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(54) **DEVICE FOR DETECTING RAIL DEFECTS AND ASSOCIATED DETECTION METHOD**

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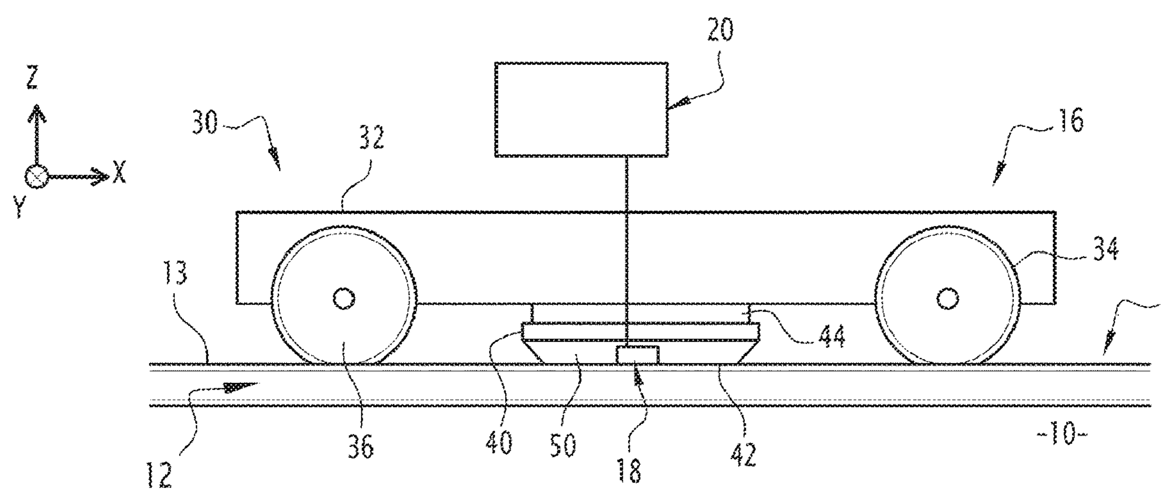
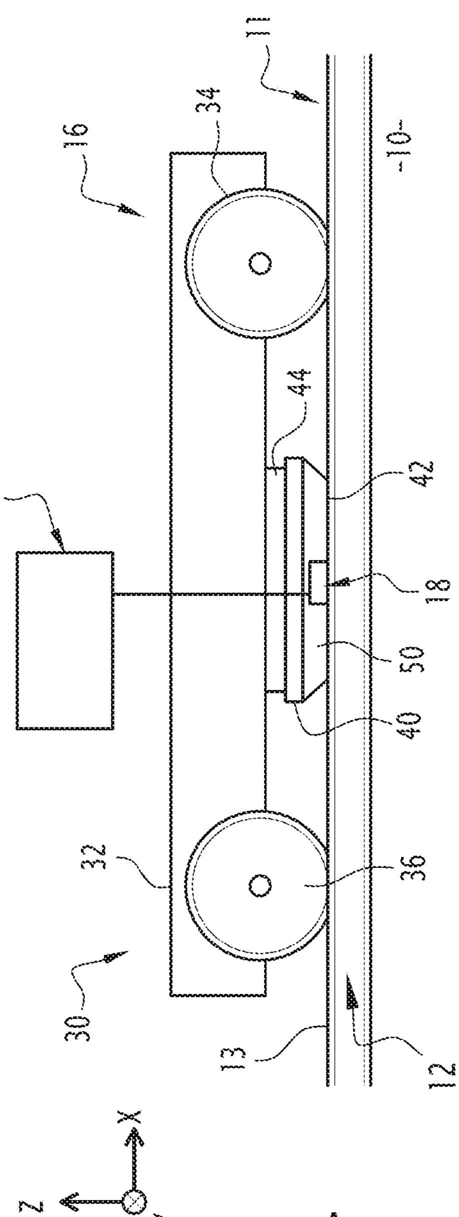
(57) **ABSTRACT**

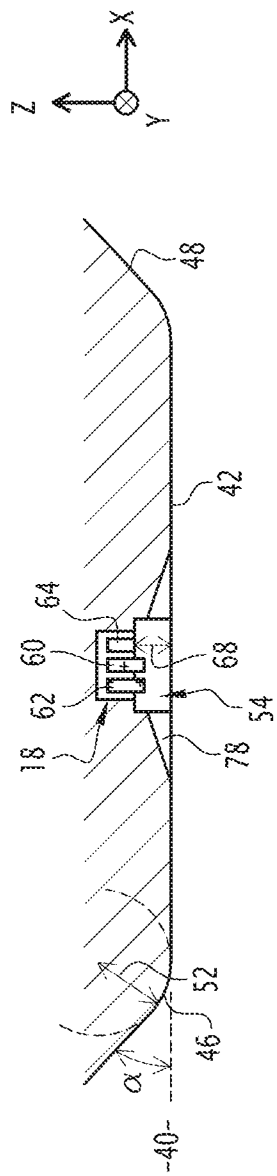
The present invention relates to a device for detecting defects in a rail, including at least one collection of sensors which are able to generate an electrical signal indicative of a distance (dn,i) separating the sensors and the rail, and at least one rail vehicle able to move along the rail; the collection of sensors being assembled to the rail vehicle; the rail vehicle being configured to rest on the rail in such a way that said sensors are positioned facing and some distance away from said rail. The device includes a friction pad comprising a lower surface able to slide along the rail, the friction pad further comprising at least one cavity formed in the lower surface, the at least one collection of sensors being housed in the cavity.





