail industry, and define a SIL (Safety Integrity Level) that can have value 1, 2, 3 or 4.

[0011] The origin of the hot bearing detection comes from general railway diagnostic systems which are not reliability-related, therefore very limited accounting for the above CENELEC standards.

[0012] The aim of the present disclosure is to provide a wayside train hot bearing detection system that is directed, at least in part, to improving or overcoming one or more aspects of the prior art system.

[0013] Within the scope of this aim, an object of the invention is to provide a wayside train hot bearing detection system architecture that complies with a SIL (Safety Integrity Level) of 2, 3 or 4 according to above-mentioned CENELEC standards.

Brief Summary of the Invention

[0014] The present disclosure describes a wayside train hot bearing detection system, comprising an upstream wheel detector and a downstream wheel detector arranged at a railway track, both connected to a wheel detectors management group which comprises a first wheel detectors management unit, and a plurality of temperature IR detectors connected to the first wheel detectors management unit, characterized in that:

the system further comprises a first synchronization wheel detector and a second synchronization wheel detector arranged at the railway track between the upstream wheel detector and the downstream wheel detector;

the wheel detectors management group further comprises a second wheel detectors management unit; the first synchronization wheel detector is connected to the first wheel detectors management unit, the second synchronization wheel detector is connected to the second wheel detectors management unit, and the upstream wheel detector and the downstream wheel detector are connected to both the first wheel detectors management unit and the second wheel detectors management unit; and

the first wheel detectors management unit and the second wheel detectors management unit are both configured for sending activation signals whenever they receive detection signals from the upstream

wheel detector or the downstream wheel detector, and for sending synchronization signals whenever they receive detection signals from the first synchronization wheel detector and the second synchronization wheel detector, respectively.

Brief Description of the Drawings

[0015] The foregoing and other features and advantages of the present disclosure will be more fully understood to those skilled in the art from the following description of various embodiments of the wayside train hot bearing detection system according to the disclosure, when read together with the accompanying drawings, in which:

Figure 1 is a block diagram that schematically shows a first embodiment of the wayside train hot bearing detection system according to the present disclosure;

Figure 2 is a block diagram that schematically shows a second embodiment of the wayside train hot bearing detection system according to the present disclosure;

Figure 3 is a block diagram that schematically shows a detail of the embodiments of the wayside train hot bearing detection system of Figures 1 and 2;

Figure 4 is a multiple graph over time that shows the synchronization process of an embodiment of the wayside train hot bearing detection system according to the present disclosure;

Figure 5 shows schematically an arrangement along a railway track of a portion of an embodiment of the wayside train hot bearing detection system according to the present disclosure.

Detailed Description

[0016] This disclosure relates to a wayside train hot bearing detection system, generally designated by the reference numeral 10, for the rail vehicles diagnostics and the rail reliability by means of the temperature detection of rail vehicle undercarriage components, in particular train wheel or train wheel bearings, via IR detectors.

[0017] With reference to Figure 5, the wayside train hot bearing detection system 10 may be located along a portion of a railway track 50 for detecting and analyzing the temperature of the wheel bearing of passing rail vehicles. The system 10 comprises wheel detectors 12, 14, 16 and 16' that may be positioned in a rail bed of the railway track 50, for example at the longitudinal sides of, or within, a cross tie or a sleeper.

[0018] With reference to the Figures 1, 2 and 3, the system 10 comprises an upstream wheel detector 12 (abbreviated as "RR" in Figures) arranged at the railway track 50, for example at a longitudinal side of, or within, a cross tie or a sleeper. The upstream wheel detector 12 is configured for sending respective detection signals,

for example of the analog type, for example an impulse, whenever a wheel of a rail vehicle passes over it. The upstream wheel detector 12 may comprise two coils. The upstream wheel detector 12 is connected to a wheel detectors management group 42. Preferably, this connection comprises two channels 40.

[0019] The system 10 comprises a downstream wheel detector 14 (abbreviated as "GR" in Figures) arranged at the railway track 50, for example at a longitudinal side of, or within, a cross tie or a sleeper. The downstream wheel detector 14 is configured for sending respective detection signals, for example of the analog type, for example an impulse, whenever a wheel of a rail vehicle passes over it. The downstream wheel detector 14 may comprise two coils. The downstream wheel detector 14 is connected to the wheel detectors management group 42. Preferably, this connection comprises two channels 40.

[0020] The upstream wheel detector 12 and the downstream wheel detector 14 are positioned far from each other along a railway track 50, for example at 30 to 100 meters of distance.

[0021] The system 10 comprises a first synchronization wheel detector 16 (abbreviated as "MK" in Figures) and a second synchronization wheel detector 16' (abbreviated as "MK'" in Figures) arranged at the railway track 50, for example at the longitudinal sides of, or within, a same cross tie or a same sleeper. The first synchronization wheel detector 16 and the second synchronization wheel detector 16' are configured for sending respective detection signals, for example of the analog type, for example an impulse, whenever a wheel of a rail vehicle passes over them. The first synchronization wheel detector 16 and the second synchronization wheel detector 16' may comprise two coils, respectively. The first synchronization wheel detector 16 and the second synchronization wheel detector 16' are independently connected to the wheel detectors management group 42. Preferably, this connection comprises two channel 40.

[0022] The first synchronization wheel detector 16 and the second synchronization wheel detector 16' are positioned at the railway track 50 between the upstream wheel detector 12 and the downstream wheel detector 14. For example, along a railway track 50, the upstream wheel detector 12 may be positioned at a distance of 30 to 100 meters before the first 16 and the second 16' synchronization wheel detectors; the first synchronization wheel detector 16 and the second synchronization wheel detector 16' may be positioned at a distance of one meter or less from each other; and the downstream wheel detector 14 may be positioned at a distance of 30 to 100 meters after the first 16 and the second 16' synchronization wheel detectors.

[0023] As above-mentioned, the systems 10 comprises a wheel detectors management group 42. The wheel detectors management group 42 is connected to an Ethernet bus 38. The wheel detectors management group 42 comprises a first wheel detectors management unit

18 (abbreviated as "SP" in Figures) and a second wheel detectors management unit **18'** (abbreviated as "SP'" in Figures).

[0024] The first wheel detectors management unit **18** is directly connected to the upstream wheel detector **12** and the first synchronization wheel detector **16**; and the first wheel detectors management unit **18** is indirectly connected to the downstream wheel detector **14**. The upstream wheel detector **12** sends its detection signals to the first wheel detectors management unit **18**, when a wheel of a rail vehicle passes over it. The downstream wheel detector **14** sends its detection signals to the first wheel detectors management unit **18**, when a wheel of a rail vehicle passes over it. The first synchronization wheel detector **16** sends its detection signals to the first wheel detectors management unit **18**, when a wheel of a rail vehicle passes over it.

[0025] The first wheel detectors management unit **18** is configured for receiving the input detection signals directly from the upstream wheel detector **12** and indirectly from the downstream wheel detector **14**. The first wheel detectors management unit **18** is configured for turning on, i.e. for activating, the system **10** when it receives the detection signals from the upstream wheel detector **12** or the downstream wheel detector **14**. In particular, the first wheel detectors management unit **18** is configured for sending, preferably broadcasting, activation signals or datasets whenever it receives the detection signals from the upstream wheel detector **12** or the downstream wheel detector **14**.

[0026] The "indirect" connection between the downstream wheel detector **14** and the first wheel detectors management unit **18** means that a replica of the input detection signal, galvanically insulated, is provided. The galvanic separation element **36** provides this galvanically insulated replica.

[0027] The first wheel detectors management unit **18** is configured for receiving the input detection signals directly from the first synchronization wheel detector **16**. The first wheel detectors management unit **18** is configured for sending, preferably broadcasting, synchronization signals or datasets whenever it receives the detection signals from the first synchronization wheel detector **16**.

