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IN REPLY REFER TO:

Attorney Docket No. 78771
Date: 11 April 2002

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Serial Number 09/832,087

Filing Date 11 April 2001

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Attorney Docket No. 78771

METHOD AND APPARATUS FOR DETECTING MISALIGNED RAILROAD TRACKS

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT THEODORE R. ANDERSON, citizen of the United States of America, employee of the United States Government and resident of Galway, County of Saratoga, State of New York, has invented certain new and useful improvements entitled as set forth above of which the following is a specification:

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METHOD AND APPARATUS FOR DETECTING MISALIGNED TRACKS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention generally relates to warning and alarm systems and more particularly to railway warning and alarm systems that can detect a railroad track misalignment.

(2) Description of the Prior Art

Various alarm systems have been proposed for detecting a number of conditions in a railroad system including broken tracks, train collisions and other faults. For example, United States Letters Patent No. 3,696,243 (1972) to Risley discloses a broken rail detector in which a transmitter provides coded pulses to a relay. The relay, intermittently and according to the code, applies electrical energy to each track at different polarities. A receiver receives the coded energy at a position remote from the transmitter. Any change in the received code indicates to

the transmitter that some change in track characteristics has occurred.

United States Letters Patent No. 4,207,569 (1980) to Meyer discloses a railroad radio frequency waveguide for conducting radio frequency signals ahead of a train and along a railroad line comprising the ballast, ties and rails. Reflections received by a receiver on the train represent changes in the characteristics impedance of the waveguide. These reflections may be compared to anticipated reflections in order to detect improper conditions such as a broken track or the presence of another train.

United States Letters Patent No. 4,306,694 (1981) to Kuhn discloses a dual signal frequency motion monitor and broken rail detector. A highway crossing warning system for monitoring the motion and predicting the time of arrival of an approaching train at the highway crossing and for detecting the presence of a broken rail in the approach zone is acheived by feeding dual frequency signals into the track rails and measuring the track impedances at the two frequencies and the phase angle of the lower of the two frequencies.

United States Letters Patent No. 4,886,226 (1989) to Frielinghaus discloses a broken rail and/or broken rail joint bar detection system. This system detects rail breaks in dark territory track sections, i.e., track sections that do not have a signaling system. A communications link may exist between the ends of the track sections.

United States Letters Patent No. 4,932,618 (1990) to Davenport et al. discloses a sonic track condition determination system. Sonic transponders mount on a train and the track upon which it rolls and transmit and receive sonic vibrations along the track. Information currently being transmitted electrically may also be transmitted sonically. Since the track interferes with the sonic vibrations more than it does with an electrical signal, the condition of the track may also be determined. Specifically, this invention utilizes six steps including (1) impressing a first sonic vibration in a predetermined form on the track at the train, (2) receiving the first sonic vibration from the track at the point on the track distant from the train, (3) impressing a second sonic vibration, in a predetermined form, on the track at the point of the track distant from the train, (4) receiving the second sonic vibration from the track at the train, (5) comparing the first or second sonic vibration as received with the corresponding sonic vibration as predetermined, and (6) converting the comparison of the vibration as received with the corresponding vibration as predetermined into a determination of the condition of the track between the train and the point on the track distant from the train.

United States Letters Patent No. 4,979,392 (1990) to Guinon discloses a railroad track detector that mounts on a track vehicle and uses the track ahead or behind the vehicle as a transmission line for a high frequency signal. The transmission line has a known characteristic impedance and a condition of no track fault. The impedance is included in a bridge network that

is excited with the high frequency signal. Bridge imbalance indicates a track fault that can be a complete or partial short circuit or open circuit. The bridge excitation is applied to the track through moving contacts, like brushes, ahead of the front wheels or behind the last wheels. The shunt effect of the wheels close to the brushes is eliminated by a tuning impedance that creates an effective infinite impedance to the portion of the track between the moving contacts and the shunting wheels.