20
16
34
11
10
44
42
18
50
40
32
36
30
13
12
Z
X
Y

FIG.1



Z
X
Y
48
42
64
60
62
18
68
54
78
52
46
α
40

FIG.2

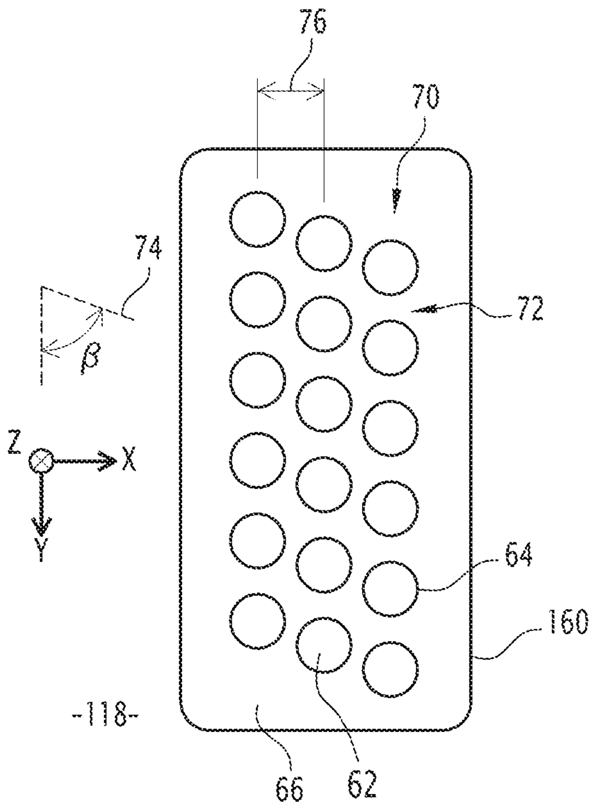


FIG.3

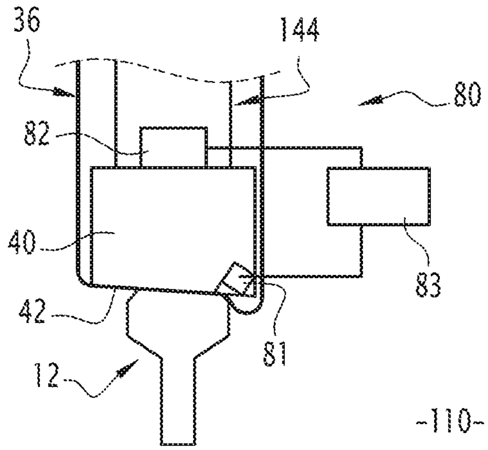


FIG.4

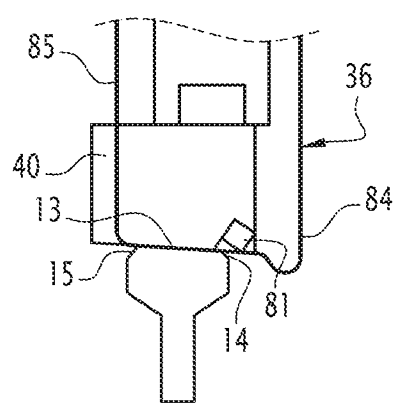


FIG.5

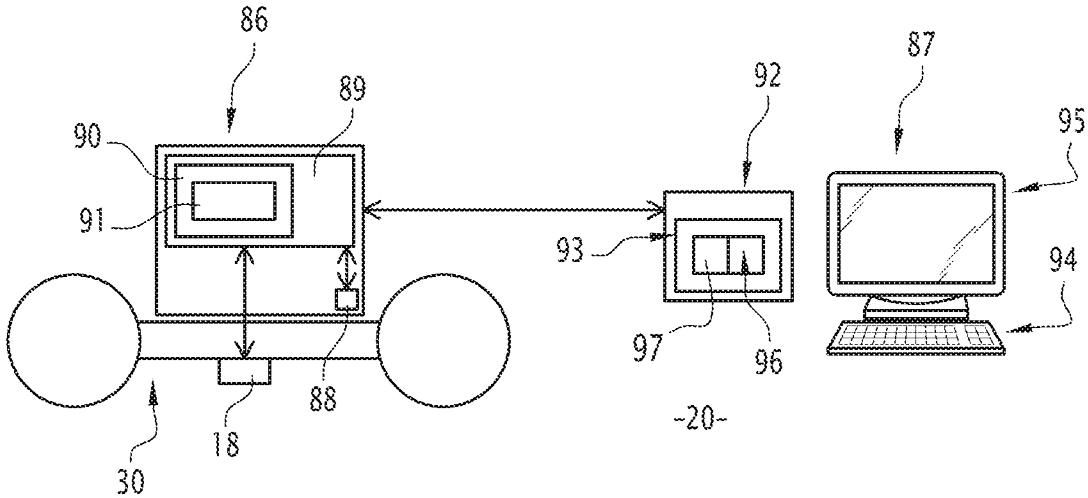

86
89
90
91
92
87
95
93
94
97
96
88
18
30
-20-

FIG.6

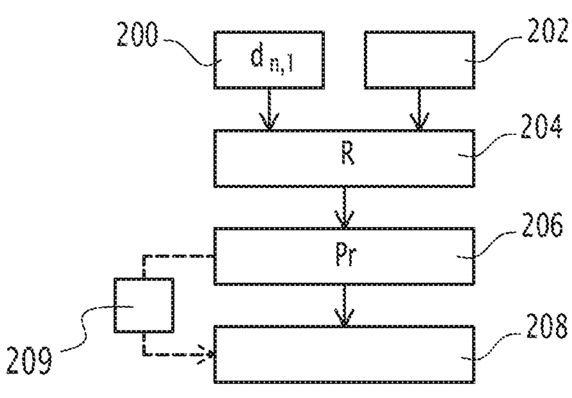

200
$d_{n,1}$
202
R
204
Pr
206
208
209

FIG.7

DEVICE FOR DETECTING RAIL DEFECTS AND ASSOCIATED DETECTION METHOD

[0001] The present invention relates to a device for detecting defects in a rail, including: at least one collection of sensors, each of said sensors being able to generate an electrical signal indicative of a distance separating said sensor and the rail, and at least one rail vehicle able to move along the rail; the collection of sensors being assembled to the rail vehicle; the rail vehicle being configured to rest on the rail in such a way that said sensors are positioned facing and some distance away from said rail.

[0002] The invention particularly applies to the detection of defects of an upper surface of the rail. The surface defects have a high potential for degradation toward the core of the rail and can degenerate toward a complete break of the section. Frequent monitoring of the surface of the rail is therefore of great interest to retain an overview of the quality of a rail network. It is thus possible to plan or trigger the necessary corrective maintenance actions when the state of a rail section appears to be too deteriorated, or preventive maintenance actions when the state of a rail section presents the risk of deteriorating toward a state requiring heavy maintenance, for example the replacement of the damaged rail section.

[0003] Several methods are known from the prior art to detect rail defects. A method implementing dimensional metrology sensors is in particular described in document EP 0,044,885. This document describes a collection of sensors suspended from a rail vehicle in contact with the track by means of four wheels.

[0004] Such a device nevertheless exposes the sensors to a level of vibrations that may exceed the resolution of the sensors by several orders of magnitude. The obtained measurements are next difficult to correct.

[0005] The present invention aims to propose a detection device leading to more reliable measurements, making it possible to detect and characterize the defects of the upper surface of a rail.

