(12) UK Patent Application (19) GB (11) 2 426 340 (13) A

(43) Date of A Publication 22.11.2006

(21) Application No: 0510346.0

(22) Date of Filing: 20.05.2005

(71) Applicant(s):
Sperry Rail (International) Limited
(Incorporated in the United Kingdom)
Trent House, RTC Business Park,
London Road, DERBY, DE24 8UP,
United Kingdom

(72) Inventor(s):
Graham Dale

(74) Agent and/or Address for Service:
Abel & Imray
20 Red Lion Street, LONDON, WC1R 4PQ,
United Kingdom

(51) INT CL:
B61K 9/10 (2006.01) B61L 23/04 (2006.01)

(52) UK CL (Edition X):
G1N NACNR NAHK N3S11

(56) Documents Cited:
GB 2166274 A
EP 1175593 A1
EP 0414693 A1
WO 2002/030729 A1
US 6055862 A
US 5970438 A
US 4864306 A
US 20020099507 A1

(58) Field of Search:
UK CL (Edition X) **G1G, G1N**
INT CL^7 **B61K, B61L, G01D**
Other: **Online: WPI, EPODOC.**

(54) Abstract Title: **Detecting the position of defects in rails**

(57) A rail defect is detected using a rail defect detecting system 28 that travels along the rail (e.g. an ultrasonic fault detector mounted on an inspection test vehicle), and the absolute position of the defect is determined using data relating to the time at which the rail defect detecting system 28 passes a plurality of position indicators 30 (e.g. mile posts, automatic warning magnets, landmarks) along with data from the vehicle encoder 32. Position data identifying the position indicators 30, and relative distance data indicative of the distance travelled by the rail defect detecting system 28 over time is obtained, and time stamps 36 applied to both the position and relative distance data. The position of and identified rail fault is obtained by determining the position of the defect detecting system 28 relative to the identified position of a position indicator 30 at the time the defect is identified. The position indicators 30 may be recognised automatically using optical recognition RFID tags, GPS etc.