United States Letters Patent No. 5,713,540 (1989) to Gerszberg et al. discloses a method and apparatus for detecting railway activity by means of a highly reliable, early warning system that can provide efficient detection of railway activity in which an acoustic sensor circuit coupled to the railway detects sound waves resulting from physical vibrations on the tracks. An acoustic analysis of the detected sound waves identifies any suspect conditions and generates an alarm signal accordingly. An acoustic signal processing unit stores detected sound waves in a sound file for quick retrieval and analysis. The alarm signal may be transmitted over any communications system to the central control office and to trains traveling on the dangerous track. The stored sound files may be locally retrieved or downloaded to a remote location over a cellular system thus enabling the analysis of the actual sound generated by the dangerous condition to determine the cause therefore.

Generally speaking, the foregoing references can be categorized as suggesting the detection of an imbalance in the electrical characteristic of two rails. The Meyer patent also

discloses the concept of using an imbalance to signal a fault. Each of these systems, however, requires reasonably expensive installations particularly requiring equipment at various sites. Moreover, these patents disclose systems that will detect major faults, as a broken track. However, there are a number of situations in which mere misalignment of a track may cause a derailment. Such misalignments can often occur at bridges, for example, where the tracks on the bridge span may be swung out of position or moved out of alignment with the tracks on land. It is important when the bridge is closed that the tracks exactly align in both the horizontal and vertical orientations. None of these references appears to disclose or suggest any modality that is sufficiently sensitive to detect any such misalignment. What is needed is a system that can be used to detect such misalignments and can be easily installed in the vicinity of a track subject to such a misalignment, as at any bridge.

SUMMARY OF THE INVENTION

Therefore it is an object of this invention to provide a method and apparatus for detecting track misalignments.

Another object of this invention is to provide a method and apparatus for detecting track misalignments that is efficient to operate.

In accordance with one aspect of this invention, the detection of a railroad track misalignment in a predetermined track area includes directing RF energy to a proximally positioned rail remotely from the predetermined track area

whereby the track acts as a traveling wave antenna. The RF signal is then detected at a remote site proximate the site of the potential misalignment. An alarm responds to the level of the received signal when the received signal exceeds a predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

The appended claims particularly point out and distinctly claim the subject matter of this invention. The various objects, advantages and novel features of this invention will be more fully apparent from a reading of the following detailed description in conjunction with the accompanying drawings in which like reference numerals refer to like parts, and in which:

FIG. 1 is a block diagram in perspective form of an area of a railroad track that includes detection apparatus constructed in accordance with this invention;

FIG. 2 is a diagram of two sections of a rail in alignment; and

FIG. 3 is a perspective view of two rails in misalignment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 depicts an apparatus for detecting railroad track misalignment 10, including one track section 11 that forms a part of a drawbridge, or the like, with fixed track rails 12 and 13 and a section of track 14 with track rails 15 and 16 permanently affixed to the ground. As depicted by the dashed lines, the track section 11 can be pivoted or otherwise displaced to a

position 11A out of alignment with the track section 14. FIG. 1 depicts a representative cross tie with each track section.

As shown in FIGS. 1 and 2, when the track rails 12 and 15 of the sections 11 and 14 are aligned, the surfaces of the track 12 essentially constitute an extension or continuation of the surfaces of the track rail 15. There is a small gap between the track rails 12 and 15, but essentially the surfaces of the adjacent tracks as shown by the gaps 17 and 18 in FIG. 1 remain aligned. FIG. 3 depicts a misalignment whereby the track rail 12 is depressed and slightly to the left of track rail 15. Now there is a significant discontinuity at 17 because the extensions of the surfaces of the track rail 15 intersect the end of the track rail 12 at the gap 17.