[0006] To that end, the invention relates to a detection device of the aforementioned type, including a friction pad comprising a substantially flat lower surface, said friction pad being assembled to the rail vehicle in such a way that the movement of said vehicle along the rail causes a sliding on said rail by said lower surface, along a longitudinal direction of said friction pad; the friction pad further comprising at least one cavity formed in the lower surface, the at least one collection of sensors being housed in said cavity.

[0007] According to other aspects of the invention, the detection device includes one or more of the following features, considered alone or according to any technically possible combination(s):

[0008] the at least one collection of sensors comprises at least one row of sensors aligned in a transverse direction, perpendicular to the longitudinal direction of the friction pad;

[0009] the at least one collection of sensors comprises several rows, each row being formed by sensors aligned in a transverse direction, perpendicular to the longitudinal direction of the friction pad;

[0010] the sensors of the at least one collection are arranged in a regular mesh, formed by lines extending in the transverse direction and lines extending in a direction inclined by an angle relative to said transverse direction, said angle preferably being between 45° and 90°;

[0011] the friction pad further comprises at least one groove arranged in the lower surface in the longitudinal direction, the at least one groove emerging on the at least one cavity;

[0012] the friction pad is assembled to the rail vehicle by a suspension provided with means for fixed maintenance of a constant transverse position of at least one collection of sensors relative to the wagon;

[0013] the friction pad is assembled to the rail vehicle by a suspension provided with means for maintenance by slaving of a constant transverse position of the at least one collection of sensors relative to an edge of the rail;

[0014] the detection device further comprises an electronic processing device for information provided by the sensors, said device comprising at least one electronic detector for spatial coordinates and at least one on board controller, said electronic detector and said on board controller being secured to the rail vehicle, said on board controller being connected to the electronic detector and to the collection of sensors;

[0015] the processing device includes several on board controllers secured to a same rail vehicle or several different rail vehicles, each on board controller being connected to a collection of sensors, the processing device further comprising a centralized logic controller provided with means for communicating with each of the on board logic controllers.