[0028] The first wheel detectors management unit **18** of the wheel detectors management group **42** is connected to the Ethernet bus **38**. The first wheel detectors management unit **18** sends activation signals or datasets to the Ethernet bus **38**. The Ethernet bus **38** receives activation signals or datasets from the first wheel detectors management unit **18**. The first wheel detectors management unit **18** sends synchronization signals or datasets to the Ethernet bus **38**. The Ethernet bus **38** receive synchronization signals or datasets from the first wheel detectors management unit **18**.

[0029] The second wheel detectors management unit **18'** is directly connected to the downstream wheel detector **14** and the second synchronization wheel detector

16'; and the second wheel detectors management unit **18'** is indirectly connected to the upstream wheel detector **12**. The upstream wheel detector **12** sends its detection signals to the second wheel detectors management unit **18'**, when a wheel of a rail vehicle passes over it. The downstream wheel detector **14** sends its detection signals to the second wheel detectors management unit **18'**, when a wheel of a rail vehicle passes over it. The second synchronization wheel detector **16'** sends its detection signals to the second wheel detectors management unit **18'**, when a wheel of a rail vehicle passes over it.

[0030] The second wheel detectors management unit **18'** is configured for receiving the input detection signals indirectly from the upstream wheel detector **12** and directly from the downstream wheel detector **14**. The second wheel detectors management unit **18'** is configured for turning on, i.e. for activating, the system **10** when it receives the detection signals from the upstream wheel detector **12** or the downstream wheel detector **14**. In particular, the second wheel detectors management unit **18'** is configured for sending, preferably broadcasting, activation signals or datasets whenever it receives the detection signals from the upstream wheel detector **12** or the downstream wheel detector **14**.

[0031] The "indirect" connection between the upstream wheel detector **12** and the second wheel detectors management unit **18'** means that a replica of the input detection signal, galvanically insulated, is provided. The galvanic separation element **36** provides this galvanically insulated replica.

[0032] The second wheel detectors management unit **18'** is configured for receiving the input detection signals from the second synchronization wheel detector **16'**. The second wheel detectors management unit **18'** is configured for sending, preferably broadcasting, synchronization signals or datasets whenever it receives the detection signals from the second synchronization wheel detector **16'**.

[0033] In an embodiment, the system **10** comprises a pair of galvanic separation elements **36**: the first galvanic separation element **36** is connected between the upstream wheel detector **12** and the second synchronization wheel detector **18'**, and the second galvanic separation element **36** is connected between the downstream wheel detector **14** and the first wheel detectors management unit **18**.

[0034] By means of these galvanic separation elements **36**, a galvanically separated replica of the detection signal of the upstream wheel detector **12** is provided to the second wheel detectors management unit **18'**, and a galvanically separated replica of the detection signal of the downstream wheel detector **14** is provided to the first wheel detectors management unit **18**.

[0035] The system **10** comprises a plurality of temperature IR detectors **20** (abbreviated as "EPOS1", "EPOS2" and "EPOSn" in Figures) arranged along the railway track **50**. Preferably, the plurality of temperature IR detectors **20** are positioned at the railway track **50**

between the upstream wheel detector **12** and the downstream wheel detector **14**. The plurality of temperature IR detectors **20** are adapted to detect the temperature of the wheel bearing of passing rail vehicles. Preferably, the plurality of temperature IR detectors **20** are of the Easy Pull Out System type.

[0036] The plurality of temperature IR detectors **20** are directly connected to the first wheel detectors management unit **18**. The first wheel detectors management unit **18** directly sends activation signals or datasets to the plurality of temperature IR detectors **20**. The plurality of temperature IR detectors **20** directly receive activation signals or datasets from the first wheel detectors management unit **18**. The first wheel detectors management unit **18** directly sends synchronization signals or datasets to the plurality of temperature IR detectors **20**. The plurality of temperature IR detectors **20** directly receive synchronization signals or datasets from the first wheel detectors management unit **18**.

[0037] The plurality of temperature IR detectors **20** are connected to the Ethernet bus **38**. The plurality of temperature IR detectors **20** are configured for sending respective wheel bearing temperature signals or datasets to the Ethernet bus **38**. In an embodiment, each temperature IR detector **20** sends wheel bearing temperature signals or datasets comprising a buffer of **120** to **240** samples.

[0038] The first wheel detectors management unit **18** sends activation signals or datasets to the plurality of temperature IR detectors **20** via the Ethernet bus **38**. The plurality of temperature IR detectors **20** receive activation signals or datasets from the first wheel detectors management unit **18** via the Ethernet bus **38**. The first wheel detectors management unit **18** sends synchronization signals or datasets to the plurality of temperature IR detectors **20** via the Ethernet bus **38**. The plurality of temperature IR detectors **20** receive synchronization signals or datasets from the first wheel detectors management unit **18** via the Ethernet bus **38**.

[0039] The system **10** comprises a data elaboration group **44**. The data elaboration group **44** is connected to the Ethernet bus **38**. The wheel detectors management group **42** and the plurality of temperature IR detectors **20** are connected to the data elaboration group **44** via the Ethernet bus **38**.

[0040] The wheel detectors management group **42** sends activation signals or datasets to the data elaboration group **44** via the Ethernet bus **38**. The data elaboration group **44** receives activation signals or datasets from the wheel detectors management group **42** via the Ethernet bus **38**. The wheel detectors management group **42** sends synchronization signals or datasets to the data elaboration group **44** via the Ethernet bus **38**. The data elaboration group **44** receives synchronization signals or datasets from the wheel detectors management group **42** via the Ethernet bus **38**.

[0041] The plurality of temperature IR detectors **20** send respective wheel bearing temperature signals or

datasets to the data elaboration group **44** via the Ethernet bus **38**. The data elaboration group **44** receives wheel bearing temperature signals or datasets from the plurality of temperature IR detectors **20** via the Ethernet bus **38**.

[0042] The data elaboration group **44** comprises a vital processing unit **22** (abbreviated as "Vital SAFPL" in Figures) and a standard, or non-vital, processing unit **24** (abbreviated as "DE" in Figures). The vital processing unit **22** and the standard processing unit **24** are connected to each other, directly or via the Ethernet bus **38**.

[0043] The system **10** interfaces to a railway interlocking system **32** (abbreviated as "IXL" in Figures). The vital processing unit **22** is connected to the railway interlocking system **32**. The vital processing unit **22** is configured for analyzing the wheel bearing temperatures of passing rail vehicles, detected by the plurality of temperature IR detectors **20**, and for consequently generating vital data about the passing rail vehicles. The vital processing unit **22** is configured for sending an alarm signal or dataset, for example through a vital protocol, to the railway interlocking system **32** whenever a wheel bearing temperature of a passing rail vehicle, detected by the plurality of temperature IR detectors **20**, is higher than a pre-set wheel bearing temperature threshold.

[0044] When the railway interlocking system **32** receives an alarm signal or dataset from the vital processing unit **22**, the railway interlocking system **32** is configured for signaling to the train driver of the passing rail vehicle to stop the same rail vehicle due to failure of the detected wheel bearing, for example in order to avoid potential railway accidents. The railway interlocking system **32** signals to stop the passing rail vehicle by means of known railway signaling systems, for example rail traffic lights or semaphores.

[0045] The system **10** comprises a remote announcement display system **26** (abbreviated as "RAD" in Figures) to manage the hot bearing alarms. The standard processing unit **24** is connected to the remote announcement display system **26**. The standard processing unit **24** is configured for analyzing the wheel bearing temperatures of passing rail vehicles, detected by the plurality of temperature IR detectors **20**, and for consequently generating diagnostic data about the passing rail vehicles. The standard processing unit **24** is configured for sending the wheel bearing temperature signals or datasets and the diagnostic data of passing rail vehicles to the remote announcement display system **26**, that is operated by rail infrastructure managers.

[0046] The system **10** comprises an ambient temperature sensor **34** (abbreviated as "pt100" in Figures). The standard processing unit **24** is connected to the ambient temperature sensor **34**. The ambient temperature sensor **34** is adapted to detect the ambient temperature along the railway track **50**. The ambient temperature sensor **34** is configured for sending the ambient temperature to the standard processing unit **24**. The standard processing unit **24** is configured for receiving the ambient temperature from the ambient temperature sensor **34**. This am-

ambient temperature is used as a parameter for the definition of the above-mentioned pre-set wheel bearing temperature threshold: the higher the ambient temperature, the higher the temperature threshold; and the lower the ambient temperature, the lower the temperature threshold.