Referring again to FIG. 1, apparatus 10 senses any variation in the gap caused by a track misalignment as shown in FIG. 3. Specifically, an RF transmitter 20 includes an RF generator 21, a waveguide 22 and a horn antenna 23. The horn antenna 23 directs RF energy along a transmission axis 24 to intercept the track rail 15 at a location 25 that is spaced from the predetermined area of the gaps 17 and 18. In this particular embodiment the RF transmitter 20 is proximate the fixed track section 14 but spaced from the track rail 15. When the generator 21 produces an RF energy, that energy moves along the axis 24 and intercepts the track rail 15 where the electromagnetic wave from the horn antenna 23 becomes a traveling wave that travels along the track rail 15, so the track rail acts as a traveling wave antenna.

An RF detector 30 includes a horn antenna 31 positioned proximate the track rails 12 and 15 and aimed at the gap 17. A waveguide 32 directs RF energy received by the horn antenna 31 along the axis 33 into a receiver 34. When the receiver 34 receives a signal of sufficient strength, it energizes an alarm 35. If the track rails 12 and 15 are in alignment, a minimal surface discontinuity exists at the gap 17. Thus as shown in FIG. 2, only minimal RF energy 41 radiates from the gap 17. The alarm 35 will be set so that the output from the receiver 34 will not sound an alarm at such an output magnitude.

When however the track rail 15 and track rail 12 are not in alignment, as shown in FIG. 3, there is no continuity of the surfaces at the gap 17. The resulting discontinuity causes a greater level of RF energy 42 to radiate from the discontinuity. When this occurs, the RF signal intercepted by the horn antenna 31 and sent to the receiver 34 along the axis 33 and through the waveguide 32 produces a larger signal that exceeds a predetermined value or threshold so the alarm 35 announces the misalignment.

The RF transmitter 20 and RF detector 30 can operate at any of a wide range of RF frequencies. For a specific implementation, a selected frequency could be up to about 60 GHz. The selection will depend upon a number of factors, such as desired measurement accuracy, as known in the art.

Each horn antenna will be spaced from the rail, preferably within a few wavelengths of the rail to minimize power dissipation. Generally the physical characteristics of the

environment will be determinative of specific spacing for an application.

FIG. 1 also depicts a control circuit 36 that connects to the RF generator 21, the RF receiver 34 and alarm 35. In one embodiment the control 36 could schedule tests on a time or event basis. A scheduled train arrival time would be an example of a time basis; a bridge closure, an event basis. The test sequence could be defined with the steps of energizing circuits, waiting for a warm-up interval, conducting an active test and then shutting the system down. As will be apparent, the control 36 could be local or remote and could perform any of a variety of additional or alternative functions.

There are many possible implementations of this invention. The entire system could operate continuously or intermittently. For example, part of the bridge closure process could include energizing the RF transmitter 20 and RF detector 30 thereby to check the alignment of tracks immediately after each closure. In FIG. 2 the RF transmitter 20 transfers data onto a track 15 on land. The RF transmitter 20 could also be placed on the bridge with the RF energy being coupled onto the rail 12. In either case the rails 12 and 15 will act as a traveling wave antenna.

Further, the embodiment of FIG. 1 is depicted on a dual railroad track. It is understood that the apparatus 10 can be used on any single or multiple rail system where the rail can act as a traveling wave antenna.

FIG. 1 depicts an embodiment of this invention in which the process is directed to the rails 12 and 15. In the alternative,

the rails 13 and 16 would be tested. Any such single rail, of course, assumes that the rails on the movable span remain exactly parallel and that there is no possibility of any misalignment of the non-tested rail. If that assumption is not correct, a dual system can be used to test both tracks simultaneously. Such a dual system might incorporate independent RF transmitters and detectors or a single RF transmitter with a single or double RF detector arrangement.

FIG. 1 also depicts a system in which the transmitting axis 24 is at about 45° to the track rail 15 while the receiving axis 33 is at about 90° to the tracks rails 12 and 15 at the gap 17. These are representative angles only. In different installations the operating parameters and physical constraints on equipment location might result in other angular relationships.

This application has disclosed a system with various components at a block level. It will be apparent such elements for generating a specific design frequency will be produced by conventional means without additional inventive input. That is, the design and construction of such components is well within the abilities of the persons of ordinary skill in the art.