[0016] The invention also relates to an operating method for a detection device as described above, said method including the following steps: movement of the rail vehicle along the rails; during said movement, measuring the distance between the sensors of the at least one collection and an upper surface of the rail; and simultaneously detecting spatial coordinates and the speed of the vehicle; then developing a first spatial representation of the upper surface of the rail; then comparing said first spatial representation with reference representations in order to identify defects of the upper surface; then generating an alert in case of identified defect. According to other advantageous aspects of the invention, the method includes one or more of the following features, considered alone or according to all technically possible combinations:

[0017] the method further comprises a step for comparing the first spatial representation with a second spatial representation previously stored in a data memory, so as to lead to tracking of the evolution of the defects of the upper surface;

[0018] the reference representations comprise several types of defects associated with spatial characteristics and in which the comparison step comprises determining analysis windows corresponding to said spatial characteristics.

[0019] The invention will be better understood upon reading the following description, provided solely as a non-limiting example and done in reference to the drawings, in which:

[0020] FIG. **1** is a schematic side view of a detection device according to a first embodiment of the invention;

[0021] FIG. **2** is a partial sectional view of the device of FIG. **1**;

[0022] FIG. **3** is a detailed bottom view of an embodiment variant of the device of FIG. **1**;

[0023] FIGS. **4** and **5** are schematic detailed views of a detection device according to a second embodiment of the invention including a position slaving system;

[0024] FIG. 6 is a schematic view of an element of the device of FIG. 1; and

[0025] FIG. 7 is a logic diagram corresponding to an operating method of a detection device such as the device of FIG. 1.

[0026] FIG. 1 schematically shows a device 10 for detecting defects of a rail according to one embodiment of the invention.

[0027] The device 10 is in particular able to detect the defects of a railway track 11 made up of two substantially parallel rails 12. A rail 12 in particular includes an upper surface 13 delimited by an inner edge 14 and an outer edge 15 (FIG. 5). The inner edge 14 is the edge oriented toward the inside of the railway track 11, i.e., that faces the other rail 12 of said railway track.

[0028] The device 10 is particularly intended to detect defects of the upper surface 13 of at least one rail 12.

[0029] The expected defects can have very different spatial characteristics. Defects of the corrugation type extend over a significant length. On the contrary, defects of the squat or shelling type are small defects. Defects of intermediate size also exist, such as delaminations.

[0030] The device 10 in particular includes a rail vehicle 16, at least one collection 18 of sensors connected to said vehicle 16 and an electronic processing device 20 for information supplied by said sensors.

[0031] The rail vehicle 16 is preferably a transport vehicle, in particular of the train, subway, tram or commuter train type. In a variant, the railway vehicle 16 is a measuring or maintenance vehicle, motorized or movable manually.

[0032] The rail vehicle 16 comprises at least one wagon 30. Said wagon 30 includes a chassis 32 connected to four wheels, in particular two front wheels 34 and two rear wheels 36. The rail vehicle 16 is able to move along the railway track 11 such that each of the front wheels 34 rolls on a different rail 12 and each of the rear wheels 36 rolls on a different rail 12.

[0033] Preferably, the wagons 30 form at least one of the bogies of the rail vehicle 16, such that a same rail vehicle 16 comprises several wagons 30.

[0034] FIG. 1 shows an orthonormal base (X, Y, Z) associated with the wagon 30. The direction X represents a longitudinal movement direction of the wagon 30, the direction Y represents a transverse direction and the direction Z represents the vertical.

[0035] The wagon 30 further includes at least one friction pad 40, in particular comprising a substantially flat lower surface 42. The friction pad 40 is arranged below the chassis 32, between a front wheel 34 and a rear wheel 36. The wagon 30 further includes at least one suspension 44 connecting the friction pad 40 to the chassis 32, such that the movement of the wagon 30 on the railway track 11 causes sliding of the lower surface 42 on one of the rails 12.

[0036] Preferably, the friction pad 40 and the suspension 44 are substantially equidistant from the front wheel 34 and the rear wheel 36, such that the longitudinal direction X is substantially tangential to the rail 12 in the middle of the friction pad 40.

[0037] Preferably, the wagon 30 includes at least two friction pads 40, each of said pads being arranged over one of the rails 12 of the railway track 11.