[0047] In an embodiment, the ambient temperature sensor 34 is of the analog type, and therefore an analog-to-digital converter 28 (abbreviated as "LEM" in Figures) may be connected between the standard processing unit 24 and the ambient temperature sensor 34.

[0048] In another embodiment, the ambient temperature sensor 34 is of the analog type, and therefore the standard processing unit 24 may comprise an analog-to-digital converter.

[0049] With reference to the Figure 1, the second wheel detectors management unit 18' of the wheel detectors management group 42 is connected to the Ethernet bus 38.

[0050] The second wheel detectors management unit 18' sends activation signals or datasets to the Ethernet bus 38. The Ethernet bus 38 receives activation signals or datasets from the second wheel detectors management unit 18'. The second wheel detectors management unit 18' sends synchronization signals or datasets to the Ethernet bus 38. The Ethernet bus 38 receives synchronization signals or datasets from the second wheel detectors management unit 18'.

[0051] The second wheel detectors management unit 18' sends activation signals or datasets to the plurality of temperature IR detectors 20 via the Ethernet bus 38. The plurality of temperature IR detectors 20 receive activation signals or datasets from the second wheel detectors management unit 18' via the Ethernet bus 38. The second wheel detectors management unit 18' sends synchronization signals or datasets to the plurality of temperature IR detectors 20 via the Ethernet bus 38. The plurality of temperature IR detectors 20 receive synchronization signals or datasets from the second wheel detectors management unit 18' via the Ethernet bus 38.

[0052] The vital processing unit 22 of the data elaboration group 44 is connected to the Ethernet bus 38. The Ethernet bus 38 sends activation signals or datasets to the vital processing unit 22. The vital processing unit 22 receives activation signals or datasets from the Ethernet bus 38. The Ethernet bus 38 sends synchronization signals or datasets to the vital processing unit 22. The vital processing unit 22 receives synchronization signals or datasets from the Ethernet bus 38. The Ethernet bus 38 sends wheel bearing temperature signals or datasets to the vital processing unit 22. The vital processing unit 22 receives wheel bearing temperature signals or datasets from the Ethernet bus 38.

[0053] The vital processing unit 22 is configured for sending, i.e. forwarding, the wheel bearing temperature signals or datasets to the standard processing unit 24. The standard processing unit 24 is configured for receiving the wheel bearing temperature signals or datasets from the vital processing unit 22.

[0054] The system 10 further comprises a second ambient temperature sensor 34' (abbreviated as "pt100" in Figures). The vital processing unit 22 is connected to the second ambient temperature sensor 34'. The second ambient temperature sensor 34' is adapted to detect the ambient temperature along the railway track 50. The second ambient temperature sensor 34' is configured for sending the ambient temperature to the vital processing unit 22. The vital processing unit 22 is configured for receiving the ambient temperature from the second ambient temperature sensor 34'. This ambient temperature is used as a parameter for the definition of the above-mentioned pre-set wheel bearing temperature threshold: the higher the ambient temperature, the higher the temperature threshold; and the lower the ambient temperature, the lower the temperature threshold.

[0055] In an embodiment, the second ambient temperature sensor 34' is of the analog type, and therefore the vital processing unit 22 may comprise an analog-to-digital converter.

[0056] In another embodiment, the second ambient temperature sensor 34' is of the analog type, and therefore an analog-to-digital converter may be connected between the vital processing unit 22 and the second ambient temperature sensor 34'.

[0057] The system 10 further comprises user interface means 30 (abbreviated as "Operator" in Figures) arranged at the railway track 50. The standard processing unit 24 is connected to user interface means 30 operated by a human user, i.e. a maintenance engineer or technician that works along the railway track 50.

[0058] With reference to the Figure 2, the second wheel detectors management unit 18' of the wheel detectors management group 42 is connected to a single temperature IR detector 20 of the plurality of temperature IR detectors 20.

[0059] The second wheel detectors management unit 18' sends activation signals or datasets to the single temperature IR detector 20. The single temperature IR detector 20 receives activation signals or datasets from the second wheel detectors management unit 18'. The second wheel detectors management unit 18' sends synchronization signals or datasets to the single temperature IR detector 20. The single temperature IR detector 20 receives synchronization signals or datasets from the second wheel detectors management unit 18'.

[0060] The standard processing unit 24 is configured for sending, i.e. forwarding, the wheel bearing temperature signals or datasets and the diagnostic data of passing rail vehicles to the vital processing unit 22. The vital processing unit 22 is configured for receiving the wheel bearing temperature signals or datasets and the diagnostic data of passing rail vehicles from the standard processing unit 24.

[0061] The system 10 further comprises a second standard, or non-vital, processing unit 24' (abbreviated as "DE" in Figures). The data elaboration group 44 further comprises a second standard, or non-vital, process-

ing unit **24'**. The vital processing unit **22** and the second standard processing unit **24'** are connected to each other, directly or via the Ethernet bus **38**.

[0062] The second standard processing unit **24'** is configured for analyzing the wheel bearing temperatures of passing rail vehicles, detected by the plurality of temperature IR detectors **20**, and for consequently generating diagnostic data about the passing rail vehicles.

[0063] The second standard processing unit **24'** is configured for sending, i.e. forwarding, the wheel bearing temperature signals or datasets and the diagnostic data of passing rail vehicles to the vital processing unit **22**. The vital processing unit **22** is configured for receiving the wheel bearing temperature signals or datasets and the diagnostic data of passing rail vehicles from the second standard processing unit **24'**.

[0064] The first **24** and the second **24'** standard processing units of the data elaboration group **44** are connected to the Ethernet bus **38**. The Ethernet bus **38** sends activation signals or datasets to the first **24** and the second **24'** standard processing units. The first **24** and the second **24'** standard processing units receive activation signals or datasets from the Ethernet bus **38**. The Ethernet bus **38** sends synchronization signals or datasets to the first **24** and the second **24'** standard processing units. The first **24** and the second **24'** standard processing units receive synchronization signals or datasets from the Ethernet bus **38**. The Ethernet bus **38** sends wheel bearing temperature signals or datasets to the first **24** and the second **24'** standard processing units. The first **24** and the second **24'** standard processing units receive wheel bearing temperature signals or datasets from the Ethernet bus **38**.

[0065] The system **10** further comprises a second ambient temperature sensor **34'** (abbreviated as "pt100" in Figures). The second standard processing unit **24'** is connected to the second ambient temperature sensor **34'**. The second ambient temperature sensor **34'** is adapted to detect the ambient temperature along the railway track **50**. The second ambient temperature sensor **34'** is configured for sending the ambient temperature to the second standard processing unit **24'**. The second standard processing unit **24'** is configured for receiving the ambient temperature from the second ambient temperature sensor **34'**. This ambient temperature is used as a parameter for the definition of the above-mentioned pre-set wheel bearing temperature threshold: the higher the ambient temperature, the higher the temperature threshold; and the lower the ambient temperature, the lower the temperature threshold.

[0066] In an embodiment, the second ambient temperature sensor **34'** is of the analog type, and therefore the second standard processing unit **24'** may comprise an analog-to-digital converter.

[0067] In another embodiment, the second ambient temperature sensor **34'** is of the analog type, and therefore an analog-to-digital converter may be connected between the second standard processing unit **24'** and the

second ambient temperature sensor **34'**.

[0068] With reference to the Figure **3**, the first synchronization wheel detector **16** is connected to the first wheel detectors management unit **18**, the second synchronization wheel detector **16'** is connected to the second wheel detectors management unit **18'**, and the upstream wheel detector **12** and the downstream wheel detector **14** are connected to both the first wheel detectors management unit **18** and the second wheel detectors management unit **18'**.