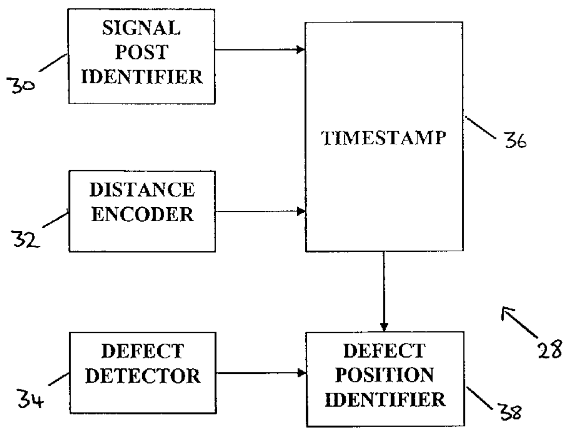

Figure 3

GB 2 426 340 A

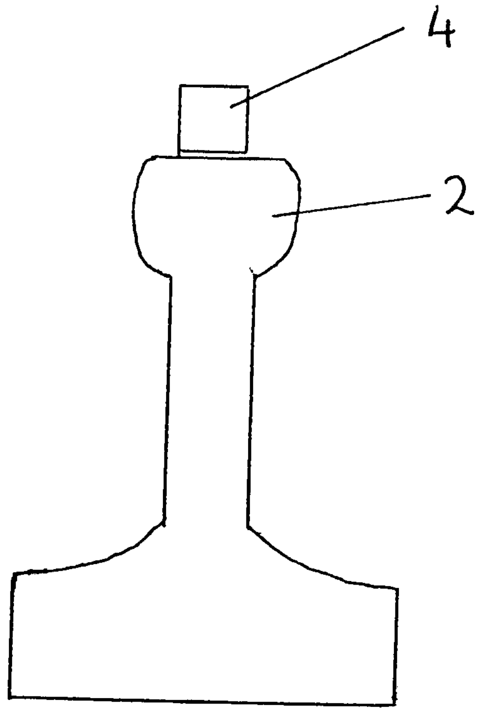

Figure 1

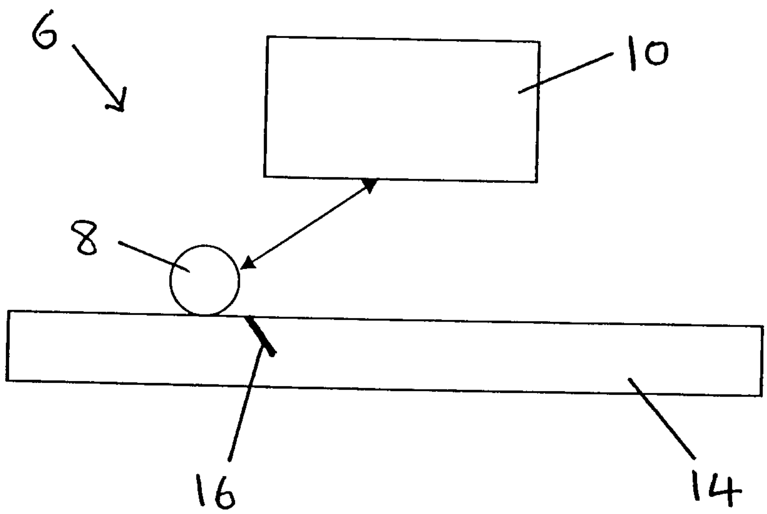

Figure 2

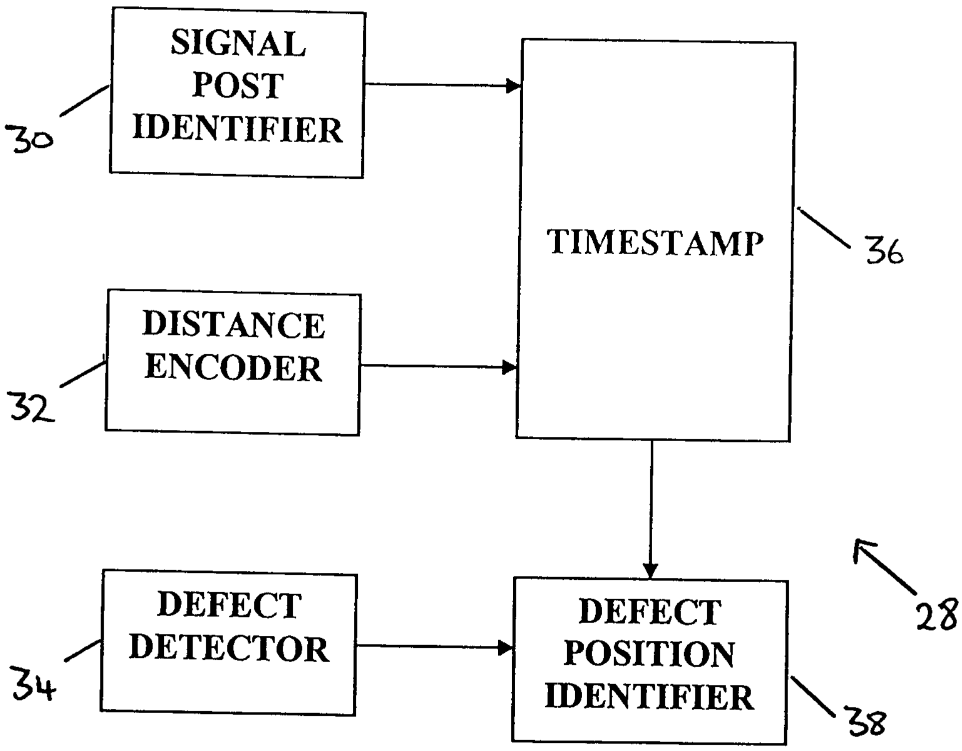
SIGNAL POST IDENTIFIER
30
DISTANCE ENCODER
32
DEFECT DETECTOR
34
TIMESTAMP
36
DEFECT POSITION IDENTIFIER
38
28