[0038] FIG. 2 shows a detailed sectional view of the friction pad 40 of FIG. 1.

[0039] The inner surface 42 is positioned in a plane (X, Y) and is delimited by an edge 46, substantially rectangular in shape. For information, a length of the lower surface 42 in the longitudinal direction X is between 50 cm and 1.5 m. Said length is preferably adapted based on the size of the expected defects, in particular the wavelength of the corrugations. A width of the lower surface 42 in the transverse direction Y is preferably chosen to be close to a width of the wheels 34, 36.

[0040] The edge 46 is adjacent to two front faces 48 and two side faces 50 of the friction pad 40. Preferably, the front 48 and side 50 faces are substantially flat.

[0041] The front faces 48 are positioned in front of and behind the friction pad 40, in the longitudinal direction X. Preferably, the front faces 48 are substantially flat and tilted by an angle a smaller than 45° relative to the horizontal. Preferably, the side faces 50 are positioned substantially along the planes (X, Z).

[0042] The edge 46 forms a curved surface between the lower surface 42 on the one hand and the front 48 and side 50 faces on the other hand. A curve radius 52 of the edge 46 is preferably between 5 mm and 50 mm.

[0043] The friction pad 40 further comprises a cavity 54 arranged in the lower surface 42. The cavity 54 is preferably elongated, extending along the transverse direction Y. According to one embodiment, the cavity 54 emerges on the side faces 50. According to another embodiment, the cavity 54 is contained entirely in the lower surface 42.

[0044] FIG. 3 shows a bottom view of a collection 118 of sensors able to replace the collection 18 in an embodiment variant of the device of FIGS. 1 and 2. The collections 18 and 118 are described at the same time, the shared elements being designated using the same reference numbers.

[0045] The collection 18, 118 of sensors in particular comprises a support block 60, 160 and sensors 62, 64. The support block 60, 160 has a substantially parallelepiped shape and in particular includes a lower face 66.

[0046] The sensors 62, 64 are dimensional metrology sensors, each sensor being able to generate an electrical signal representative of a distance separating said sensor and the corresponding rail 12. The sensors 62, 64 are for example chosen from among capacitive sensors, optical sensors and inductive sensors, in particular with eddy currents.

[0047] The sensors 62, 64 are inserted into the support block 60, 160. According to one embodiment, at least one sensor 62 forms a protrusion relative to the lower face 66 of said support block. According to one embodiment, at least one sensor 64 is flush with the lower face 66 of said support block. The position of the sensors relative to the lower face 66 is in particular chosen based on the nature of said sensors, for example, to avoid the influence of metal masses too close to the hot spot of the sensors on their measurement.

[0048] The support block 60, 160 is housed in the cavity 54 of the friction pad, the lower face 66 being oriented downward so as to be located across from the upper surface 13 of the rail 12. The support block 60, 160 is positioned so as to arrange a non-nil distance 68, between the sensors 62, 64 and the lower surface 42 of the friction pad 40. Said lower surface 42 thus provides a shared reference plane to all of the sensors 62, 64.

[0049] Said distance 68 is chosen to be as small as possible based on the characteristics of the sensors and the anticipated wear of the lower surface 42 of the friction pad 40. For example, for inductive sensors, the distance **68** is chosen to be of the same order of magnitude as a diameter of said sensors.

[0050] Preferably, the collection **18**, **118** of sensors is configured so as to cover the largest possible portion of the rail **12**, in order to detect the largest possible portion of defects.

[0051] More specifically, the sensors **62**, **64** are preferably positioned in at least one row **70** of sensors aligned in the transverse direction Y. In order to increase the resolution of the detection, the sensors are more preferably positioned in several rows. In the embodiments of FIGS. **2** and **3**, the collections **18** and **118** include three rows of sensors aligned in the transverse direction Y.

[0052] Preferably, the sensors **62**, **64** are distributed on the lower face **66** in a regular mesh **72** (FIG. **3**), made up of lines extending in the transverse direction Y and lines extending in a direction **74**, inclined by an angle β of between 45° and 90° relative to said transverse direction. Such an arrangement in particular makes it possible to minimize a distance **76** between two rows **70** of consecutive sensors and therefore to optimize the number of sensors on the lower face **66**.

[0053] The friction pad **40** further comprises at least one drainage groove **78** arranged in the lower surface **42** in the longitudinal direction X. Said drainage groove **78** emerges on the cavity **54** and preferably extends in front of and behind said cavity so as to allow an operation in both senses of the direction X.

[0054] According to one variant to the embodiment of FIG. **2**, the friction pad **40** comprises several cavities **54**, distributed in the longitudinal direction X, each of the cavities containing a collection **18**, **118** of sensors.

[0055] FIGS. **4** and **5** show detailed schematic front views of a detection device **110** similar to the device **10** of FIG. **1**. The device **110** corresponds to the description above of the device **10**, but includes a suspension **144** different from the suspension **44**. The suspensions **44** and **144** will be described at the same time, the shared elements being designated using the same reference numbers.