[0069] The first **18** and the second **18'** wheel detectors management units manage three wheel detectors, respectively. In particular, the first wheel detectors management unit **18** manages the upstream wheel detector **12**, the downstream wheel detector **14**, and the first synchronization wheel detector **16**; and the second wheel detectors management unit **18'** manages the upstream wheel detector **12**, the downstream wheel detector **14**, and the second synchronization wheel detector **16'**.

[0070] In simple words, the wheel detectors management group **42** of the system **10** allows the crossing connection of the first **18** and the second **18'** wheel detectors management units. This configuration allows to have a pair of operating wheel detectors management units, i.e. the first **18** and the second **18'** wheel detectors management units, with the addition of only one wheel detector, i.e. the second synchronization wheel detector **16'**. This configuration allows to increase the fault-tolerance of the wayside train hot bearing detection system **10**, for example in case of failure of one of the synchronization wheel detectors **16** or **16'**. Furthermore, this configuration allows the detection of a failure, for example when the first **18** and the second **18'** wheel detectors management units provide different data, therefore turning the system **10** in reliable-state.

[0071] The first **18** and the second **18'** wheel detectors management units have a respective power supply, preferably of **24 Vdc**. The upstream wheel detector **12** and the first synchronization wheel detector **16** are directly powered by the **24 Vdc** power supply of the first wheel detectors management unit **18**. The downstream wheel detector **14** and the second synchronization wheel detector **16'** are directly powered by the **24 Vdc** power supply of the second wheel detectors management unit **18'**.

[0072] With reference to the Figure **4**, the synchronization process of an embodiment of the wayside train hot bearing detection system **10** is described hereinafter.

[0073] At time t_1 , the first synchronization wheel detector **16** detects a passing wheel of a rail vehicle, and sends a corresponding detection signal. Consequently, the first wheel detectors management unit **18** receives the detection signal from the first synchronization wheel detector **16**, and sends a synchronization signal or dataset, in particular to the plurality of temperature IR detectors **20**.

[0074] Similarly, at time t_2 , the second synchronization wheel detector **16'** detects the same passing wheel of a rail vehicle, and sends a corresponding detection signal.

Consequently, the second wheel detectors management unit **18'** receives the detection signal from the second synchronization wheel detector **16'**, and sends a synchronization signal or dataset, in particular to the plurality of temperature IR detectors **20**.

[0075] The ideal exact measure time (abbreviated as *E-tm* in Figures) is in the middle of the interval *t1* to *t2*. Therefore, in formula, exact measure time $E-tm = (t1 + t2) / 2$.

[0076] Each temperature IR detectors **20** makes its estimate of measure time (abbreviated as *tm* in Figures) by the use of internal clock, rail vehicle speed and static delay. Therefore, in formula, measure time $tm1 = (t1 + static_delay) / 2$ for a first temperature IR detector **20**, and measure time $tm2 = (t2 + static_delay) / 2$ for a second temperature IR detector **20**.

[0077] For each axle, i.e. for each detected rail vehicle wheel bearing, the temperature IR detectors **20** send the corresponding wheel bearing temperature signal or dataset, for example graphically shown as graph **46** for the first temperature IR detector **20** and as graph **48** for the second temperature IR detector **20**. This wheel bearing temperature signal or dataset comprises the time-clock of the central sample of the dataset, in short "centering time", and the dataset width in millimeters, in short "d-width", estimated by the rail vehicle speed.

[0078] Both the first **18** and the second **18'** wheel detectors management units are configured for estimating the corresponding axle speed and position for each axle, and to send, preferably broadcast, these estimated axle speed and position, for example via the Ethernet bus **38**.

[0079] Furthermore, both the first wheel detectors management unit **18** and the second wheel detectors management unit **18'** are configured for sending, preferably broadcasting, the time-clock of the detection signals from the first synchronization wheel detector **16** and the second synchronization wheel detector **16'**, respectively. For example, the time-clock of the detection signal from the first synchronization wheel detector **16** corresponds to time *t1*, and the time-clock of the detection signals from the second synchronization wheel detectors **16'** corresponds to time *t2*.

[0080] The first standard processing unit **24** and the optional second standard processing unit **24'** are configured for verifying in each dataset that measure time *tm* and *d-width* are the same, within a tolerance (for example of 100 microseconds), in the first temperature IR detector **20** and the second temperature IR detector **20**, and for generating an integrity failure alarm in case an out-of-tolerance event is detected.

[0081] As above-mentioned, the system **10** comprises an Ethernet bus **38**, which is configured to operate according to the following features:

- each dataset that passes through the Ethernet bus **38** has a time-stamp to fulfill a data-fresh control requirement;
- each dataset that passes through the Ethernet bus

38 is discarded if the time-stamp is recognized delayed, for example of **50** to **100** milliseconds, or no longer valid, for example when a dataset with a more recent time-stamp is provided;

- each device of the system **10**, in particular the first wheel detectors management unit **18**, the second wheel detectors management unit **18'**, the plurality of temperature IR detectors **20**, the first standard processing unit **24**, and the optional second standard processing unit **24'**, needs a synchronization mechanism to ensure that its clock is aligned to the others, for example within **10** milliseconds of tolerance;
- a device of the system **10**, preferably the second wheel detectors management unit **18'**, periodically sends sync datasets to ensure the above clock is the same for all the devices of the system **10**;
- in case the system **10** comprises the optional second standard processing unit **24'**, the first standard processing unit **24** manages the first **18** and the second **18'** wheel detectors management units, and the plurality of temperature IR detectors **20**, through a protocol, for example a broadcast protocol such as UDP, that allows the optional second standard processing unit **24'** to get a copy of the datasets from the first **18** and the second **18'** wheel detectors management units, and the plurality of temperature IR detectors **20**.

[0082] The skilled person would appreciate that foregoing embodiments may be modified or combined to obtain the system **10** of the present disclosure.

Industrial Applicability

[0083] This disclosure describes a wayside train hot bearing detection system **10** that combines the rail vehicles diagnostics aspect and the rail reliability aspect, both using the temperature detection of train wheels or train wheel bearings, via IR infrared detectors **20**.

[0084] The wayside train hot bearing detection system **10** may be fault-tolerant, by redundancy, i.e. by the duplication of critical components of the system **10**, to comply with a certain SIL (Safety Integrity Level) that can have value 1, 2, 3 or 4 according to above-mentioned CENELEC standards. In particular, the fault-tolerance or the redundancy is achieved thanks to the above configuration of the wheel detectors **12**, **14**, **16** and **16'** and the wheel detectors management group **42**.

[0085] The temperature IR detectors **20** may be used to obtain temperature data from rail vehicle undercarriage components. The temperature data may be obtained by sensing a wheel or a wheel bearing of a rail vehicle passing over the wheel detectors **12**, **14**, **16** and **16'** and over the same temperature IR detectors **20**. The wheel detectors **12**, **14**, **16** and **16'** and the temperature IR detectors **20** may be located along a portion of a rail track **50**. Abnormal thermal readings may indicate the possibility of overheating of undercarriage components,

such as train wheels or train wheel bearings that are failing.

[0086] The system 10 may comprise a second wheel detectors management unit 18', similar to a first wheel detectors management unit 18, and connected to an upstream wheel detector 12, a downstream wheel detector 14, and a second synchronization wheel detector 16'. The second wheel detectors management unit 18' may be configured for sending, preferably broadcasting, activation signals or datasets whenever it receives the detection signals from the upstream wheel detector 12 or the downstream wheel detector 14. The second wheel detectors management unit 18' may be configured for sending, preferably broadcasting, activation or synchronization signals or datasets whenever it receives the corresponding detection signals from the second synchronization wheel detector 16'.

[0087] The system 10 may comprise a vital processing unit 22, connected to a railway interlocking system 32, and configured for sending an alarm signal or dataset to the railway interlocking system 32 whenever a wheel bearing temperature of a passing rail vehicle, detected by the temperature IR detectors 20, is higher than a preset wheel bearing temperature threshold, preferably defined in respect to the ambient temperature.

[0088] Preferably, the vital processing unit 22 is arranged before the standard processing unit 24, in order to give priority to the rail reliability aspect of the system 10 than the rail vehicles diagnostics aspect of the system 10.