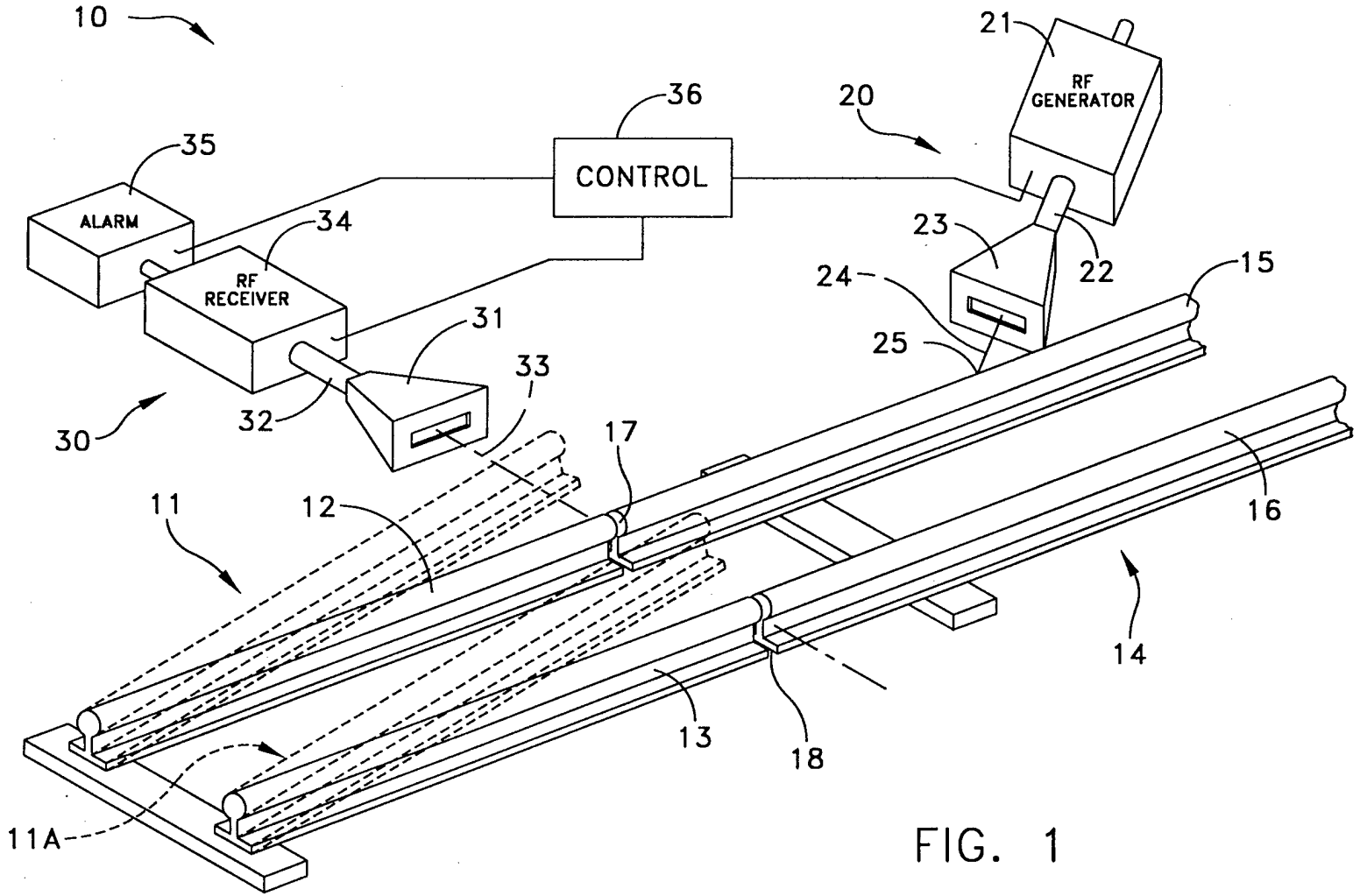
This invention has been disclosed in terms of certain embodiments. It will be apparent that many modifications can be made to the disclosed apparatus without departing from the invention. Therefore, it is the intent of the appended claims to cover all such variations and modifications as come within the true spirit and scope of this invention.