[0056] The suspension **44**, **144** is configured to exert, on the friction pad **40**, a vertical force oriented toward the rail **12**, or downward, while limiting the downward travel of said pad in order to prevent it from descending below the plane of the track. Furthermore, the suspension **44**, **144** comprises resilient return means in order to absorb the vertical movements of the pad that may be caused by irregularities of the railway track **11** or by the passage on track apparatuses.

[0057] In the embodiment of FIG. **1**, the suspension **44** is configured such that the friction pad **40** is stationary relative to the chassis **32** in the transverse direction Y. Preferably, this positioning is such that seen from the front, the pad is completely in the shadow of the wheels **34**, **36**. In this embodiment, it is preferable for the center distance of the wheels **34**, **36** to be reduced in order to limit the movement of the axis of the friction pad **40** relative to the tangent to the corresponding rail **12**.

[0058] In the embodiment of FIGS. **4** and **5**, the suspension **144** includes a device **80** for slaving the position of the pad **40** above the rail **12**. The slaving device **80** is not visible in FIG. **5**. FIGS. **4** and **5** respectively show two different configurations of the detection device **110**, depending on the transverse position of the rear wheel **36** relative to the rail **12**.

[0059] The slaving device **80**, shown in FIG. **4**, includes a detector **81**, a translation member **82** and an electronic slaving module **83**.

[0060] The detector **81** is able to detect the position of the pad relative to the rail in the transverse direction Y. The detector **81** is for example a dimensional metrology sensor similar to the sensor **62**, **64**. The detector **81** is preferably arranged in a well emerging on the lower surface **42** of the friction pad **40**.

[0061] The translation member **82** is able to move the friction pad **40** relative to the chassis **32** in the transverse direction Y. The translation member **82** for example includes an electric motor and a worm engaged in a set of gears connected to the pad.

[0062] The electronic slaving module **83** is able to interpret the data from the detector **81** in order to command the translation member **82** so that the friction pad **40** keeps a same position relative to the inner edge **14** of the rail **12** in the transverse direction Y. Said position is chosen so as to optimize the position of the sensors **62**, **64** relative to the upper surface **13** of said rail **12**. Preferably, said position means that all of the sensors **62**, **64** of at least one collection **18**, **118** carried by the pad **40** are plumb with said upper surface **13**.

[0063] Preferably, the travel of the pad **40** allowed by the translation member **82** is limited such that said pad cannot form a protrusion relative to an inner face **84** of the wheels **34**, **36**, i.e., a face of the wheels oriented toward the inside of the railway track **11**. Like in FIG. **5**, the pad **40** is preferably allowed to protrude past the outer face **85** of the wheels **34**, **36**, opposite the inner face. This access is, however, contained within the limit authorized by the gauge defined by standard UIC 505-1.

[0064] The embodiment of FIGS. **4** and **5** requires an additional apparatus for the slaving device **80**, but in return it makes it possible to save on the number of sensors **62**, **64**, since the latter are kept entirely above the rail.

[0065] The processing device **20** is shown schematically in FIG. **6**. The processing device **20** includes at least one on-board device **86**, secured to the rail vehicle **16**, and a ground device **87**. A same on-board device **86** is connected to one or several friction pads **40**. The number of on-board devices **86** in a same rail vehicle **16** will therefore depend on the number of friction pads **40** and the capacity of the on-board device **86**.

[0066] The on-board device **86** includes an electronic detector **88** for spatial coordinates of the rail vehicle **16** making it possible to determine the spatial coordinates of the centers of the wagon(s) **30** managed by said on-board device **86**. Said spatial coordinates are for example the longitude and the latitude of the detector **88**, which is preferably connected to a system of the GPS type. The detector **88** is preferably positioned near at least one collection **18**, **118** of sensors. The electronic detector **88** is also able to measure the longitudinal speed of the wagon(s) **30**.

[0067] Each on-board device **86** further includes at least one on-board controller **89**. The on-board controller **89** includes a processor **90** that stores a program **91**. The on-board controller **89** is provided with means for communicating with the spatial coordinate detector **88**, with the sensors **62**, **64** of at least one collection **18**, **118** secured to the wagon **30**, and with the slaving device **80** if applicable.

[0068] The ground device **87** includes a central logic controller **92** such as a computer. The central logic controller

92 comprises a processor **93**, a man-machine interface **94** such as a keyboard, and a display unit **95** such as a monitor. The processor **93** stores a program **96**. In one embodiment, the ground device **87** further includes a data memory **97**, able to store the data collected over a defined duration.

[0069] The ground device **87** further includes means for communicating, for example by radio waves, with the on-board device(s) **86** of the vehicle **16**.