[0089] Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein.

[0090] Where technical features mentioned in any claim are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, neither the reference signs nor their absence have any limiting effect on the technical features as described above or on the scope of any claim elements.

[0091] One skilled in the art will realize the disclosure may be embodied in other specific forms without departing from the disclosure or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting of the disclosure described herein. Scope of the invention is thus indicated by the appended claims, rather than the foregoing description, and all changes that come within the meaning and range of equivalence of the claims are therefore intended to be embraced therein.

Claims

1. Wayside train hot bearing detection system (10), comprising an upstream wheel detector (12) and a downstream wheel detector (14) arranged at a railway track (50), both connected to a wheel detectors management group (42) which comprises a first wheel detectors management unit (18), and a plurality of temperature IR detectors (20) connected to the first wheel detectors management unit (18), **characterized in that:**

the system (10) further comprises a first synchronization wheel detector (16) and a second synchronization wheel detector (16') arranged at the railway track (50) between the upstream wheel detector (12) and the downstream wheel detector (14);

the wheel detectors management group (42) further comprises a second wheel detectors management unit (18'); **characterised in that:**

the first synchronization wheel detector (16) is connected to the first wheel detectors management unit (18), the second synchronization wheel detector (16') is connected to the second wheel detectors management unit (18'), and the upstream wheel detector (12) and the downstream wheel detector (14) are connected to both the first wheel detectors management unit (18) and the second wheel detectors management unit (18'); and

the first wheel detectors management unit (18) and the second wheel detectors management unit (18') are both configured for sending activation signals whenever they receive detection signals from the upstream wheel detector (12) or the downstream wheel detector (14), and for sending synchronization signals whenever they receive detection signals from the first synchronization wheel detector (16) and the second synchronization wheel detector (16'), respectively.

2. Wayside train hot bearing detection system (10) of claim 1, wherein the system (10) further comprises a data elaboration group (44) comprising a standard processing unit (24), which is configured for analyzing the wheel bearing temperatures of a passing rail vehicle, detected by the plurality of temperature IR detectors (20), and for generating diagnostic data about the passing rail vehicle.
3. Wayside train hot bearing detection system (10) of claim 2, wherein the data elaboration group (44) further comprises a vital processing unit (22) connected

to a railway interlocking system (32), the vital processing unit (22) being configured for sending an alarm signal to the railway interlocking system (32) whenever a wheel bearing temperature of a passing rail vehicle, detected by the plurality of temperature IR detectors (20), is higher than a pre-set wheel bearing temperature threshold.

4. Wayside train hot bearing detection system (10) of claim 3, wherein the standard processing unit (24) is configured for sending the diagnostic data of the passing rail vehicle to the vital processing unit (22).
5. Wayside train hot bearing detection system (10) of any one of claims 2-4, wherein the standard processing unit (24) is connected to a first ambient temperature sensor (34), adapted to detect the ambient temperature along the railway track (50), and configured for sending the ambient temperature to the standard processing unit (24).
6. Wayside train hot bearing detection system (10) of claim 5, wherein an analog-to-digital converter (28) is connected between the standard processing unit (24) and the first ambient temperature sensor (34).
7. Wayside train hot bearing detection system (10) according to claim 3 and optionally also according to any of claims 4-6, wherein the vital processing unit (22) is connected to a second ambient temperature sensor (34'), adapted to detect the ambient temperature along the railway track (50), and configured for sending the ambient temperature to the vital processing unit (22).
8. Wayside train hot bearing detection system (10) of any one of claims 2-7, wherein the data elaboration group (44) further comprises a second standard processing unit (24') connected to the vital processing unit (22).
9. Wayside train hot bearing detection system (10) according to claims 7 and 8, wherein the second standard processing unit (24') is connected to the second ambient temperature sensor (34').
10. Wayside train hot bearing detection system (10) of any one of claims 2-9, wherein the standard processing unit (24) is connected to a remote announcement display system (26), the standard processing unit (24) being configured for sending the wheel bearing temperatures and the diagnostic data of the passing rail vehicle to the remote announcement display system (26).
11. Wayside train hot bearing detection system (10) of any one of claims 2-10, wherein the standard processing unit (24) is connected to user interface

means (30) arranged at the railway track (50) and operated by a human user.

12. Wayside train hot bearing detection system (10) of any one of claims 2-11, wherein the wheel detectors management group (42) and the plurality of temperature IR detectors (20) are connected to the data elaboration group (44) via an Ethernet bus (38).
13. Wayside train hot bearing detection system (10) of any one of preceding claims, wherein the plurality of temperature IR detectors (20) are of the Easy Pull Out System type.

Patentansprüche

1. Gleisseitiges Heißläufer-Detektionssystem (10), das einen stromaufwärts gelegenen Raddetektor (12) und einen stromabwärts gelegenen Raddetektor (14) umfasst, angeordnet an einem Bahngleis (50), die beide mit einer Raddetektor-Steuerungsgruppe (42) verbunden sind, welche eine erste Raddetektor-Steuerungseinheit (18) und eine Vielzahl von IR-Temperaturdetektoren (20), verbunden mit der ersten Raddetektor-Steuerungseinheit (18), umfasst; **dadurch gekennzeichnet, dass** das System (10) weiter einen ersten Synchronisierungs-Raddetektor (16) und einen zweiten Synchronisierungs-Raddetektor (16'), angeordnet am Bahngleis (50) zwischen dem stromaufwärts gelegenen Raddetektor (12) und dem stromabwärts gelegenen Raddetektor (14), umfasst; die Raddetektor-Steuerungsgruppe (42) weiter eine zweite Raddetektor-Steuerungseinheit (18') umfasst; **dadurch gekennzeichnet, dass** der erste Synchronisierungs-Raddetektor (16) mit der ersten Raddetektor-Steuerungseinheit (18) verbunden ist, der zweite Synchronisierungs-Raddetektor (16') mit der zweiten Raddetektor-Steuerungseinheit (18') verbunden ist und der stromaufwärts gelegene Raddetektor (12) und der stromabwärts gelegene Raddetektor (14) sowohl mit der ersten Raddetektor-Steuerungseinheit (18) als auch mit der zweiten Raddetektor-Steuerungseinheit (18') verbunden sind; und sowohl die erste Raddetektor-Steuerungseinheit (18) als auch die zweite Raddetektor-Steuerungseinheit (18') konfiguriert sind, um immer dann Aktivierungssignale zu senden, wenn sie Detektionssignale vom stromaufwärts gelegenen Raddetektor (12) oder vom stromabwärts gelegenen Raddetektor (14) empfangen, und immer dann Synchronisationssignale zu senden, wenn sie Detektionssignale vom ersten Synchronisierungs-Raddetektor (16) beziehungsweise vom zweiten Synchronisierungs-Raddetektor (16') empfangen.

2. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß Anspruch 1, wobei das System (10) weiter eine Datenverarbeitungsgruppe (44) umfasst, die eine Standard-Verarbeitungseinheit (24) umfasst, welche konfiguriert ist, um die Radlagertemperaturen eines vorbeifahrenden Schienenfahrzeugs zu analysieren, die durch die Vielzahl von IR-Temperaturdetektoren (20) erfasst werden, und um Diagnosedaten zu dem vorbeifahrenden Schienenfahrzeug zu generieren.
3. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß Anspruch 2, wobei die Datenverarbeitungsgruppe (44) weiter eine mit einem Eisenbahnblockiersystem (32) verbundene Vital-Verarbeitungseinheit (22) umfasst, wobei die Vital-Verarbeitungseinheit (22) konfiguriert ist, um immer dann ein Alarmsignal an das Eisenbahnblockiersystem (32) zu senden, wenn eine Radlagertemperatur eines vorbeifahrenden Schienenfahrzeugs, erfasst durch die Vielzahl von IR-Temperaturdetektoren (20), höher ist als ein vordefinierter Radlagertemperatur-Schwellenwert.
4. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß Anspruch 3, wobei die Standard-Verarbeitungseinheit (24) konfiguriert ist, um die Diagnosedaten des vorbeifahrenden Schienenfahrzeugs an die Vital-Verarbeitungseinheit (22) zu senden.
5. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der Ansprüche 2-4, wobei die Standard-Verarbeitungseinheit (24) mit einem ersten Umgebungstemperatursensor (34) verbunden ist, der ausgebildet ist, um die Umgebungstemperatur entlang dem Bahngleis (50) zu erfassen und um die Umgebungstemperatur an die Standard-Verarbeitungseinheit (24) zu senden.
6. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß Anspruch 5, wobei ein Analog/Digital-Wandler (28) zwischen der Standard-Verarbeitungseinheit (24) und dem ersten Umgebungstemperatursensor (34) angeschlossen ist.
7. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß Anspruch 3 und wahlweise auch gemäß einem beliebigen der Ansprüche 4-6, wobei die Vital-Verarbeitungseinheit (22) mit einem zweiten Umgebungstemperatursensor (34') verbunden ist, der ausgebildet ist, um die Umgebungstemperatur entlang dem Bahngleis (50) zu erfassen, und konfiguriert, um die Umgebungstemperatur an die Vital-Verarbeitungseinheit (22) zu senden.
8. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der Ansprüche 2-7, wobei die Datenverarbeitungsgruppe (44) weiter eine zweite

Standard-Verarbeitungseinheit (24') umfasst, die mit der Vital-Verarbeitungseinheit (22) verbunden ist.

9. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß den Ansprüchen 7 und 8, wobei die zweite Standard-Verarbeitungseinheit (24') mit dem zweiten Umgebungstemperatursensor (34') verbunden ist.
10. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der Ansprüche 2-9, wobei die Standard-Verarbeitungseinheit (24) mit einem Fernankündigungs-Anzeigesystem (26) verbunden ist, wobei die Standard-Verarbeitungseinheit (24) konfiguriert ist, um die Radlagertemperaturen und die Diagnosedaten des vorbeifahrenden Schienenfahrzeugs an das Fernankündigungs-Anzeigesystem (26) zu senden.
11. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der Ansprüche 2-10, wobei die Standard-Verarbeitungseinheit (24) mit Benutzeroberflächenmitteln (30) verbunden ist, die am Bahngleis (50) angeordnet sind und von einem menschlichen Benutzer bedient werden.
12. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der Ansprüche 2-11, wobei die Raddetektor-Steuerungsgruppe (42) und die Vielzahl von IR-Temperaturdetektoren (20) mit der Datenverarbeitungsgruppe (44) über einen Ethernet-Bus (38) verbunden sind.
13. Gleisseitiges Heißläufer-Detektionssystem (10) gemäß einem beliebigen der obigen Ansprüche, wobei die Vielzahl von IR-Temperaturdetektoren (20) vom Easy Pull Out System-Typ ist.

Revendications

1. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie, comprenant un détecteur de roue amont (12) et un détecteur de roue aval (14) disposés sur une voie ferrée (50), les deux étant connectés à un groupe de gestion de détecteurs de roues (42) qui comporte une première unité de gestion de détecteurs de roues (18) et une pluralité de capteurs de température IR (20) connectés à la première unité de gestion de détecteurs de roues (18), **caractérisé en ce que** :

le système (10) comprend en outre un premier détecteur de roue de synchronisation (16) et un deuxième détecteur de roue de synchronisation (16') disposés sur la voie ferrée (50), entre le détecteur de roue amont (12) et le détecteur de roue aval (14) ;

le groupe de gestion de détecteurs de roues (42) comprend en outre une deuxième unité de gestion de détecteurs de roues (18'), **caractérisé en ce que :**

le premier détecteur de roue de synchronisation (16) est connecté à la première unité de gestion de détecteurs de roues (18), le deuxième détecteur de roue de synchronisation (16') est connecté à la deuxième unité de gestion de détecteurs de roues (18'), et le détecteur de roue amont (12) et le détecteur de roue aval (14) sont connectés à la fois à la première unité de gestion de détecteurs de roues (18) et à la deuxième unité de gestion de détecteurs de roues (18') ; et la première unité de gestion de détecteurs de roues (18) et la deuxième unité de gestion de détecteurs de roues (18') sont toutes deux configurées pour émettre des signaux d'activation chaque fois qu'elles reçoivent des signaux de détection du détecteur de roue amont (12) ou du détecteur de roue aval (14), et pour émettre des signaux de synchronisation chaque fois qu'elles reçoivent des signaux de détection respectivement du premier détecteur de roue de synchronisation (16) et du deuxième détecteur de roue de synchronisation (16').

2. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon la revendication 1, où le système (10) comprend en outre un groupe d'élaboration de données (44) comportant une unité de traitement standard (24) qui est configurée pour analyser les températures des roulements de roues d'un véhicule ferroviaire qui passe, détectées par la pluralité de capteurs de température IR (20), et pour générer des données de diagnostic concernant le véhicule ferroviaire qui passe.
3. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon la revendication 2, dans lequel le groupe d'élaboration de données (44) comprend en outre une unité de traitement vital (22) connectée à un système d'enclenchement ferroviaire (32), l'unité de traitement vital (22) étant configurée pour émettre un signal d'alarme au système d'enclenchement ferroviaire (32) chaque fois qu'une température de roulement de roue d'un véhicule ferroviaire qui passe, détectée par la pluralité de capteurs de température IR (20), est supérieure à un seuil prédéfini de température de roulement de roue.
4. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon la revendication 3, dans lequel l'unité de traitement standard (24) est configurée pour transmettre à l'unité de traitement

vital (22) les données de diagnostic du véhicule ferroviaire qui passe.

5. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications 2 à 4, dans lequel l'unité de traitement standard (24) est connectée à une première sonde de température ambiante (34), adaptée pour détecter la température ambiante le long de la voie ferrée (50) et configurée pour transmettre la température ambiante à l'unité de traitement standard (24).
6. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon la revendication 5, dans lequel un convertisseur analogique-numérique (28) est branché entre l'unité de traitement standard (24) et la première sonde de température ambiante (34).
7. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon la revendication 3 et, de manière facultative, également selon l'une quelconque des revendications 4 à 6, dans lequel l'unité de traitement vital (22) est connectée à une deuxième sonde de température ambiante (34'), adaptée pour détecter la température ambiante le long de la voie ferrée (50) et configurée pour transmettre la température ambiante à l'unité de traitement vital (22).
8. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications 2 à 7, dans lequel le groupe d'élaboration de données (44) comprend en outre une deuxième unité de traitement standard (24') connectée à l'unité de traitement vital (22).
9. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon les revendications 7 et 8, dans lequel la deuxième unité de traitement standard (24') est connectée à la deuxième sonde de température ambiante (34').
10. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications 2 à 9, dans lequel l'unité de traitement standard (24) est connectée à un système d'affichage d'annonces à distance (26), l'unité de traitement standard (24) étant configurée pour transmettre les températures des roulements de roue et les données de diagnostic du véhicule ferroviaire qui passe au système d'affichage d'annonces à distance (26).
11. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications 2 à 10, dans lequel l'unité

de traitement standard (24) est connectée à un moyen formant interface (30) disposé sur la voie ferrée (50) et commandé par un utilisateur humain.

12. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications 2 à 11, dans lequel le groupe de gestion de détecteurs de roue (42) et la pluralité de détecteurs de température IR (20) sont connectés au groupe d'élaboration de données (44), par l'intermédiaire d'un bus Ethernet (38). 5 10
13. Système (10) de détection de boîtes chaudes de trains situé en bordure de voie selon l'une quelconque des revendications précédentes, dans lequel la pluralité de détecteurs de température IR (20) sont de type système à retrait facile. 15

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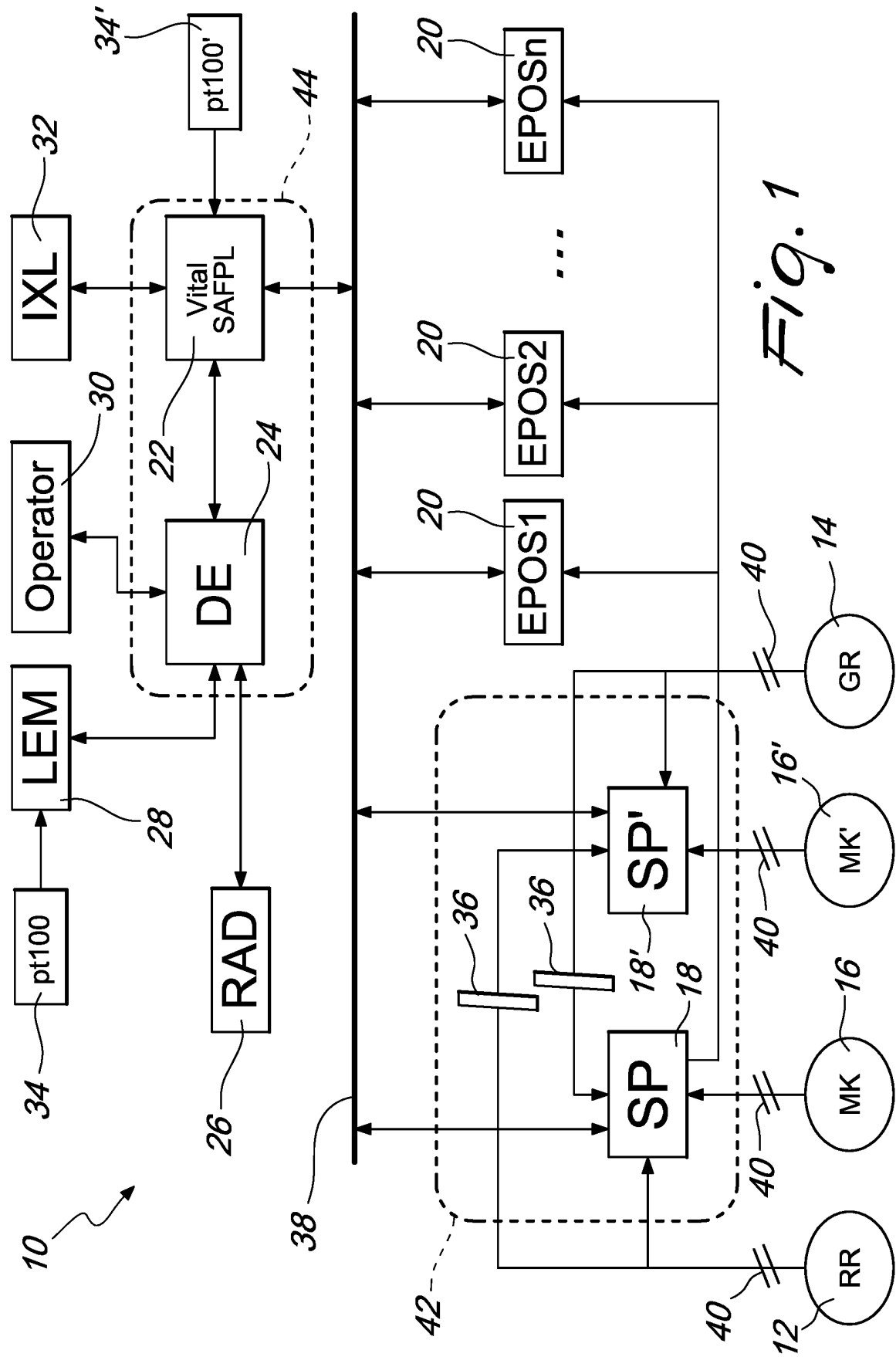
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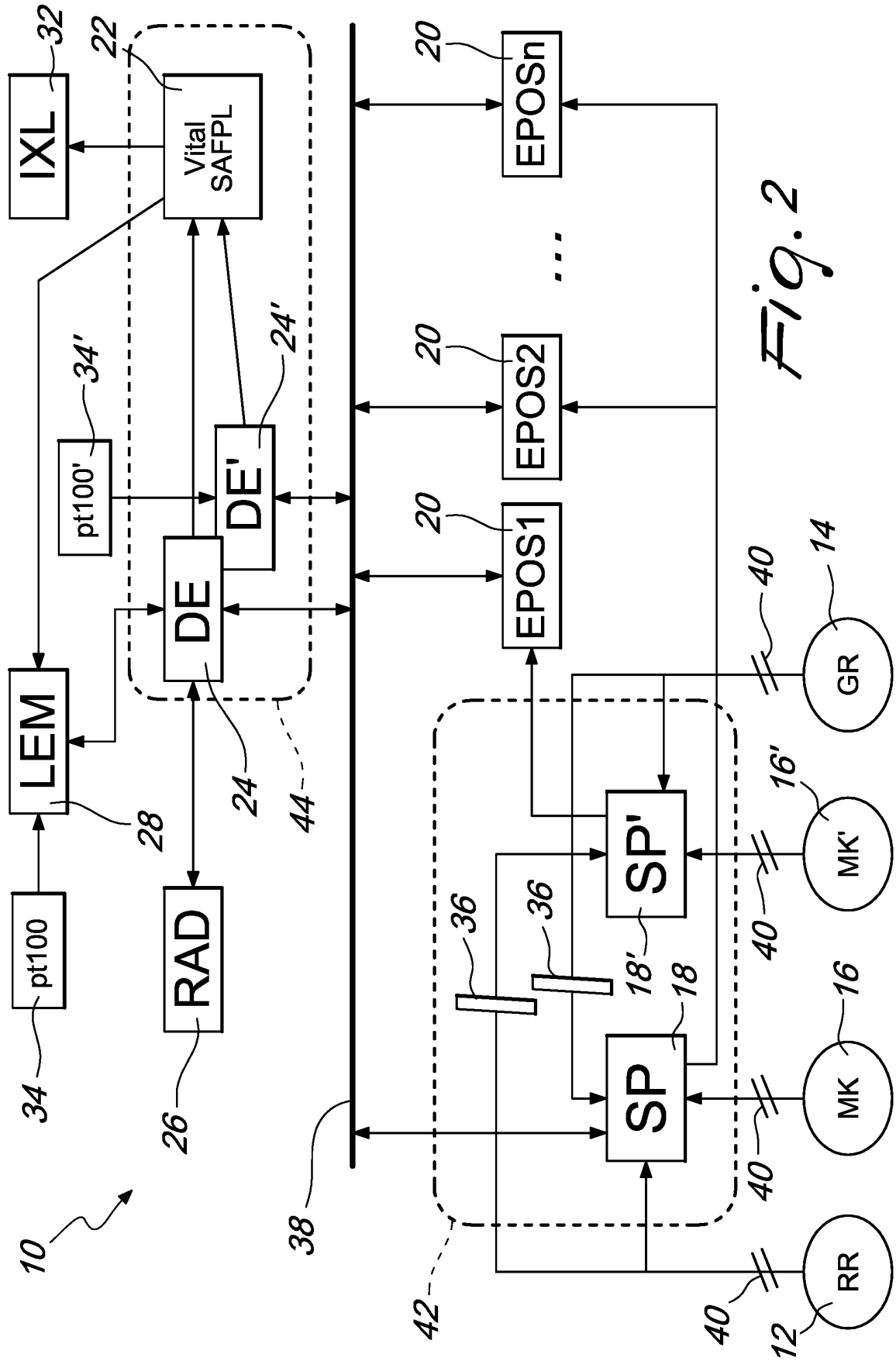
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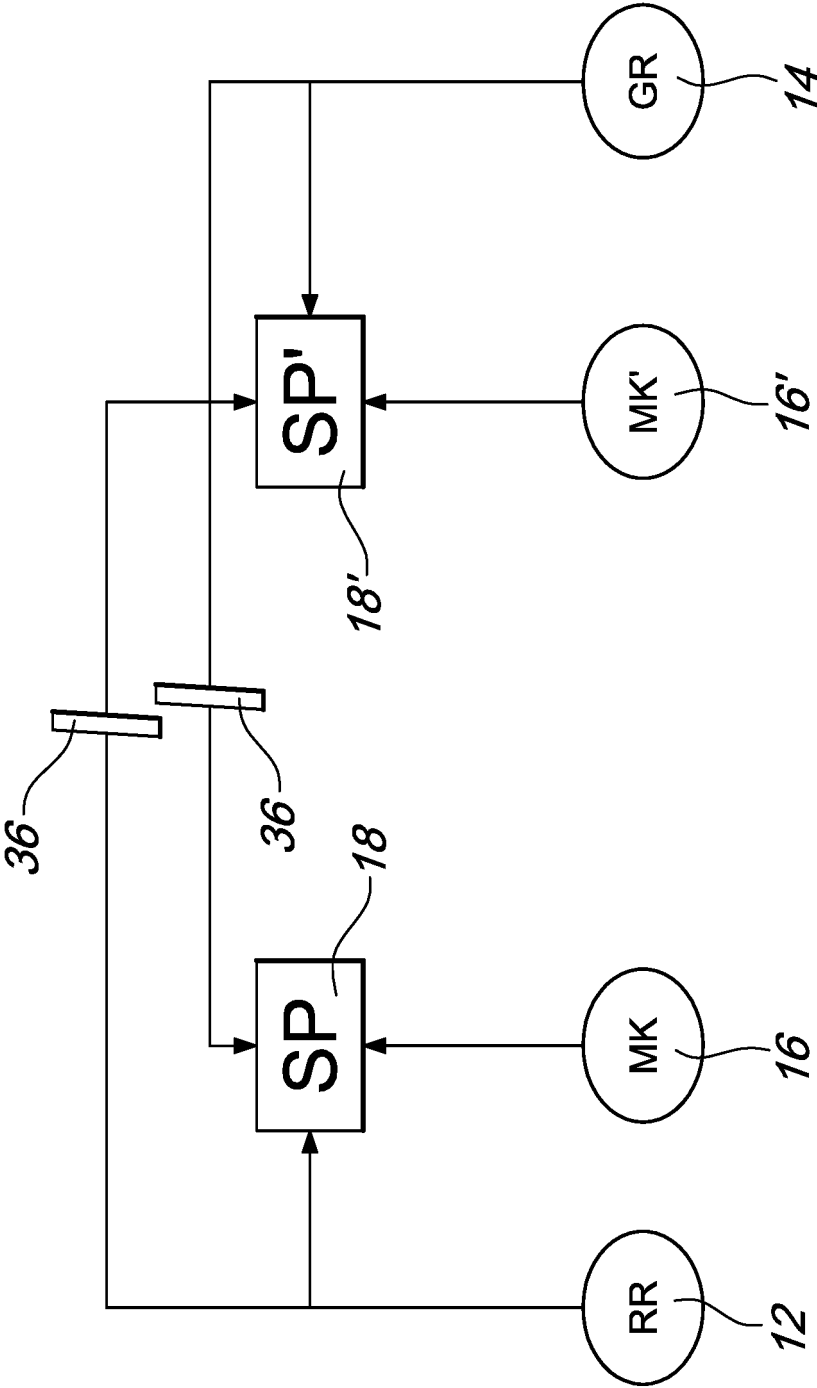
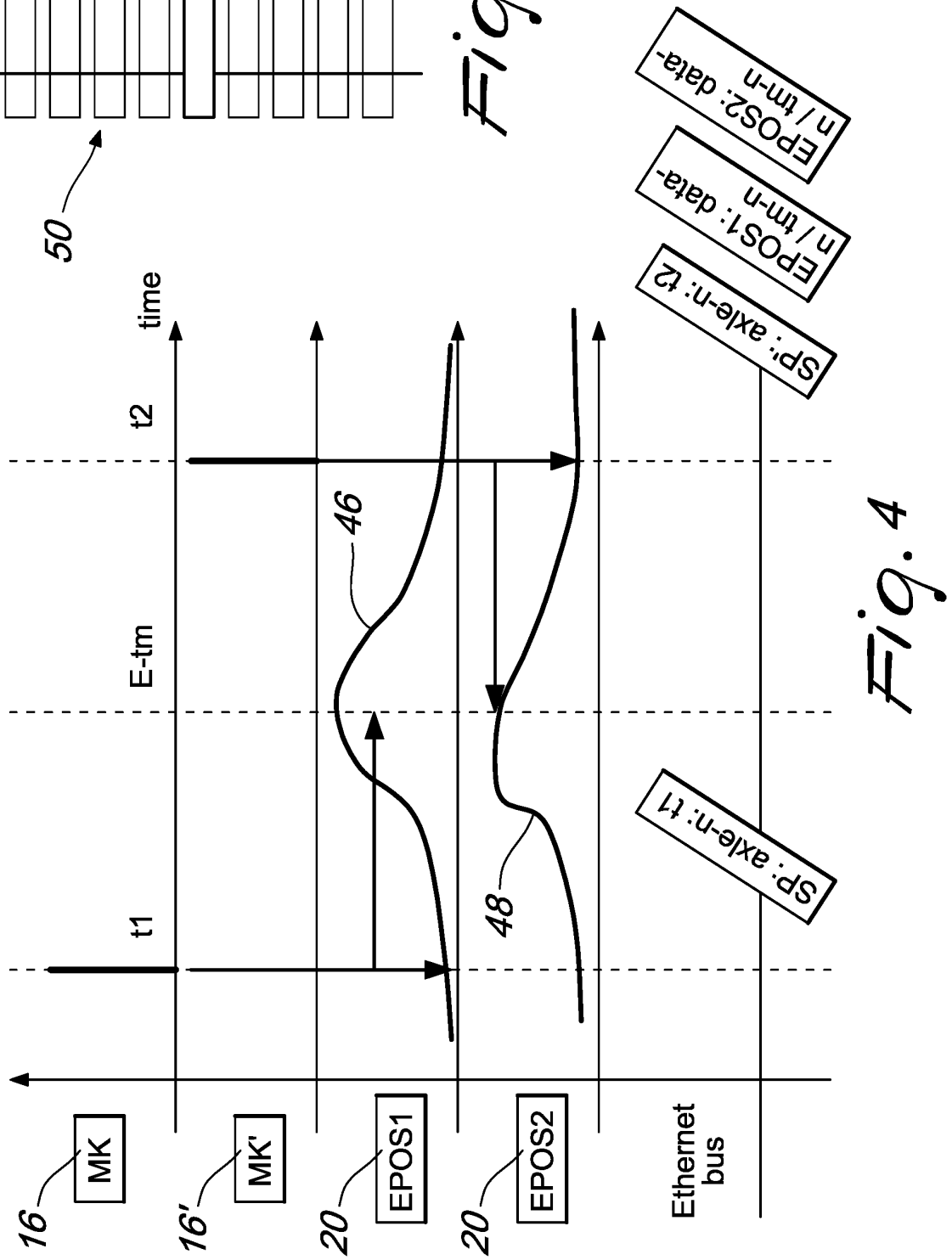
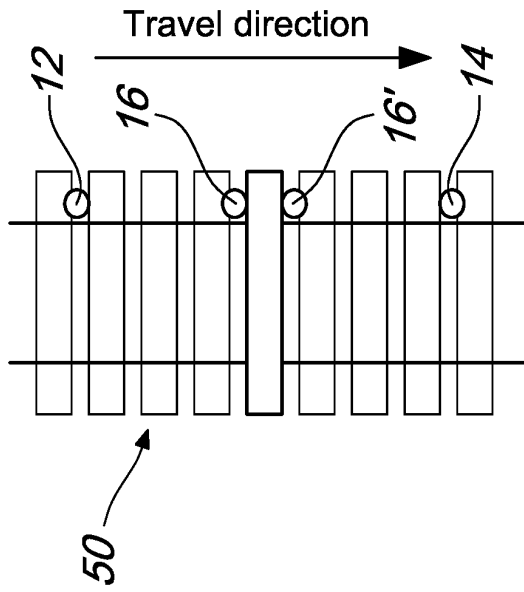


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

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