Attorney Docket No. 78771

METHOD AND APPARATUS FOR DETECTING MISALIGNED RAILROAD TRACKS

ABSTRACT OF THE DISCLOSURE

A warning system for identifying a track misalignment. An RF generator and horn antenna direct energy onto a track rail that acts as a traveling wave antenna. An antenna near a potential discontinuity radiates RF energy, the amount of energy radiated being related to the amount of misalignment in the track. If radiated energy exceeds a certain threshold, a receiver energizes an alarm that announces a misalignment.


10
21
RF
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RF
RECEIVER
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11A

FIG. 1

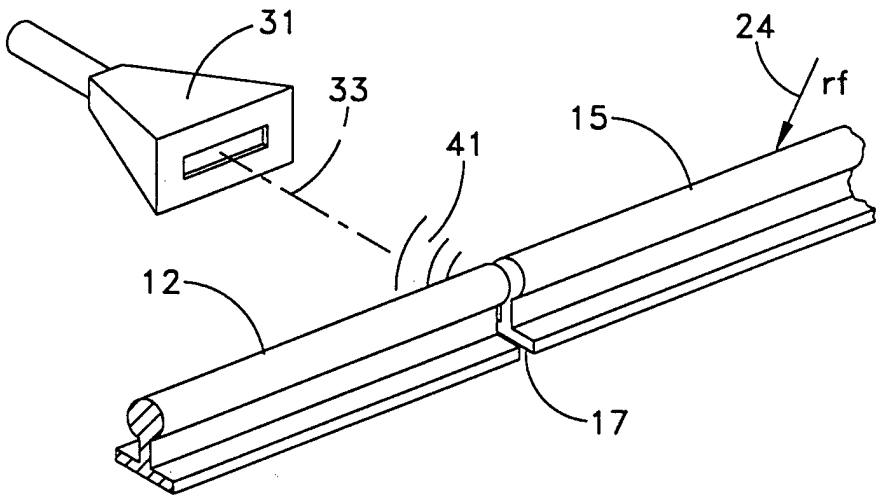

FIG. 2

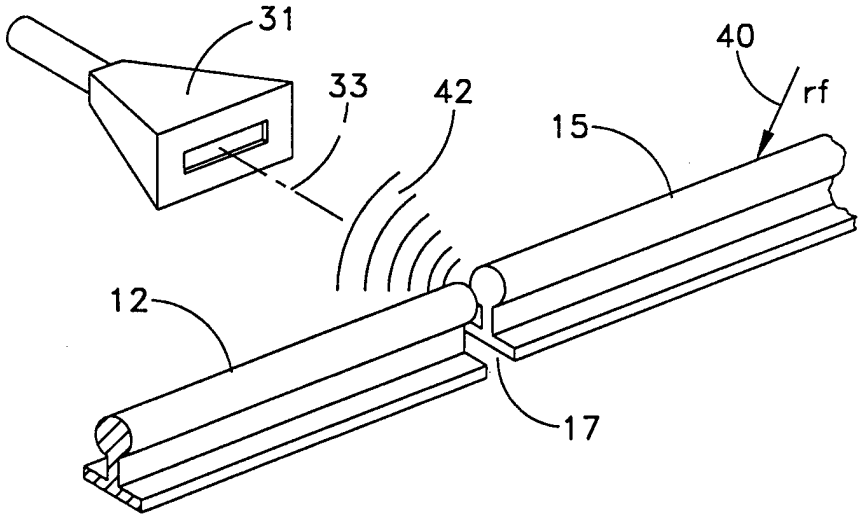

FIG. 3