Figure 3

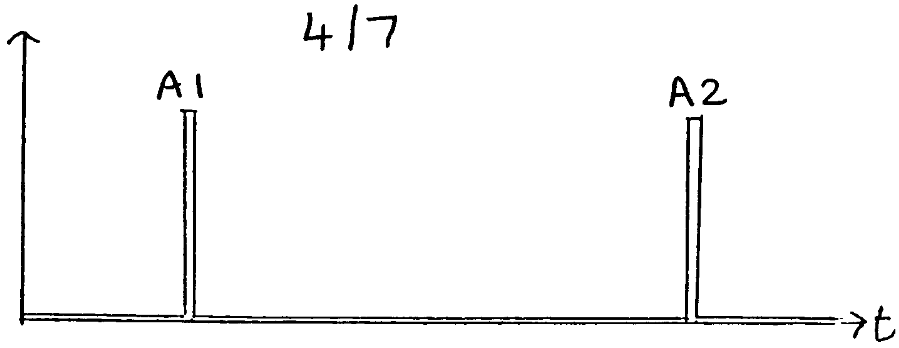

Figure 4

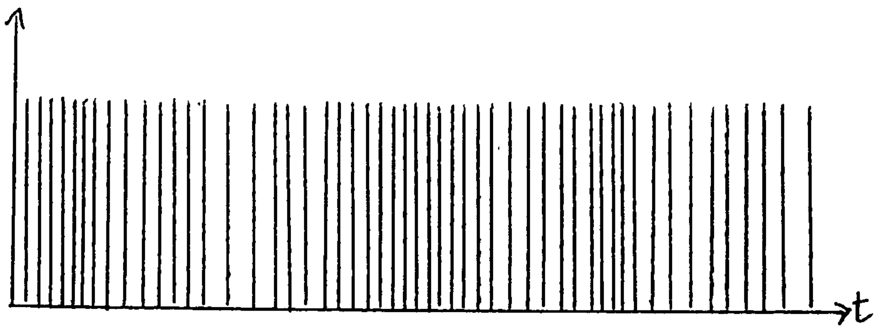

Figure 5

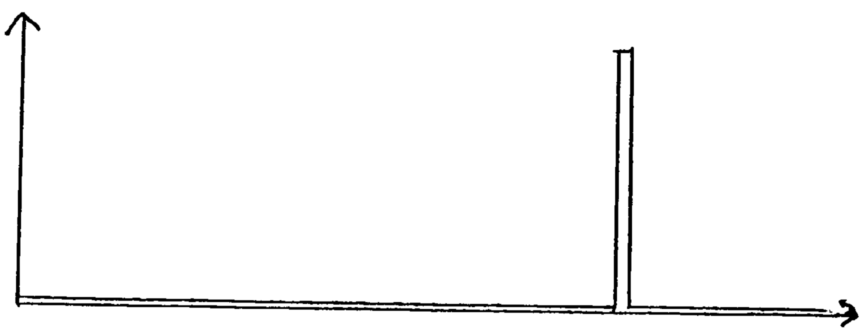

Figure 6

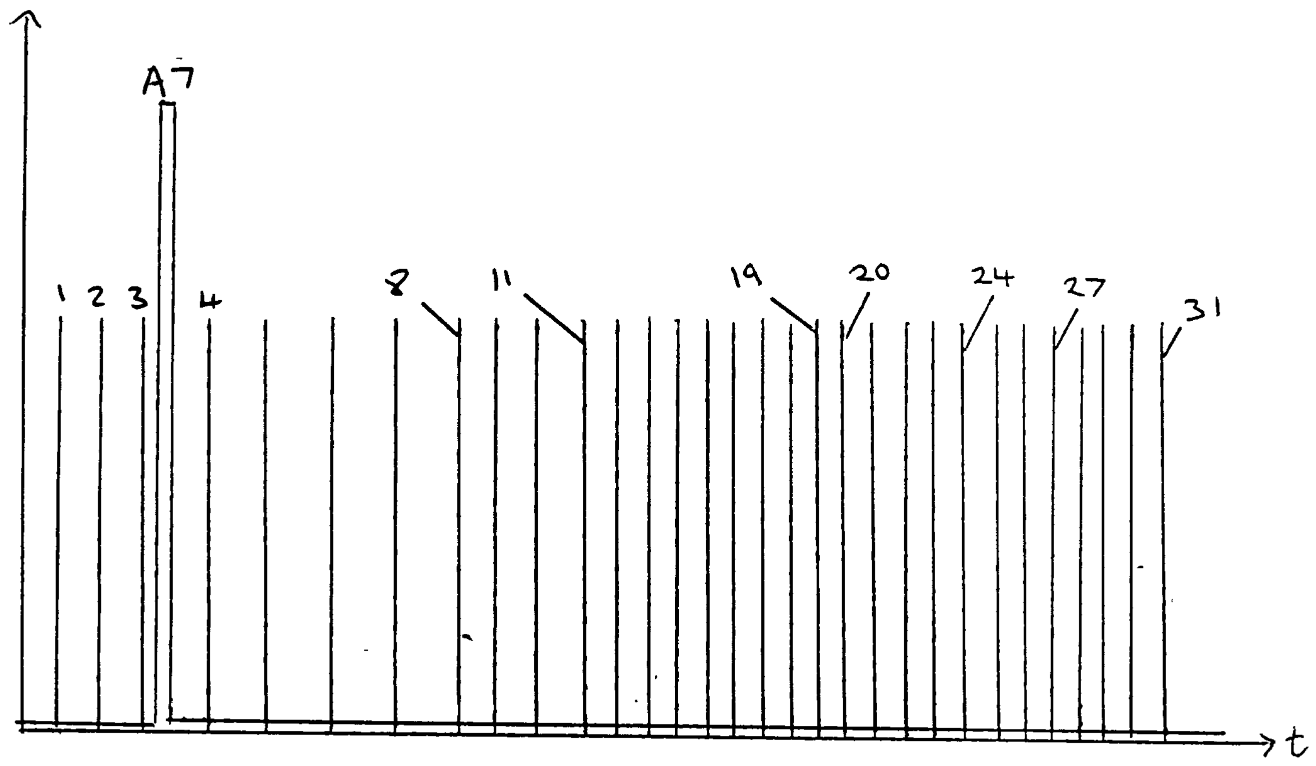

Figure 7

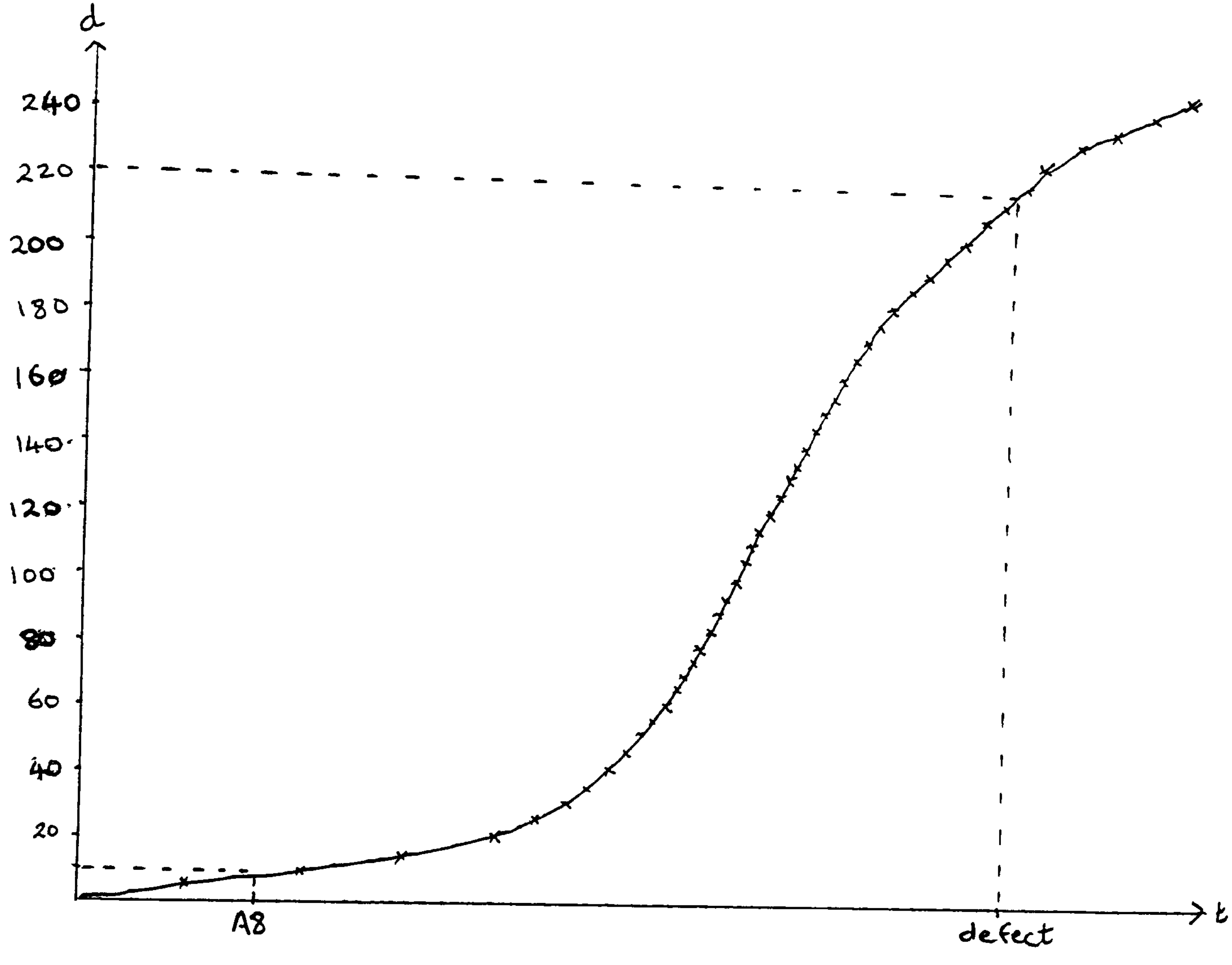

Figure 8

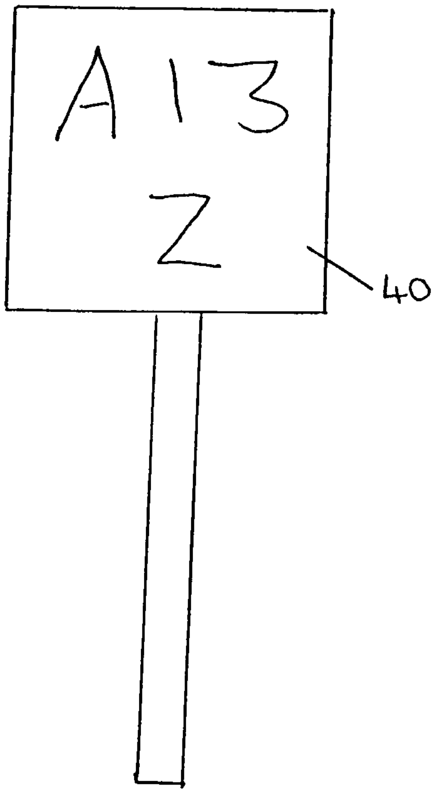

Figure 9

Apparatus and method for the detection of defects in rails

This invention relates to the detection of rail defects, in particular defects in railway rails.

One aspect of rail maintenance is checking rails for the many defect types that can occur. This takes a variety of forms, including visual inspections by skilled engineers and the use of ultrasonic testing equipment.

The large size of most railway networks and the high proportion of rail in good condition mean that automated rail inspection schemes are crucial if rail inspection is to be carried out in a cost-effective manner.

The use of ultrasonic techniques to inspect railway rails is well established in the art. Conventional ultrasonic rail inspection uses one or more ultrasonic probes mounted under an inspection vehicle and mounted in contact with the rail. A typical arrangement is shown in Figure 1, which shows a rail 2 and an ultrasonic probe 4 in cross-section.

Acoustic waves are emitted by the ultrasonic probe 4 that propagate through the rail. The waves generally propagate through the rail without reflection, but reflections are caused by cracks or other defects in the rail. If a defect, such as a crack, causes the ultrasonic wave to be reflected, this can be detected at the ultrasonic probe, which is typically able to both emit ultrasonic signals and detect ultrasonic echoes.

Inspection vehicles have been developed to make use of ultrasonic probes to detect a variety of defects that can occur in railway rails, in real time. Data is logged using computers and can be examined in many ways after the recording run has finished. It has been shown over many years that the rail defects can be detected using ultrasonic techniques in real time as the rail inspection vehicle passes over the defect.

Figure 2 shows an ultrasonic defect detection system 6 that is part of an inspection vehicle travelling along a rail 14. The ultrasonic defect detection system 6 includes an ultrasonic probe assembly 8 and a processing system 10. The rail 14 is shown having a crack 16 in the surface of the rail. In use, acoustic pulses having an ultrasonic frequency are emitted from the ultrasonic probe assembly 8 into rail 14 and reflections from defects in the rail 14 (such as crack 16) are detected by the ultrasonic probe assembly 8. The detected reflections are processed by the processing system 10 to determine whether or not a defect is present in the rail.

Although inspection vehicles have been developed to identify defects in rails, in order to address such defects, a team of engineers is required to visit the site of the defect. A problem exists in providing the engineers with accurate information regarding the location of the defects.

The present invention seeks to overcome or address one or more of the problems identified above.

The present invention provides a method of identifying a position of an identified defect in a rail of a rail transport system, the method using a rail defect position indicator system which travels along the rail of said rail transport system, the rail transport system having a plurality of position indicators, the method comprising the steps of:

using a defect detector to identify defects in said rail, the defect detector providing a defect signal on identifying a defect;

obtaining position indicator data identifying said position indicators;

providing relative distance data indicative of the distance travelled by said rail defect position indicator system over time;

applying a series of corresponding timestamps to both said position indicator data and said relative distance data; and

determining, from the time-stamped position indicator and relative distance data, the absolute position of said identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect.

The present invention also provides a rail defect position indicator system for use in a rail transport system having a plurality of position indicators, wherein, in use, the rail defect position indicator system travels along the rail of said rail transport system, the rail defect position indicator system comprising:

a defect detector arranged to identify defects in a rail of said rail transport system and to provide a defect signal on identifying a defect;

position indicator identifying means arranged to provide position indicator data identifying said position indicators;

means for providing relative distance data indicative of the distance travelled by said rail defect position indicator over time; and

a timestamp arranged to apply corresponding timestamps to said position indicator data and said relative distance data,

wherein the position of an identified defect is calculable by determining, from the time-stamped position indicator and relative distance data, the absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect.

The rail defect position indicator system of the present invention may include processing means arranged to:

identify a position indicator from the position indicator data relating to that position indicator; and

determine, from the time-stamped position indicator data and the time-stamped relative distance data, an absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect

The present invention further provides a rail defect position indicator system for use in a rail transport system having a plurality of position indicators, the rail defect position indicator system comprising:

a defect detector arranged to identify defects in a rail of said rail transport system and to provide a defect signal on identifying a defect;

position indicator identifying means arranged to provide position indicator data identifying said position indicators;

means for providing relative distance data indicative of the distance travelled by said rail defect position detector over time; and

a timestamp arranged to apply corresponding timestamps to said position indicator data and said relative distance data,

wherein the rail defect position indicator system further comprises processing means arranged to:

identify a position indicator from the position indicator data relating to that position indicator; and

determine, from the time-stamped position indicator data and the time-stamped relative distance data, an absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect,

wherein, in use, the rail defect position indicator system travels along said rail of said rail transport system.

Thus, the present invention enables the position of a defect to be determined relative to a position indicator, the position of which is known. The system also enables the position of any identified defect to be determined automatically.