[0070] An operating method of the detection device **10**, **110** will now be described. Said method is shown schematically by a logic diagram in FIG. **7**.

[0071] It is considered that for each collection **18**, **118** of sensors, each of the sensors **62**, **64** corresponds to an identifier C_n in the program **91** of the on-board device **86** connected to said collection **18**, **118**. Each identifier C_n is attached to a position of the corresponding sensor on the inner face **66** of the support block **60**, **160**.

[0072] First, the rail vehicle **16** moves on the railway track **11**. The or each friction pad **40** of the or each wagon **30** slides along the corresponding rail **12**.

[0073] The suspension **44**, **144** makes it easier for the pad **40** to cross the track apparatuses. Likewise, the curved shape of the edge **46** of the lower surface **42** makes it possible to reduce the impacts experienced upon approaching irregularities in the track, such impacts being able to disrupt the measurements done by the sensors **62**, **64**.

[0074] Depending on the technology used, these measurements can also be sensitive to climate conditions, such as humidity. During the movement of the pad **40**, the drainage grooves **78** contribute to preventing water buildup in the cavity **54**.

[0075] During said movement, the sensors **62**, **64** of the or each collection **18**, **118** provide the on-board device **86** with information on a distance $d_{n,i}$ of each sensor C_n relative to the upper surface **13** of the rail **12**, at each moment t_i (step **200**).

[0076] In the case of the device **10** previously described, comprising a suspension **44**, the position of the collection **18**, **118** of sensors can vary relative to the inner **14** and outer **15** edges of the rail **12**. Preferably, the collection **18**, **118** is extended enough in the transverse direction Y for the sensors **62**, **64** to detect the position of at least one of the inner **14** and outer **15** edges. In particular, the sensors located above the empty space, therefore separated from the rail **12**, send a saturated signal to the on-board logic controller **89**. The position of the irregularities of the upper surface **13** relative to the edges **14**, **15** of the rail is information that contributes to characterizing the type of defect in question.

[0077] In the case of the device **110** previously described, comprising a suspension **144**, the position of the collection **18**, **118** of sensors is in principle stationary relative to the edges of the rail. The detection of at least one of said edges can, however, be done for confirmation.

[0078] Simultaneously with the measurements done by the sensors **62**, **64**, the electronic detector **88** of the or each on-board device **86** determines the spatial coordinates of the or each wagon **30** at several successive moments t_i (step **202**).

[0079] The electronic detector **88** also measures the speed of the wagon **30** at each moment t_i, which allows the program **91** to convert the distance **76** between two rows **70** of sensors into a time shift. The measurements of the different rows of sensors of the same collection **18**, **118** are thus synchronized, so as virtually to form a single transverse alignment with a high density of sensors C_n.

[0080] The spatial coordinates of the wagon **30** at several moments t_i, combined with the distances $d_{n,i}$ measured by the sensors C_n, makes it possible to define (step **204**) a spatial representation R of the upper surface(s) **13** on which the rail vehicle **16** has traveled. The spatial representation R is defined by the program **91** of the or each on-board device **86** and/or by the program **96** of the ground device **87**.

[0081] Preferably, the detection device **10**, **110** offers one or several levels of redundancy making it possible to refine said spatial representation R. A first level can be obtained by the on-board device **86** or by the ground device **87** in the case where a same friction pad **40** houses several collections **18**, **118** of sensors, connected to a same on-board device **86**.

[0082] A second level of redundancy is obtained by the ground device **87**, in the case where the rail vehicle **16** includes several wagons **30**, each of said wagons being equipped with an on-board device **86** connected to the ground device **87**.

[0083] A third level of redundancy is obtained by the ground device **87** in the case where several rail vehicles **16** move on the railway track **11** or in the case where a same rail vehicle **16** performs the same journey several times in a row.

[0084] The spatial representation R is next analyzed (step **206**) so as to detect the defects of the upper surface(s) **13**. This analysis step is done by the program **91** of the or each on-board device **86** and/or by the program **96** of the ground device **87**.

[0085] As an example, the analysis step **206** includes the following operations:

[0086] for each collection **18**, **118** of sensors, calculating a reference transverse profile P_r of the upper surface **13**. The profile P_r is calculated by taking the average of the distances $d_{n,i}$ measured by the sensors C_n over a range of successive moments t_i. This operation makes it possible to define, for each sensor of a collection **18**, **118**, a reference level relative to the rail section being traveled and also provides an indication on the wear of the upper surface(s) **13** of the rail;

[0087] for each collection **18**, **118**, storing signal windows each corresponding to a different examination distance, in order to identify different defects. For example, a "long" window with a length of 5 m will contain enough information to identify long defects of the corrugation type. A "medium" window with a length of 0.5 m will contain enough information to identify throat defects of the delamination type. A "short " window with a length of 0.1 to 0.2 m will contain enough information to identify local defects of the squat and shelling type.