In one form of the invention, the defect signal comprises a defect pulse denoting the time at which a defect is detected. This provides a simple data set that clearly identifies when a defect has been detected.

In one form of the invention, the position indicator data comprises a position indicator pulse denoting the time at which a position indicator is detected. The position indicator data may also provide data identifying an individual position indicator, for example by way of a code assigned to that position indicator, which code may be unique to that position indicator.

The relative distance data may comprises an encoder pulse denoting each time the rail defect position indicator system travels a predetermined distance along said rail. In one embodiment, an encoder pulse is output by a distance encoder each time a distance of 5mm is travelled. A count of the number of encoder pulses since a start point may be maintained. Distance encoders for generating such encoder pulses are well known in the art.

In one form of the invention, the absolute position of said identified defect relative to the position of an identified position indicator is determined from the encoder count at the time of detecting the defect and the encoder count at the time of detecting the position indicator. Such a method is prone to errors and the method may additionally provide means for estimating, and compensating for, such errors.

In a preferred embodiment of the invention, the defect detector is an ultrasonic defect detector. Ultrasonic defect detectors are known and are well established in the area of rail defect detection. Nevertheless, the present invention is not limited to the use of ultrasonic defect detectors: alternative defect detectors could be used.

In one exemplary embodiment of the invention, an ultrasonic defect detector is used that comprises an ultrasonic probe assembly arranged to emit acoustic waves having an ultrasonic frequency into said rail and to detect reflections of said acoustic waves. Such arrangements have been successfully used in the industry for some time.

The step of obtaining position indicator data may comprise taking images of position indicators to provide image data relating to said images and processing said image data to identify said position indicators. Any suitable imaging device may be used to take said images of said position indicators: a digital camera is one example.

The position indicators may be identified by alphanumeric characters on said position indicators. Existing, and well established, licence plate reading technology can readily be used to identify such position indicators from the alphanumeric characters on the position indicators.

Alternatively, or in addition, the step of obtaining position indicator data may comprise providing a radio frequency identification tag at each position indicator arranged to transmit an identification code to a receiver at said rail defect position indicator system, thereby enabling individual position indicators to be identified.

Alternatively, or in addition, the step of obtaining position indicator data may include the step of identifying automatic warning system magnets.

Alternatively, or in addition, the step of obtaining position indicator data may include the step of using a global positioning system receiver to obtain position data.

There are a number of ways in which individual position indicators can be identified and a number of different objects that can be used as position identifiers. Signal posts can be used, as can so-called mile posts that are traditionally placed alongside railway lines. As noted above, the present invention is not limited to use which markers alongside the track: automatic warning system magnets can be used, for example. Indeed, any object that has a known position and that can be identified can be used as a position indicator. Furthermore, the system may make use of a number of different position indicators within the same system. The use of different position indicator types within the same system might be used to increase the number of reference points, thereby improving the accuracy of the data. Alternatively, or in addition, the use of different position indicator types within the same system might be used to increase user confidence in the data generated.

Data relating to landmarks can be recorded, again to increase user confidence in the data and/or to include more reference points in the data. Examples of landmarks include entering and leaving a station and entering and leaving a tunnel.

In a preferred form of the invention, the rail defect position indicator system travels along the rail of said rail transport system on a wheeled carriage.

Embodiments of the invention will now be described with reference to the accompanying schematic drawings of which:

Figure 1 is a cross-section of a conventional ultrasonic rail probe;

Figure 2 shows a known ultrasonic defect detection system that forms part of an inspection vehicle travelling along a rail;

Figure 3 is a block diagram showing the functionality of a rail defect position indicator system in accordance with an embodiment of the present invention;

Figure 4 is a graph showing an exemplary output of a signal post detector that forms part of an embodiment of the present invention;

Figure 5 is a graph showing an exemplary output of a distance encoder that forms part of an embodiment of the present invention;

Figure 6 is a graph showing an exemplary output of an ultrasonic defect detector that forms part of an embodiment of the present invention;

Figure 7 is a graph showing exemplary signal post detector data and distance encoder data plotted on the same graph;

Figure 8 is a graph showing distance travelled by a system in accordance with the present invention over time; and

Figure 9 shows a signal post suitable for use with the present invention.

It is known to provide signal posts alongside the rails of a railway track and to provide information on the posts that identifies individual posts. Assuming that the absolute position of each signal post is known, it is possible to determine the absolute position of a rail inspection vehicle as it passes a post by identifying that post.

It is also known to provide a distance encoder for determining the distance travelled by a wheel of an inspection vehicle to assist in determining the position of a vehicle.

The absolute position of an inspection vehicle can be determined by determining the distance travelled by the vehicle relative to a signal post. Thus, the absolute location of a defect identified by a defect detector of an inspection vehicle can be determined by determining the position of the defect relative to a signal post.

Figure 3 shows a rail defect position indicator system indicated generally by the reference numeral 28. The rail defect position indicator system 28 comprises a signal post identifier 30, a distance encoder 32, a defect detector 34, a timestamp 36 and a defect position identifier 38.

The signal post identifier 30 provides data from which the identity of a post and the time at which that post was passed by the rail defect position indicator system 28 can be identified. The distance encoder 32 provides data from which the distance travelled by the rail defect position indicator system 28 over time can be determined. The defect detector 34 provides data indicating that a defect has been identified.

The timestamp 36 adds time information to both the signal post identifier output and the distance encoder output. By providing the same timestamp to the data outputs from both the signal post identifier 30 and the distance encoder 32 it is possible to make use of both sets of data together in order to determine an absolute position of the rail defect position indicator system 28 relative to a signal post at any given time.

Thus, on detection of a defect by the defect detector 34, the defect position identifier 38 is able to determine the position of the defect relative to a signal post and, hence, the absolute position of that defect.

The functionality of the rail defect position indicator system 28 will now be described in more detail with reference to the exemplary timing diagrams of Figures 4 to 7.

Figure 4 shows an exemplary output of the signal post identifier 30, wherein a pulsed signal is output each time a signal post is detected. In addition to the pulsed output shown in Figure 4, an output is provided by the signal post indicator 30 indicating the identity of that post, in a manner described in more detail below. Two pulses are shown in Figure 4. The first pulse indicates the time at which post A1 was detected: the second pulse indicates the time at which post A2 was detected.

Figure 5 shows an exemplary output of the distance encoder 32, wherein a pulsed signal is output each time the rail defect position indicator system 28 travels a distance of 5mm. An encoder count is maintained that simply counts the number of encoder pulses since beginning of the measurement, as described further below. It should be noted that the spacing between encoder pulses is dependent on the speed at which the distance encoder is travelling.

Figure 6 shows an exemplary output of the defect detector 34, wherein a pulsed signal is output each time a defect is detected. The detection of a single defect is shown in the example of Figure 6.

As described above, the timestamp 36 adds a timestamp to both the signal post identifier output and the distance encoder output. In this way, the data from the signal post identifier and the distance encoder can be considered together. Figure 7 combines an exemplary signal post identifier output and an exemplary distance encoder output onto one timing diagram. In the example of Figure 7, a pulse relating to the detection of signal post A7 is shown. In addition, a number of encoder pulses are shown. The encoder count relating to some of the encoder pulses is also shown, starting at 1 and extending to 31.

Providing the same timestamp to the data outputs from both the signal post identifier and the distance encoder enables the absolute position of the rail defect position indicator system 28 relative to a signal post to be determined at any given time.

Consider the position of the rail defect position indicator system 28 when the encoder count in the example of Figure 7 changes from 19 to 20. As can be seen in Figure 7, the encoder count was 3 when the signal post A7 was detected. Thus, the distance from the signal post A7 to the position at the time at which the encoder count changes from 19 to 20 must be sixteen full encoder count distances (16 times 5mm) plus one partial encoder count distance (the distance before the encoder count changed from 3 to 4). Thus, the absolute position of the rail defect position indicator system 28 when the encoder count changed from 19 to 20 was between 80mm and 85mm from the signal post A7.

The uncertainty is due to the unknown distance before the encoder count changes from 3 to 4. This distance can be estimated in a number of ways, as described below.

When a defect is detected by the defect detector 34, that defect is tagged with the encoder count at that point. From the encoder count, it is possible to determine between which two encoder pulses the defect occurred. From this data, it is possible to estimate the absolute position of the detected defect.

Consider the exemplary situation when, as in the exemplary data shown in Figure 7, the signal post A7 is identified when the encoder count is 3. Assume that a defect is detected when the encoder count is 71 (not shown in Figure 7). When the encoder count changed from 70 to 71, the position of the rail defect position indicator system 28 was between 335mm and 340mm from the signal post A7. Similarly, when the encoder count changed from 71 to 72, the position of the rail defect position indicator system 28 was between 340mm and 345mm. Thus, when the encoder count is 71, the absolute position of the rail defect position indicator system 28 must have been between 335mm and 345mm from signal post A7.

Thus, a measure of the absolute position of the rail defect position indicator system 28 to within 10mm can be readily obtained. There are two significant sources of uncertainty here: the distance travelled after signal post A7 was detected before the encoder count changed from 3 to 4 and the distance travelled after the encoder count changed from 70 to 71 before the defect was detected. A more precise estimate of the location of the defect can be determined by estimating both of the distances described above.

Figure 8 shows a graph in which the timing of the encoder count pulses is converted into a graph showing the distance travelled by rail defect position indicator system 28 over time. As indicated above, an encoder pulse is output every time the distance encoder travels 5mm. When a pulse is output, the position of the distance encoder relative to a start position is known precisely. By determining a curve that best fits the data provided by the distance encoder, the distance travelled from a start point can be estimated for any given time. Further, the distance travelled between any start and finish times can be estimated. Of course, many schemes for providing curves that fit a number of data points are known to persons skilled in the art. Details of such schemes are not given here.

In the example of Figure 8, a time "A8" is shown, representing the time at which a signal post A8 was identified and a time "defect" is shown representing the time at which a defect was detected. From the graph, it can be estimated that at the time at which the signal post A8 was identified, the rail defect position indicator system 28 had travelled a distance of 10mm from a start point and at the time at which the defect was detected, the rail defect position indicator system 28 had travelled a distance of 220mm from a start point. Thus, the graph shows that the defect is located approximately 210mm from the signal post A8.

The algorithm described with reference to Figure 8 is one method for estimating the uncertainties described above. The skilled person would be aware of many other algorithms that could be used.

As described above, ultrasonic systems that automatically detect defects in rails are well known in the art. The present invention provides a system that automatically determines the position of the detected defects. In order for this process to be automated, the detection of both the presence and the identity of the signal posts must also be automated.

Figure 9 shows an exemplary signal post 40. The signal post 40 includes a unique identifier, which is typically a series of alphanumeric characters ("A13Z" in the example of Figure 9).

It is well known to provide camera systems that are able to accurately and reliably determine the alphanumeric characters provided on such a post. One exemplary system is the P372 'SPIKE' Camera manufactured by PIPS Technology Ltd (street address: Pips Technology Limited, York House, School Lane, Chandler's Ford, Eastleigh, SO53 4DG, United Kingdom. Website: www.pipstechnology.com).

The Spike camera is a fully integrated licence-plate reading camera incorporating the camera, illuminator and the automatic licence plate recognition (ALPR) processor within a single sealed enclosure. Triggering of the ALPR reader can be internal from the video image, or by an external sensor.

The use of such cameras in the licence plate recognition market is well established. The Spike camera available from Pips Technology Limited is one example of many that are available.

It should be noted that cameras used for the signal post detection captures a field at 50Hz in the UK and 60Hz in the US. Accordingly, there is a granularity in the capture time of 20ms in the UK and 16ms in the US. The signal post plate may be in the field of view for a number of fields. The camera selects the best image to perform the optical character (OCR) recognition of the text on the signal post plate. The time stamp of the image used by the OCR engine may vary by multiples of 20ms depending upon which field was used by the OCR engine.