[0088] for each window, calculating a quadratic sum of the deviations from the reference profile P_r and comparing these sums to control values representative of the noise that can be encountered on the rails. Any result above a control value will trigger a defect analysis;

[0089] for the window to be analyzed, extracting, from the measurements, the relevant parameters for the window in question. For the long window, this may involve spatial frequencies of the measurements for which a local maximum is found in the spectral power spectrum of the signal from the sensor closest to the center of the rail line. For the medium window and the short window, it may involve the contour of the zone for which the deviation from the reference profile exceeds two or three standard deviations;

[0090] comparing the parameters thus extracted with reference data, preferably stored in the central logic controller **92**, in order to determine the type of defect. Said comparison operation is preferably accompanied by a probability expressing the confidence to be placed in the identification of the defect. The parameters thus extracted further make it possible to determine the extension, the depth and other characteristics of said defect.

[0091] In the event the device includes a data memory **97**, during an optional step **209**, the new data relative to the detected defects are subject to a comparison analysis relative to the data previously stored in the data memory **97**. This comparison results in monitoring of the evolution of the defect in question.

[0092] For each detected defect, an alert is next generated (step **208**), the latter being reflected by a text and/or graphic message on the display unit **95** of the central logic controller **92**. For example, the display unit displays a map of the rail network, signaling, in real time using a color code, the various defects and their locations on the network. A maintenance team can thus be sent quickly to the locations in question.

[0093] The different levels of redundancy make it possible to confirm the detection of defects in order to limit the number of false positives. This makes it possible to deploy maintenance teams optimally on the network.

What is claimed is:

1. A device for detecting rail defects, comprising:

at least one collection of sensors, each of said sensors being able to generate an electrical signal indicative of a distance separating said sensor and the rail,

at least one rail vehicle able to move along the rail;

the collection of sensors being assembled to the rail vehicle; the rail vehicle being configured to rest on the rail in such a way that said sensors are positioned facing and some distance away from said rail;

wherein the device includes a friction pad comprising a substantially flat lower surface,

said friction pad being assembled to the rail vehicle in such a way that the movement of said vehicle along the rail causes a sliding on said rail by said lower surface, along a longitudinal direction of said friction pad;

the friction pad further comprising at least one cavity formed in the lower surface, the at least one collection of sensors being housed in said cavity.

2. The detection device according to claim **1**, wherein the at least one collection of sensors comprises at least one row of sensors aligned in a transverse direction, perpendicular to the longitudinal direction of the friction pad.

3. The detection device according to claim **1**, wherein the at least one collection of sensors comprises several rows, each row being formed by sensors aligned in a transverse direction, perpendicular to the longitudinal direction of the friction pad.

4. The detection device according to claim **3**, wherein the sensors of the at least one collection are arranged in a regular mesh, formed by lines extending in the transverse direction (Y) and lines extending in a direction inclined by an angle relative to said transverse direction, said angle preferably being between 45° and 90°.

5. The detection device according to claim **1**, wherein the friction pad further comprises at least one groove arranged in the lower surface in the longitudinal direction, the at least one groove emerging on the at least one cavity.

6. The detection device according to claim **1**, wherein the friction pad is assembled to the rail vehicle by a suspension provided with means for fixed maintenance of a constant transverse position of at least one collection of sensors relative to the wagon.

7. The detection device according to claim **1**, wherein the friction pad is assembled to the rail vehicle by a suspension provided with means for maintenance by slaving of a constant transverse position of the at least one collection of sensors relative to an edge of the rail.

8. The detection device according to claim **1**, further comprising an electronic processing device for information provided by the sensors, said device comprising at least one electronic detector for spatial coordinates and at least one on board controller, said electronic detector and said on board controller being secured to the rail vehicle, said on board controller being connected to the electronic detector and to the collection of sensors.

9. The detection device according to claim **7**, wherein the processing device includes several on board controllers secured to a same rail vehicle or several different rail vehicles, each on board controller being connected to a collection of sensors, the processing device further comprising a centralized logic controller provided with means for communicating with each of the on board logic controllers.

10. An operating method for a detection device according to claim **1**, said method including the following steps:

moving the rail vehicle along the rail;

during said movement, measuring the distance between the sensors of the at least one collection and an upper surface of the rail; and simultaneously detecting spatial coordinates and the speed of the vehicle; then

developing a first spatial representation of the upper surface of the rail; then

comparing said first spatial representation with reference representations in order to identify defects of the upper surface; then

generating an alert in case of identified defect.

11. The method according to claim **10**, further comprising a step for comparing the first spatial representation with a second spatial representation previously stored in a data memory, so as to lead to tracking of the evolution of the defects of the upper surface.

12. The method according to claim **10**, wherein the reference representations comprise several types of defects associated with spatial characteristics and in which the comparison step comprises determining analysis windows corresponding to said spatial characteristics.

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