As the speed of the train varies the distance travelled in this period of uncertainty will vary. The spatial relationship between the signal post detection and the position of the defect will vary. Thus, there is a small error inherent in the timestamp data with which the defect data is associated. Alternatives to camera-based identification systems are discussed below.

Encoders suitable for implementing the distance encoder 32 described above are well known in the art. An exemplary system is the HD25-2048-FS-HV-AB50-ID-CN10 manufactured by US Digital Corporation (street address: US Digital Corporation, 11100 NE 34th Circle, Vancouver, WA 98682 USA. Website: www.usdigital.com).

Encoders in the HD25 range are optical incremental shaft encoders designed for heavy-duty industrial applications. There are, of course, many other encoder devices available that could be used instead of the US Digital Corporation product identified above.

An embodiment of the present invention has been described above. The person skilled in the art would be aware of many modifications that could be made to that system.

For example, the distance encoder could output a pulse when a distance greater or smaller than 5mm is travelled. Further, the position of an inspection vehicle between encoder pulses could be estimated in a number of ways, for example by assuming that the speed of the inspection vehicle is constant from the time taken for the distance travelled between encoder counts. An alternative embodiment could reset the encoder count to zero when a signal post is detected. In another variant, the distance encoder could be replaced with any device that can be used to generate data recording the distance travelled over time. Although an ultrasonic defect detector has been described, other forms of defect detectors could be used. Further, the imaging system described above for identifying the signal posts could be replaced in a number of ways, for example, the posts themselves could transmit a signal indicative of that post, with the signal post identifier comprising a receiver that detects that signal and identifies the post from that signal.

The system described above makes use of optical recognition of signal posts to define an absolute position. This is not essential. Any system that can reliably define an absolute position could be used.

By way of example, the use of radio frequency identification (RFID) tags for automatically tolling on motorways is well known. Such RFID tags could be mounted on signal posts or other similar structures on the railway network, with a detector being provided at the inspection vehicle that responds to the unique ID of the RFID tag of a particular signal post as the inspection vehicle passes. Thus, an RFID system can readily be implemented instead of, or in addition to, the optical camera system described above.

The well known Global Position System (GPS) makes use of satellite technology to provide absolute position information to a GPS receiver. The present invention can make use of a GPS receiver in the inspection vehicle to obtain a position fix. This position fix combined with the encoder count can give a location measurement. The inspection teams that go back to the location where a defect is reported can also use a GPS receiver to return to a known point and measure the distance specified by the encoder from the GPS location to the defect. Other instruments can be combined with the GPS receiver to improve the quality of the position fix. An example of another instrument would be a fibre optic gyro.

Mileposts are typically provided alongside railway tracks. As an inspection vehicle passes a milepost, an operator can reset the encoder count to the start of a new mile. It should be noted that mile posts on any railway network may not be spaced by statute miles. Other standard distances (e.g. kilometres) may be used. Also, the distances between posts may vary: railways typically use long and short miles and local knowledge determines their exact location. Nevertheless, the absolute location of each milepost is known, making them suitable for use as position indicators.

An operator can indicate when the inspection vehicle enters or leaves a station or other landmark and hence add an indication to the inspection records at a measured encoder count to improve the location measurement for the inspection vehicle.

There are other features on the railway network that can be automatically detected by the inspection vehicle to improve the location measurement. An example is an AWS (Automatic Warning Signal) magnet in the track. The location of an AWS magnet has a known position in railway miles on the network.

It should be noted that the list of features that can be used as position indicators given above is not exhaustive. Further, it should be noted that any of these features can be used alone or in combination with others. The use of different types of position indicators in the same system may be used to increase the number of reference points (thereby increasing the overall accuracy of the system) and/or to increase user confidence in the data generated.

It should also be noted that signal post detection can be used on underground railways where GPS will not work to improve the location measurement of the defect.

Signal post detection is also useful to confirm that the inspection vehicle is on the correct track. The route of an inspection test for a vehicle is planned in advance of the test but for operational reasons the inspection vehicle might not be able to complete the planned route. Signal post detection provides a record of where the inspection vehicle actually travelled which provides invaluable information for the team that analyses the data from the vehicle and for the inspection teams that go back onto the track to confirm the defect.

Claims:

1. A method of identifying a position of an identified defect in a rail of a rail transport system, the method using a rail defect position indicator system which travels along the rail of said rail transport system, the rail transport system having a plurality of position indicators, the method comprising the steps of:

using a defect detector to identify defects in said rail, the defect detector providing a defect signal on identifying a defect;

obtaining position indicator data identifying said position indicators;

providing relative distance data indicative of the distance travelled by said rail defect position indicator system over time;

applying a series of corresponding timestamps to both said position indicator data and said relative distance data; and

determining, from the time-stamped position indicator and relative distance data, the absolute position of said identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect.

2. A method as claimed in claim 1, wherein said defect signal comprises a defect pulse denoting the time at which a defect is detected.

3. A method as claimed in claim 1 or claim 2, wherein said position indicator data comprises a position indicator pulse denoting the time at which a position indicator is detected.

4. A method as claimed in any preceding claim, wherein said relative distance data comprises an encoder pulse denoting each time the rail defect position indicator system travels a predetermined distance along said rail.

5. A method as claimed in claim 4, further comprising the step of maintaining a count of the number of encoder pulses since a start point.

6. A method as claimed in claim 5, wherein the absolute position of said identified defect relative to the identified position of an identified position indicator is determined from the encoder count at the time of detecting the defect and the encoder count at the time of detecting the position indicator.

7. A method as claimed in any preceding claim, wherein said defect detector is an ultrasonic defect detector.

8. A method as claimed in claim 7, wherein said ultrasonic defect detector comprises an ultrasonic probe assembly arranged to emit acoustic waves having an ultrasonic frequency into said rail and to detect reflections of said acoustic waves.

9. A method as claimed in any preceding claim, wherein the step of obtaining position indicator data comprises taking images of position indicators to provide image data relating

to said images and processing said image data to identify said position indicators.

10. A method as claimed in claim 9, further comprising the step of using a digital camera to take said images of said position indicators.

11. A method as claimed in any preceding claim, wherein said position indicators are identified by alphanumeric characters on said position indicators.

12. A method as claimed in any preceding claim, wherein the step of obtaining position indicator data comprises providing a radio frequency identification tag at each position indicator arranged to transmit an identification code to a receiver at said rail defect position indicator system.

13. A method as claimed in any preceding claim, wherein the step of obtaining position indicator data includes the step of identifying automatic warning system magnets.

14. A method as claimed in any preceding claim, wherein the step of obtaining position indicator data includes the step of using a global positioning system receiver to obtain position data.

15. A method as claimed in any preceding claim, wherein, in use, said rail defect position indicator system travels along the rail of said rail transport system on a wheeled carriage.

16. A rail defect position indicator system for use in a rail transport system having a plurality of position indicators, wherein, in use, the rail defect position indicator system travels along the rail of said rail transport system, the rail defect position indicator system comprising:

a defect detector arranged to identify defects in a rail of said rail transport system and to provide a defect signal on identifying a defect;

position indicator identifying means arranged to provide position indicator data identifying said position indicators;

means for providing relative distance data indicative of the distance travelled by said rail defect position indicator over time; and

a timestamp arranged to apply corresponding timestamps to said position indicator data and said relative distance data,

wherein the position of an identified defect is calculable by determining, from the time-stamped position indicator and relative distance data, the absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect.

17. A rail defect position indicator system as claimed in claim 16, wherein the rail defect position indicator system further comprises processing means arranged to:

identify a position indicator from the position indicator data relating to that position indicator; and determine, from the time-stamped position indicator data and the time-stamped relative distance data, an absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect

18. A rail defect position indicator system for use in a rail transport system having a plurality of position indicators, the rail defect position indicator system comprising:

a defect detector arranged to identify defects in a rail of said rail transport system and to provide a defect signal on identifying a defect;

position indicator identifying means arranged to provide position indicator data identifying said position indicators;

means for providing relative distance data indicative of the distance travelled by said rail defect position detector over time; and

a timestamp arranged to apply corresponding timestamps to said position indicator data and said relative distance data,

wherein the rail defect position indicator system further comprises processing means arranged to:

identify a position indicator from the position indicator data relating to that position indicator; and

determine, from the time-stamped position indicator data and the time-stamped relative distance data, an absolute position of an identified defect by determining the position of the rail defect position indicator system, relative to the identified position of an identified position indicator, at the time of identifying the defect,

wherein, in use, the rail defect position indicator system travels along said rail of said rail transport system.

19. A rail defect position indicator system as claimed in any one of claims 16 to 18, wherein said means for providing relative distance data is a distance encoder arranged to provide encoder data including an encoder pulse each time a predetermined distance is travelled by said rail defect position indicator system.

20. A rail defect position indicator system as claimed in claim 19, further comprising processing means for maintaining a count of the number of said encoder pulses since a start point.

21. A rail defect position indicator system as claimed in any one of claims 16 to 20, wherein said defect detector is an ultrasonic defect detector.

22. A rail defect position indicator system as claimed in claim 21, wherein said ultrasonic defect detector comprises an ultrasonic probe assembly arranged to emit acoustic waves having an ultrasonic frequency into said rail and to detect reflections of said acoustic waves.

23. A rail defect position indicator system as claimed in any one of claims 16 to 22, wherein said position indicator identifying means is an imaging device arranged to take

images of said position indicator and to provide image data relating to said images.

24. A rail defect position indicator system as claimed in claim 23, wherein said imaging device is a digital camera.

25. A rail defect position indicator system as claimed in any one of claims 16 to 24, wherein said position indicators are identified by alphanumeric characters on said position indicators.

26. A rail defect position indicator system as claimed in any one of claims 16 to 25, wherein said position indicators include a radio frequency identification tag and said position indicator identifying means includes a receiver for receiving an identification code transmitted by a radio frequency identification tag.

27. A rail defect position indicator system as claimed in any one of claims 16 to 26, wherein said position indicators include automatic warning system magnets and said position indicator identifying means includes means for identifying said automatic warning system magnets.

28. A rail defect position indicator system as claimed in any one of claims 16 to 27, wherein said position indicator identifying means includes a global positioning system receiver to obtain position data.

29. A rail defect position indicator system as claimed in any one of claims 16 to 28, further comprising a wheeled carriage, wherein, in use, said rail defect position

indicator system travels along said rail of said rail transport system on said wheeled carriage.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB0510346.0

Claims searched: 1-29

Examiner: Eleanor Hogan

Date of search: 8 August 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X: 1, 4, 5, 7, 8, 14-22, 28 & 29 at least; Y: 9 and 23 at least.	US 2002/099507 A1 (CLARK et al) see abstract, paras. 9 21, 30-32 & 40, and figs.
X,Y	X: 1, 4, 5, 7, 8, 14-22, 28 & 29 at least; Y: 9 and 23 at least.	WO 02/30729 A1 (SPERRY RAIL) see abstract, pages 33 & 36 and figs.
X,Y	X: 1, 4, 7, 8, 14-22, 28 & 29 at least; Y: 9 & 23 at least	US 5970438 A (CLARK et al) see abstract, cols. 6 & 7, and figs.
X,Y	X: 1 at least; Y: 9 & 23 at least.	EP 1175593 A1 (HERZOG CONTRACTING) see abstract, page 7 line 20 - page 8 line 5, and figs.
X,Y	X: 1 at least; Y: 9 & 23 at least.	EP 0414693 A1 (PEDERSEN) see abstract, page 7 and figs.
Y	9 and 23 at least.	US 4864306 A (WITTA) see abstract.

A	-	US 6055862 A (MARTENS)
A	-	GB 2166274 A (WESTINGHOUSE BRAKE & SIGNAL)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

G1G; G1N

Worldwide search of patent documents classified in the following areas of the IPC^{07}

B61K; B61L; G01D

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC.