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Application Number: 16515903 Document Date: 07/18/2019

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Form Revision Date: March 1, 2019

Siemens Exhibit 1002
Siemens et al. v. Metrom Rail

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Richard C. Carlson	Nonprovisional Application Number (if known):	
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Rami N. Moussa/	Date July 18, 2019
Name (Print/Typed) Rami N. Moussa	Practitioner Registration Number 69528

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Richard	C.	Carlson	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Palatine	State/Province	IL	Country of Residence	US

Mailing Address of Inventor:

Address 1	2381 North Newberry lane		
Address 2			
City	Palatine	State/Province	IL
Postal Code	60074	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kurt	Alan	Gunther	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

City	Woodstock	State/Province	IL	Country of Residence	US

Mailing Address of Inventor:

Address 1	2505 Thoroughbred Trail		
Address 2			
City	Woodstock	State/Province	IL
Postal Code	60098	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Sara Jo		Woitel	

Residence Information (Select One) ◉ US Residency Non US Residency Active US Military Service

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

City	Lake Zurich	State/Province	IL	Country of Residence	US

Mailing Address of Inventor:

Address 1	287 Hickory Road
Address 2	

City	Lake Zurich	State/Province	IL
Postal Code	60047	Country	US

Inventor 4 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Marc	Wayne	Cygnus	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Mundelein	State/Province	IL	Country of Residence	US

Mailing Address of Inventor:

Address 1	214 North Lakeshore Dr.
Address 2	

City	Mundelein	State/Province	IL
Postal Code	60060	Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	23446		
Email Address	mhmpto@mcandrews-ip.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL		
Attorney Docket Number	63154US03	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	17	Suggested Figure for Publication (if any)	1

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	23446		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16290576	2019-03-01

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16290576	Continuation in part of	16055905	2018-08-06
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16055905	Claims benefit of provisional	62541454	2017-08-04
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16290576	Claims benefit of provisional	62637774	2018-03-02
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Metrom Rail, LLC		
Mailing Address Information For Applicant:			
Address 1	1125 Mitchell Ct.		
Address 2			
City	Crystal Lake	**State/Province**	IL
Country	US	Postal Code	60014
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Rami N. Moussa/			Date (YYYY-MM-DD)	2019-07-18
First Name	Rami N.	Last Name	Moussa	Registration Number	69528

Additional Signature may be generated within this form by selecting the Add button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	63154US03
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ABSTRACT

Systems and methods are provided for decentralized rail signaling and positive train control. A decentralized train control system may include a plurality of wayside units, configured for placement on or near tracks in a railway network, and one or more train-mounted units, each configured for use in a train operating in a railway network that support use of the decentralized train control system. Each train-mounted unit may configured to receive communicate with any wayside unit and/or train-mounted unit that comes within range, with the communicating including use of ultra-wideband (UWB) signals, and for generating control information based on the UWB signals, for use in controlling one or more functions associated with operation of the train.

CLAIMS

What is claimed is:

1. A train-mounted device, configured for use within a train to support a decentralized train control system, the train-mounted device comprising:

one or more antennas, configured for transmitting and/or receiving wireless signals; and

one or more circuits configured to:

process signals and data, and

perform one or more functions relating to operations of the train-mounted device within the decentralized train control system;

wherein the train-mounted device is configured to, during operation of the train within a railway network that supports use of the decentralized train control system:

communicate with any wayside unit and/or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises transmission and/or reception of ultra-wideband (UWB) based signals;

processing the ultra-wideband (UWB) based signals; and

generate based on the processing of the ultra-wideband (UWB) based signals, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network.

2. The train-mounted device of claim 1, wherein the train-mounted device is configured to generate at least part of the control information based on sources other than the processing of the ultra-wideband (UWB) based signals.

3. The train-mounted device of claim 1, wherein the train-mounted device is configured to:

assess based on the processing of the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

when at least one condition meets one or more particular criteria, determine one or more responsive actions; and

perform or cause performing each of the one or more responsive actions.

4. The train-mounted device of claim 3, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:

monitor actions of the train operator;

assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

5. The train-mounted device of claim 1, wherein the train-mounted device is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or the other train-mounted unit.

6. The train-mounted device of claim 1, wherein the train-mounted device is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

7. The train-mounted device of claim 1, wherein the train-mounted device is configured for handling satellite based signals.

8. The train-mounted device of claim 7, wherein the train-mounted device is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

9. The train-mounted device of claim 1, wherein the train-mounted device is configured for connecting to and/or interfacing with other systems of the train.

10. The train-mounted device of claim 1, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.

11. The train-mounted device of claim 1, comprising a power component for supplying and/or obtaining power for components of the train-mounted device.

12. The train-mounted device of claim 1, wherein the train-mounted device is configured for communicating, directly or via at least one of the wayside unit and the other train-mounted device, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.

13. A wayside device, configured for use in a railway network that supports use of a decentralized train control system, the wayside device comprising:

one or more antennas, configured for transmitting and/or receiving wireless signals; and

one or more circuits configured to:

process signals and data, and

perform one or more functions relating to operations of the wayside device within a decentralized train control system;

wherein:

the wayside device is configured to communicate with any train-mounted unit, configured for use within a train to support the decentralized train control system during operation of the train within the railway network, when the train-mounted unit comes within communication range of the train-mounted unit; and

the communicating comprises transmission and/or reception of ultra-wideband (UWB) based signals.

14. The wayside device of claim 13, wherein the wayside device is configured for utilizing non-UWB based signals for communicating at least some data with the train-mounted unit.

15. The wayside device of claim 13, wherein the wayside device is configured for communicating with other components or devices in the railway network, not mounted within trains.

16. The wayside device of claim 15, wherein the wayside device is configured for communicating with at least one other component or device in the railway network via wired based connection.

17. The wayside device of claim 13, comprising a support structure for holding and/or supporting the wayside device when placed on or near the tracks.

18. The wayside device of claim 13, comprising a power component for supplying and/or obtaining power for components of the wayside device.

19. The wayside device of claim 13, comprising a housing for enclosing components of the wayside device;

20. A system for providing decentralized control operations in a railway network, the system comprises:

a plurality of wayside units, each configured for placement on or near tracks in the railway network; and

one or more train-mounted units, each configured for deployment on a train operating in the railway network;

wherein each train-mounted unit is configured to:

communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and

generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network.

METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

CLAIM OF PRIORITY

[0001] This patent application is a continuation of United States Patent Application Serial No. 16/290,576, filed on March 1, 2019, which claims priority to United States Provisional Patent Application Serial No. 62/637,774, filed on March 2, 2018, and which is a continuation-in-part of United States Patent Application Serial No. 16/055,905, filed on August 6, 2018, which in turn claims priority to United States Provisional Patent Application Serial No. 62/541,454, filed on August 4, 2017. Each of the above identified applications is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Aspects of the present disclosure relate to control technologies and solutions in conjunction with railway systems. More specifically, various implementations of the present disclosure relate to methods and systems for decentralized rail signaling and positive train control.

BACKGROUND

[0003] Various issues may exist with conventional approaches for controlling trains. In this regard, conventional systems and methods, if any existed, for controlling trains particularly in mass transit systems, may be costly, inefficient, and cumbersome. Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with some aspects of the present disclosure as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY

[0004] System and methods are provided for decentralized rail signaling and positive train control, substantially as shown in and/or described in connection with at least one of the figures, as set forth more completely in the claims.

[0005] These and other advantages, aspects and novel features of the present disclosure, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 illustrates an example layout of a train control system, in accordance with the present disclosure.

[0007] FIG. 2 illustrates an example output of frequency analysis of ultra-wideband (UWB) signals during example use in a train control system, in accordance with the present disclosure.

[0008] FIG. 3 illustrates an example carborne unit for use in a train control system, in accordance with the present disclosure.

[0009] FIG. 4 illustrates an example block-based implementation of train control system, in accordance with the present disclosure.

[0010] FIGs. 5A-5C illustrate an example wayside unit and an example deployment of such units in a train control system, in accordance with the present disclosure.

[0011] FIGs. 6A-6C illustrate various example performance assessments of ultra-wideband (UWB) communication within an existing transit system, used in a train control system, in accordance with the present disclosure.

[0012] FIG. 7 illustrates various example anchor positions when deploying, within an existing transit system, a train control system, in accordance with the present disclosure.

[0013] FIG. 8 illustrates use of redundant integrated sensing technologies in a train control system, in accordance with the present disclosure.

[0014] FIG. 9 illustrates an example safety program flow chart for creating safety profiles (cases) for use during operation of a train control system, in accordance with the present disclosure.

[0015] FIG. 10 illustrates an example message and information exchange flow chart in a transit systems that utilizes PTCS-2 based components, in accordance with the present disclosure.

[0016] FIG. 11 illustrates an example use scenario for utilizing a PTCS-2 based system for track identification, in accordance with the present disclosure.

[0017] FIGs. 12A and 12B illustrate example use scenarios for utilizing a PTCS-2 based system for establishing and maintaining train location with protection envelope, in accordance with the present disclosure.

[0018] FIG. 13 illustrates example use scenarios for utilizing a PTCS-2 based system for speed determination, in accordance with the present disclosure.

DETAILED DESCRIPTION

[0019] As utilized herein the terms "circuits" and "circuitry" refer to physical electronic components (e.g., hardware), and any software and/or firmware ("code") that may configure the hardware, be executed by the hardware, and or otherwise be associated with the hardware. As used herein, for example, a particular processor and memory (e.g., a volatile or non-volatile memory device, a general computer-readable medium, etc.) may comprise a first "circuit" when executing a first one or more lines of code and may comprise a second "circuit" when executing a second one or more lines of code. Additionally, a circuit may comprise analog and/or digital circuitry. Such circuitry may, for example, operate on analog and/or digital signals. It should be understood that a circuit may be in a single device or chip, on a single motherboard, in a single chassis, in a plurality of enclosures at a single geographical location, in a plurality of enclosures distributed over a plurality of geographical locations, etc. Similarly, the term "module" may, for example, refer to a physical electronic components (e.g., hardware) and any software and/or firmware ("code") that may configure the hardware, be executed by the hardware, and or otherwise be associated with the hardware.

[0020] As utilized herein, circuitry or module is "operable" to perform a function whenever the circuitry or module comprises the necessary hardware and code (if any is necessary) to perform the function, regardless of whether performance of the function is disabled or not enabled (e.g., by a user-configurable setting, factory trim, etc.).

[0021] As utilized herein, "and/or" means any one or more of the items in the list joined by "and/or". As an example, "x and/or y" means any element of the three-element set {(x), (y), (x, y)}. In other words, "x and/or y" means "one or both of x and y." As another example, "x, y, and/or z" means any element of the seven-element set {(x), (y), (z), (x, y), (x, z), (y, z), (x, y, z)}. In other words, "x, y and/or z" means "one or more of x, y, and z." As utilized herein, the term "exemplary" means serving as a non-limiting

example, instance, or illustration. As utilized herein, the terms "for example" and "e.g." set off lists of one or more non-limiting examples, instances, or illustrations.

[0022] In accordance with the present disclosure, trains, particularly trains operating under certain conditions—e.g., trains operating in transit systems, may be controlled in enhanced manner, particularly by allowing for and supporting mostly decentralized control of trains and operations thereof. This may be done, e.g., by incorporating use of low-cost technology, such as ultra-wideband (UWB) based solutions in controlling trains operating within transit systems, and functions thereof (e.g., safety and/or operation related functions). In this regard, there may be a large gap in available solutions for transit rail signaling systems, with few options available between the fixed block, trip stop based systems in place at many transit agencies, and available high end solutions, such as communications-based train control (CBTC) based solutions. Use of such high end solutions may be not desirable, for various reasons. In this regard, current CBTC systems, especially in brownfield applications, are expensive, difficult to install, have availability issues, require extensive ongoing maintenance, and do not always provide the headroom improvements which are initially projected.

[0023] Accordingly, in various implementations in accordance with the present disclosure, proposed positive train control system-phase 2 (PTCS-2) solutions may allow for filling this gap, while remedying the disadvantages and shortcoming of both legacy offerings. In this regard, PTCS-2 base solutions may provide signaling and train control systems that may encompass all or most of the features of legacy high end solutions (e.g., CBTC systems), but at a fraction of the costs (e.g., system cost, installation cost, etc.) and installation efforts. The PTCS-2 based systems may utilizes ultra-wideband (UWB) based wireless technology to enables the train to communicate with wayside devices, allowing for a "train-centric" control system. In other words, in such PTCS-2 based systems most of the functions may be implemented and/or deployed within the trains rather in the surrounding infrastructure. Such an approach

may be advantageous due to reduced costs (e.g., because the use of wireless technology may eliminate and/or reduces the amount of wayside cabling and associated maintenance; and may reduce Carborne wiring, installation effort and equipment cost), while additionally providing a modular–upgradable signaling system which may be easily customized and accommodate the existing transit agencies' operating rules.

[0024] The PTCS-2 based systems may be configured for and/or may enable or support such features and enhancements as collision avoidance, moving block train protection, increased (e.g., doubled) berthing, speed limit adherence, signal adherence, use of braking profiles, RF range testing, train location, speed and direction, signal detection (e.g., moving past red signals), adaptive motion (e.g., reverse moves), worker protection, and dead towing.

[0025] In various implementations, the main components of a PTCS-2 based system may comprise the train-borne (or carborne) equipment, wayside equipment (or anchors), and station-mounted equipment (or anchors). The train-borne equipment may comprise, for example, main control rack, mounting hardware, user interface, RFID hardware, train control interfaces, UWB and data communication radios and external antennas. The wayside equipment may comprise such sub-components as ranging and communication anchors, end-of-line, interlocking interfaces, and radios. The station-mounted equipment may comprise such sub-components as ranging anchors (e.g., for precision berthing of trains), communication anchors and/or data interfaces (e.g., cloud based, connected through station located gateways) for external data exchange, etc. Various measures may be incorporated to reduce cost. For example, the components of the PTCS-2 based system may utilize a modular design and may use many of the same components, such as ultra-wideband (UWB) radios.

[0026] FIG. 1 illustrates an example layout of a train control system, in accordance with the present disclosure. Shown in FIG. 1 is an example layout of a PTCS-2 based system 100 implemented in accordance with the present disclosure.

[0027] As noted above, a PTCS-2 based system is a train-centric system—that is, unlike traditional and/or existing systems (including, e.g., CBTC based systems), this system does not rely on a centralized entity (e.g., "back office") or centralized data structure which must be hard-wired to the system. Rather, as shown in the example implementation illustrated in FIG. 1, the system provides train-based automated control (e.g., operation, protection, etc.). In this regard, PTCS-2 based systems implemented in accordance with the disclosure (e.g., the PTCS-2 based system 100) may be configured for utilizing as core technology, a low-cost communication technology, preferably ultra-wideband (UWB), with UWB radios being used for ranging and/or data transfer.

[0028] As shown in FIG. 1, the PTCS-2 based system 100 may comprise carborne units 120 deployed on the train 110, as well as wayside units 130 deployed near tracks traversed by the trains in the transmit systems. Each of the carborne units 120 and the wayside units 130 may comprise suitable circuitry for implementing various aspects of the present disclosure. In this regard, the each of the carborne units 120 and the wayside units 130 may be configured to performed and/or support various communication, control, processing, etc. functions, and/or may incorporate suitable resources (e.g., hardware and/or software) for facilitating performing such functions. Further, each of the carborne units 120 and the wayside units 130 may be particularly configured for deployment in their respective environments—that is, the carborne units 120 may be optimized for deployment within the trains, and the wayside units 130 may be optimized for deployment on or near the tracks.

[0029] For example, each of the carborne units 120 may be configured as a train control system rack, and may comprise user interface components (and support functions related thereto), UWB radios (e.g., primary and secondary), data communications (DataCom) radios (e.g., primary and secondary), UWB antennas (e.g., primary and secondary), and DataCom antennas (e.g., primary and secondary). Each of the wayside units 130 may be configured as an anchor—e.g., for installation on structures near the tracks, such as tunnel walls, signal posts, etc., and may comprise

UWB radios, DataCom radios, and components for supporting interactions with wayside message interface (WMI), solid-state interlocking controllers (SSIC), axle counters, data communication system (DCS) (e.g., Ethernet switches, routers, fiberoptics and electrical cable), servers (e.g., diagnostic interface, non-vital messaging), automatic train supervision (ATS) systems, interface servers (e.g., for handling translating ATS messages), etc. The wayside units 130 preferably may be configured with uninterruptible power supplies.

[0030] In some implementations, multiple carborne units 120 may be deployed within a single train. In such instances where multiple carborne units 120 are deployed on a single train, typically no more than one carborne unit is deployed within each car, and preferably a number of cars (e.g., 4 car) may be grouped together, with one carborne unit being deployed to serve each such group (or alternatively, two units, with one unit at the front of the first car in the group and the second unit being deployed at the back of the last car in the group).

[0031] Further, in such instances where multiple carborne units 120 are deployed on a single train, one of the carborne units 120 may be configured as lead (or main) unit, with the remaining units being configured as "passive" units, communicating only with the each other and the lead unit—i.e., not handling interaction with other systems, on or off the train. For example, the carborne unit 120 deployed in the main engine cab, where it may be used by the train operator, may be designated as the lead unit. Thus, the lead carborne unit may automatically detect that the cab is the one in control of the train (e.g., via a wired interface to the train cab control panel), and in such manner determines that its cab is the lead unit.

[0032] The carborne units 120 may be configured to communicate with one another via wirelessly (e.g., using PTCS-2/UWB based communications). This may be the case even in instances where multiple carborne units 120 are deployed on a single train as it reduces installation cost (by eliminating the need for wired connections

between the carborne units). The communications between the carborne units may be done using direct wireless connections between these units, and/or by utilizing other devices (e.g., the wayside units/anchors) to relay data between the carborne units. For example, the carborne units may be configured to communicate wirelessly using the data communication radio (PTCS carborne-wayside link) on the train to the wayside data communication radio, which then relays the messages to the addressed carborne unit, whether on the same train unit, the other unit on the same train, or train-to-train communications to other trains operating in the system. As such data links may already be in use in the PTCS-2 based systems, there would be no additional cost for supporting such intra-car and inter-car link communications.

[0033] In some instances, PTCS-2 based systems implemented in accordance with the disclosure (e.g., the PTCS-2 based system 100) may be configured for supporting interactions with existing infrastructure and/or systems—e.g., railway signaling systems 140, on-train systems 150 (e.g., sensors such as wheel tachometers, brake systems, etc.), radio-frequency identification (RFID) systems 160 deployed on (or near) tracks and used for safety, etc.

[0034] However, in some implementations, some of the interfaces to some of the systems may be eliminated, as the functions PTCS-2 based components may be simplified—e.g., providing only UWB ranging related functions, and as such omit the need to interacted directly with other components in train and/or with non-UWB devices external to the train (e.g., wayside RFID based devices). In such implementations, the PTCS-2 based wayside units may be configured as UWB anchors (as described in more details below), thus eliminating the need to interact with sensors (e.g., tachometers) and/or the wayside/track based RFID systems 160.

[0035] In some instances, PTCS-2 based systems implemented in accordance with the disclosure (e.g., the PTCS-2 based system 100) may be configured for supporting interactions with other communication networks. For example, as shown in

FIG. 1, the PTCS-2 based system 100 may be configured for supporting communication with (e.g., reception of) satellite signals, such as signals transmitted by positioning satellites (e.g., global positioning system (GPS) based satellites/signals).

[0036] In some instances, PTCS-2 based systems implemented in accordance with the disclosure (e.g., the PTCS-2 based system 100) may be configured for supporting temporary connections (wired and/or wireless) with portable equipment (PE) 180 (e.g., laptops, etc.), which may be used, e.g., for performing such tasks as commissioning, provisioning, and diagnostics in conjunction with the carborne units 120 and/or the wayside units 130.

[0037] As noted above, the core technology utilized in the PTCS-2 based system is low-cost communication technology, preferably ultra-wideband (UWB). Use of UWB technology may be desirable as it allows for broadcasting signals over a wide bandwidth, which offers signal transmission that is virtually unaffected by multi-path distortion, which substantially affects signal integrity in conventional narrow band signals in certain areas that may be particular prevalent in transit systems, such as subway tunnels and urban environments.

[0038] UWB-based PTCS-2 solutions may also benefits from using a coherent signal processing approach where trains of pulses integrate the energy from many pulses in increase the signal to noise ratio and extend range and accuracy. For example, use of UWB-based communications may allow for operations at ranges over one half of a mile, and with sub-inch distance accuracy over such range, in either in open air or difficult tunnels environments.

[0039] The UWB-based approach may also benefit from having a low probability of intercept (LPI), as the transmit power allowed by the FCC (Federal Communications Commission) is similar to ambient noise floors such that the signal is essentially invisible to a frequency analyzer as shown in FIG. 2. In this regard, FIG. 2 illustrates a

chart 200 corresponding to an example output of frequency analysis of UWB signals during example use in a train control system, in accordance with the present disclosure.

[0040] FIG. 3 illustrates an example carborne unit for use in a train control system, in accordance with the present disclosure. Shown in FIG. 3 is an example chassis-based implementation of train-borne (or carborne) unit 300.

[0041] The carborne unit 300 may be a rack based unit, containing one or more swappable modules 310, configured such that it may be mounted in or close to a cab of a train. Each of the modules 310 may comprise suitable circuitry for supporting particular functions.

[0042] Example modules that may be included into the carborne unit 300 may comprise a main control module (MCM), which may comprise control circuitry for the system, GPS (Global Positioning System) controller module (GCM), which may be used for calibration of wheel sensors, verification of other speed measurement systems, and precise updates of the real-time clock when exposed to a satellite link; ranging module (RGM), which contains redundant UWB ranging radios; data communication module (DCM), which is used for providing redundant data channels (e.g., over spread-spectrum links); operator interface module (OIM), which is used for the operator interface display; personality controller module (PCM), which is contains all interfaces unique to the agency such as speed sensor inputs; host interface module (HIM), which is the emergency braking interface and bypass control unique to the agency or vehicle; the service brake module (SBM) which is the service braking interface unique to the agency or vehicle, RFID reader module (RRM), which is the RFID reader interface; power supply module (PSM), which supplies power to rack; and optionally such other modules/components as lidar, radar, and worker protection modules.

[0043] A modular rack design may allow for accommodation of variations in requirements (e.g., between different transit agencies) and/or unique train interfaces, with minimal changes to hardware and software, such that changes to safety

certifications are minimized. The other advantage of this approach is modular upgrades, in that an agency may start with a basic safety system and add capabilities though additional module additions at a later date when budgets allow.

[0044] In addition to the chassis, other on-train components may be used, such as antennas. For example, one or more antennas may be deployed, such as on the outside of the train, including a redundant-single package UWB-GPS antenna, a data communications (DataCom) antenna (or dual-version for diversity or redundancy), and an optional RFID antenna. The antennas may be configured and/or may have low profile design, cognizant of the size and space restrictions present.

[0045] Additional on-train components may include wheel sensors—e.g., wheel odometry inputs which may be furnished either by integrating into existing sensors, or by installing new wheel sensors. To ease the installation costs of wiring wheel sensors, the system is able to operate with only UWB ranging.

[0046] The system may include a user interface—e.g., user interface may be specified by the agency. The information displayed is also customer specific. A bypass switch—e.g., a system bypass control may be included, and may be integrated into an existing panel or supplied in its own enclosure; and an optional an RFID tag reading system, which may be used as parallel method for determining track occupation, as well as for temporary speed restrictions and work zones. However, the RFID functions may be provided by UWB-based track determination, and speed restrictions and work zones communicated via the data communications wireless interface, thus eliminating the need for the additional RFID equipment and installation effort.

[0047] FIG. 4 illustrates an example block-based implementation of train control system, in accordance with the present disclosure. Shown in FIG. 4 are the major components (represented as blocks), such as the modules and other components described with respect to FIG. 3, as well as interactions there between and/or functions performed thereby, in an example implementation of a train control system in

accordance with the present disclosure. However, some of the components, functions, and/or interactions shown in FIG. 4 may be eliminated in some implementations. For example, in some example PTCS-2 based implementations, the PTCS-2 systems may not include any speed sensors (thus eliminating these components/blocks as shown in FIG. 4, within the "Train Details Shown" block). Also, in some example PTCS-2 based implementations, the PTCS-2 systems may not include any RFID tags (thus eliminating the "RFID Reader Module" component/block shown in FIG. 4). Also, in some example PTCS-2 based implementations, the PTCS-2 systems may also include a serial link or other communications link-based service brake interface, in addition to the simple (vital) brake loop interface shown in FIG. 4.

[0048] FIGs. 5A-5C illustrate an example wayside unit and an example deployment of such units in a train control system, in accordance with the present disclosure. In this regard, shown in FIG. 5A is an example wayside unit (or anchor) 500 and an example deployment of a number of such anchors in relation to tracks (using a simplistic loop track for illustration purposes) in an example transit system.

[0049] The anchors (or wayside units) may comprise suitable circuitry and related components (e.g., radios, antennas, etc.) for supporting communicating in a particular manner, specifically UWB transmissions (ranging) with the train—e.g., PTCS-2 based carborne units deployed thereon. In some instances, anchors (e.g., anchor 500 as shown in FIG. 5A) may support circuitry (and related components) for other forms or types of communications, beside UWB ranging related communications. For example, an anchor (e.g., anchor 500 as shown in FIG. 5A) may comprise at least two wireless systems: one for UWB ranging and the other optimized for high-speed data transfer (e.g., DataCom), being configured for spread spectrum transmissions for data communication (thus enabling communication of large size data).

[0050] Alternatively (and preferably), the anchors may be configured as solely UWB ranging based devices, with separate devices handling the data communications

(e.g., DataCom anchors). In such implementations, the UWB ranging anchors may be connected to the DataCom anchors, to use them to communicate with other components in the transit system and/or to facilitate large data transfers. Such design may be preferable as it would allow for use and deployment of a larger number of UWB anchors compared to DataCom anchors (or devices).

[0051] The anchors may be integrated (directly and/or via other devices, such as dedicated DataCom devices) with signals, position location, data relay devices, and interlocking interfaces. Anchor design is generally customized for the agency taking into consideration such as power availability, size constraints, integration with existing assets and functionality.

[0052] The anchors communicate with each other by "hopping" data from anchor to anchor, either wireless data hopping using primarily the data communications radios, or for increased data throughput, via a cabled interface such as fiber optic Ethernet. The anchors may also perform UWB ranging to each other, for diagnostic purposes, allowing mounting location integrity checks. The anchors support wireless communications from anchor to train as well, with all communication being bi-directional. Anchors may also interface external to the line by using gateways located at stations for cloud based communication. Placement of anchors is dependent upon the geography along the track, and the various features (subway with smooth walls, subway with "castellated" walls, open air, etc.).

[0053] The anchors may be spaced to ensure optimal performance, such as based on pertinent factors—e.g., the layout of the transit network (or parts thereof), presence of nearby structures, etc. For example, the anchors may be spaced between 300-1,000 feet. The data communication anchors (if any) may be spaced even more (e.g., between 500 and 1,500 feet), as fewer of them are needed.

[0054] An example implementation of the anchor 500 (particularly when implemented as an UWB ranging anchor) is illustrated in FIG. 5B. In this regard, as

shown in FIG. 5B, the anchor 500 may comprise housing(s) 510 for enclosing various components of the anchor 500. The housing 510 may be constructed to be suitable for the intended operation environment and/or conditions of the anchor 500 (e.g., being constructed to be very rigid, to withstand accidental impacts during deployment and/or when knocked down), and to withstand environmental conditions associated with outside/external use (e.g., rain, extreme cold/heat, etc.). For example, the housing 510 may be constructed from coated aluminum. The anchor 500 may also have radome(s) 520 (constructed from, e.g., polycarbonate material), which may be attached to the housing(s) 510. The radome(s) 520 may be used to enclose components that may need to be implemented external to the housing 510, such as antennas, used in wirelessly transmitting and/or receiving signals, such as during UWB ranging related communications with PTCS-2 based carborne units).

[0055] The anchor 500/housing 510 may incorporate a power input (connector/port) 530, which may be used in connecting the anchor 500 to a power source (e.g., the power grid) to power the anchor 500. The anchor 500/housing 510 may also incorporate a network input (connector/port) 540, which may be used in connecting the anchor 500 to one or more wired-based networks (e.g., fiber). In this regard, the power input 530 and the network input 540 may be implemented adaptively to optimize performance. For example, the power input 530 and the network input 540 may use M12 connectors. In this regard, the power input 530 may utilize, for example, an A-Code connector, while the network input 540 may utilize a D-Code connector to prevent mismatching during installation.

[0056] The anchor 500/housing 510 may incorporate means for providing indications or other information. For example, indicators (e.g., LEDs) 550 may be incorporated into the housing 510, and may be configured to convey/indicate certain information (e.g., UWB radio status). Further, identification (ID) tag(s) 560 may be affixed/overlaid on a part of the outside of the housing 510, showing identification number(s) of the anchor 500.

[0057] As noted, the anchors may comprise or be coupled to support structures, to enable placement or installation of units. For example, as shown in FIG. 5B, the anchor 500 may installed using a mounting bracket 520, which may be configured to attachment to the anchor 500 (e.g., via attachment bolts 524) on one side, and for anchoring on a structure (e.g., wall, via anchoring bolts 522, for example) on the other side. For example, the attachment bolts 524 may be 1/4-20 bolts, whereas the anchoring bolts 522 may be 1/4-20 concrete anchor bolts.

[0058] Support structures, such as the mounting bracket 520, may be configured for unique mounting environments and/or to accommodate particular mounting/installation requirements. For example, the mounting bracket 520 may be configured to allow mounting the anchor 500 in particular manner—e.g., being structured such that it allows mounting the main assembly (the housing 510) at particular distance, such as 8", from the wall where it is to be mounted. Further, the mounting bracket 520 may incorporate holes for allowing for cable management and tie-down straps, thus ensuring that when the cables are connected, they should not inhibit the line of sight of the antennas. FIG. 5C illustrates the combination of the anchor 500 and the mounting bracket 520 attached together.

[0059] A description of operations in an example implementation of a train control system in accordance with the present disclosure (e.g., the system described with respect to FIGs. 1-5) is now provided.

[0060] In operation, the PTCS-2 based system initially runs through a self-checking protocol, confirming all aspects of the hardware and software are present and communicating. As the train leaves a yard or storage facility, the PTCS-2 based system may also self-check that the UWB ranging system, the data communications system, optional RFID, and optional wheel odometer systems are also functioning within specifications.

[0061] The operator may choose a route which is stored in train-borne (or carborne) equipment/unit, or in centralized control configurations, the route is chosen remotely by the central dispatcher using Automatic Train Supervision (ATS). The route is communicated to the train using the wireless data communications system. This information includes route number, and other schedule-related information.

[0062] As the train progresses, the train position and speed are determined by the train by ranging with wayside UWB anchors. As a train passes, it is able to determine its absolute location by the ID number of the anchor and referencing the distance to that anchor with the on-board track map stored in non-volatile memory. The train may also determine the speed and direction of movement by measuring the UWB ranging delta separation data of the radio signal from the train to the UWB anchors.

[0063] Train separation may be measured by the wayside anchors recording the time and speed at which a train passed, and forwarding this data through each end of the network by "hopping" the data from anchor to anchor to other trains in the system. This information is stored on the anchors or on centralized computing devices, and transferred to trains as they pass through an area. For decentralized control, train separation is determined by the train obtaining the train IDs in the area from the Wayside Messaging Interface (WMI), and then directly interrogating those trains to determine their location using the data communication network. The train will then act on this information by determining if is safe to continue moving forward, as well as the maximum allowable speed, giving the operator feedback on the user interface. The allowable speed is based upon various items, such as the normal allowable speed limit on the track at that location, any speed temporary restrictions or work zones, the path which the train is programmed to take (switches may require slower operating speed, for example), and by ensuring that the worst case safe braking distance at the determined speeds and directions of both trains which will allow the train to stop before reaching the train ahead.

[0064] At interlocking points, the train will interrogate the switch via the wireless data communications system to determine its status, whether it has priority, and if required, trigger operation and receive confirmation of proper switch lining. The system may use both UWB-based and data-communication channels for this interrogation. For example, the status inquiry may be performed via intermediate vital "data clearinghouse," using Wayside Message Interface (WMI).

[0065] At stations, the system may perform berthing control (ensuring proper alignment of the train at a station), integrating with door controls, and adjust route schedules by maintaining timetables where required. In addition, the system may be configured to perform at a station (or other location) that corresponds to the end of the line, end of line protection. Further, at stations, or other convenient interfacing locations, data gateways may be implemented to enable remote monitoring and control of the system, connecting the data hopping network (whether wireless or cabled) to remote servers.

[0066] Worker protection is accomplished through this system in at least two variations. One means is for track workers to wear either a vest in which the warning system is built-in, or a small module (mobile anchor device) equipped with an UWB based warning device. This UWB device communicates with and/or ranges with the UWB anchors along the track. The detected presence of the track worker(s) is communicated along the data hopping network to other anchors which allow wireless communication of the presence of workers to the train Operator and the train control system (to allow automatic reduction in train speed). In some implementations, an approaching train triggers a warning for the workers through a visible, audible and vibratory warning on their worker worn device. In another variation, the workers have no special worn devices, and instead are warned by visible and audible warnings from a companion device the workers place in their work zone. In yet another variation, work zones are centrally designated and warning devices are incorporated in the wayside

anchors, warning the workers by visible and audible warnings when a train is approaching.

[0067] When a train approaches a work zone, whether the zone was centrally designated or automatically detected by wayside or worker-worn devices, the train operator is warned through the train-borne user interface that a worker is present. When workers wear individual devices, the operator may also receive notification of how many workers are present, and if the workers have acknowledged their alarms. This system will also warn and enforce a work zone speed limit automatically when encountering workers. Work or slow zones may also be established temporarily by deploying specific RFID tags (if used by the system) which will notify approaching trains as the train passes the RFID tag. Finally, work or slow zones may also be established by the dispatcher in a remote location using the ATS console, where the data is communicated via the data communication network.

[0068] The PTCS-2 based system is designed to be integrated with an operator, who performs normal manual train control, as with the legacy system, however, nearby trains, signal aspects, speed limits, worker protection zones, and interlocking data will all be shown on a customized user interface according to the agencies preferences. The operator will receive warnings when safe operating violations are imminent, offering the operator a chance to rectify the situation. If the operator fails to react appropriately, the PTCS-2 based system will interrupt current operation, and either apply a penalty stop, or reduce speed using the train's service brake. In the event of a penalty stop, the operator must acknowledge the event on the user interface, then may resume normal operation once the PTCS-2 based system has determined it is safe to proceed. The enforcement event will is logged in the integral data recorder for training and or event re-construction.

[0069] In some instances, such as in conjunction with vital functions—i.e., functions that are configured for operating in a fail-safe manner, the PTCS-2 based

system may interface with emergency brake systems. For example, in the event the train fails to slow sufficiently or quickly enough to ensure safe operation using the train's service brakes, the emergency brake system may be triggered. Once the emergency brake is triggered, the train will come to a complete stop. The operator must initiate a reset procedure on the train, and it must be safe to proceed before normal operation of the train may be resumed. The emergency brake interface uses a simple, fail-safe, redundant relay contact interface to maximize reliability and safety.

[0070] Regarding interfacing with existing systems, with respect to the train-borne (or carborne), the PTCS-2 based system may be configured for minimal installation impact on the railcar by limiting the interfaces to the railcar. In an example implementation, the vehicle interfaces may consist of fifteen wires as follows: power supply (two wires, power and ground); wheel sensors—e.g., wheel speed/wheel slip detection (two interfaces, two wires each); direction status—e.g., forward/reverse (one wire); cab enable—e.g., whether the cab is in control or in standby (one wire); direction/cab enable ground (one wire); drum switch—e.g., end or middle car detection (two wires to a switch closure); braking system (two interfaces, one to the propulsion loop, the other to the braking loop, two wires each). In another implementation, automatic train operation interface may also be used, which may enable controlling propulsion in the train. Nonetheless, in some implementations, the PTCS-2 based system may incorporate simplified interface related functions—i.e., may use less interfaces and/or some of the interfaces may be simpler than described above. For example, in some implementations, such interfaces as wheel sensors, direction status, and/or drum switch interfaces may be eliminated. This may be made possible by using the UWB based function to detect or obtain information relating to train speed, direction of movement, and detection of train consist (number of cars).

[0071] In some implementations, to initiate the full-service brake, the PTCS-2 based system merely drops the drive to its brake loop and propulsion loop relays, causing the relay contacts to open, which in turn interrupts the braking and propulsion

loops on the railcar. A PTCS-2 based system brake initiation appears to the system in the same manner as an open wire in the brake and propulsion loops.

[0072] In some implementations, the service brake interface is a data communications bus, such as LonWorks, or Ethernet. In these implementations, the braking rate may be controlled, resulting in improved passenger comfort. For example, in an overspeed condition, the propulsion drive may be removed, and a 30% braking effort applied until the train drops a configurable amount below the allowable speed (such as -2 mph). Then the propulsion control will revert to manual operator control. In a penalty stop condition, a 70% braking effort may be applied, and then the braking effort reduced significantly as the train slows to several mph, allowing the train to stop gently rather than abruptly (or "flare out", as known in the industry).

[0073] In some implementations, the PTCS-2 based system may also provide sophisticated braking rate compensation abilities to ensure that when hazards are detected, the system applies the brake in a timely manner. The following factors are considered when determining the point at which brakes are triggered: range distance to the hazard; speed and direction of travel of the host railcar; if the hazard is another railcar, the speed and relative direction of travel of the other railcar (approaching or receding); the braking curve characteristic of the host railcar; the grade of the track; degraded mode operation of the host railcar; (if specified) the track conditions (if wheel slip has been detected, the stopping distance required is extended by an agreed upon margin). Additional compensation factors may include an allowance for the delay in speed measurement detection, the cycle time for vital logic processing, maximum data latency (delays in data delivery), the time delay for output transition of the relay or communication bus, a time delay for propulsion removal, and the time delay for brake activation and braking force brake build-up. Each of these potential delays require enforcement actions to begin earlier, or further away than otherwise necessary

[0074] Another compensation must be made for possible “runaway acceleration”. In a worst-case scenario, the train could begin maximum acceleration immediately after the current speed is sampled and the processing system calculates from that and other data that the train must brake. The total time delay during this data acquisition, decision, and execution process may result in the train traveling faster than the original speed measurement has indicated. The runaway acceleration compensation assumes that this maximum acceleration has occurred during the execution process to ensure that the train will be capable of stopping prior to a hazard.

[0075] The objective of this system is to apply the brakes only when necessary, and only at the point appropriate for the position and operating conditions. Aspects which increase the anticipated stopping distance include: increased speed of the railcar; another railcar is moving towards the host railcar; railcar(s) operating on a downward grade; railcar(s) braking system degraded, resulting in reduced braking rate; wheel slip has been recently detected.

[0076] The braking curve of the railcar has a significant effect on the distance at which braking is initiated. Factors in the normal service braking characteristics include: nominal braking curve, mode change delay, jerk limit, and wheel slip. In this regard, with respect to nominal braking curve, if the braking rate is not constant over (such as 3.5 mph/sec), then the braking rate is broken into zones of differing rates for various speeds. In a simple case, for example, the braking rate is constant over the entire range of operating speed except at low speeds, such as below 4 mph, where a slower braking rate occurs (due to the loss of effective regenerative braking action).

[0077] With respect to mode change delay, the railcar braking system may delay the application of brakes by a fixed time interval. This delay is considered in normal service braking distance calculations. If the railcar is accelerating when the trigger point for braking is reached, there will be two mode change delays: accelerating to maintaining speed, and maintaining speed to braking. This adjustment of the braking

distance is part of what is called “acceleration compensation”. If the railcar is already braking at the time automatic braking is triggered, there will be no mode change delay.

[0078] With respect to jerk limit, the railcar service braking system may delay the full application of brakes by application of a jerk limit, such as 3 mph/(sec x sec). The additional delay of the jerk limit factor is also considered for the stopping distance. If the railcar is accelerating at the time of automatic brake application, there are two jerk limit delays which will be added to the braking distance. This is the second part of “acceleration compensation.”

[0079] With respect to wheel slip, if desired, an additional stopping distance margin may be applied in conditions where wheel slip has been detected recently. Wheel slip may be detected by monitoring multiple independent wheels for speed variations during braking and acceleration. With installations that don’t have wheel sensors, wheel slip may be detected by comparing the commanded braking rate to the actual deceleration of the train. The additional stopping margin is not normally applied to prevent the PTCS-2 based system from braking too conservatively and applying the brakes before the operator would normally begin braking. In some instances, the PTCS-2 based system may be configured such that if the call for braking is removed (e.g., by closing the relay contacts), normal control of the vehicle returns to the operator.

[0080] PTCS-2 based systems may be configured for optimized power consumption. For example, in some implementations, the train-borne (or carborne) unit and/or the wayside anchor may be implemented to utilize low power. Further, various functions may be disabled when not used. The PTCS-2 based systems may allow for adjusting power consumption, such as based on user preferences, available power supply, etc. Further, PTCS-2 based systems may be configured such that the systems may be adapted to and/or may integrate any available wireless design. Anchor electronics may interface with either an integral design or a supplemental enclosure containing anchor electronics.

[0081] In an example implementation, PTCS-2 systems may be configured for supporting UWB ranging related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for collecting and updating range data for all relevant targets, such as through a cooperative process initiated by the PTCS-2 based carborne unit to one specific target at a time. The UWB ranging may comprise determining ranges based on UWB signals, with the range between a UWB transmitter and receiver calculated as the time of flight between the transmitter and the receiver (one way) multiplied by the speed of light. UWB ranging may be used in different use scenarios.

[0082] For example, UWB ranging may be used for determining location, such as by collecting ranges between a transmitter and at least three receivers, the PTCS-2 based carborne unit may use trilateration to determine relative location of the transmitter when multiple tracks are present. If the location of the receivers is fixed and known, this information can be used to determine the absolute location of the transmitter. In certain conditions, the operating track may be determined using only one anchor, such as where the train passes the anchor at a relatively slow speed. This may be possible, for example, if the anchors for the other tracks are much further away, such as on the opposite side of the other track. Thus, as the train passes the anchor, if the shortest distance measured to the anchor is under a certain value, the train may detect that the anchor identified is associated with the train's operating track (e.g., from a track map).

[0083] UWB ranging may also be used for determining speed (or velocity), such as by taking multiple range calculations over a specific time period, thus allowing the distance traveled by the UWB transmitter to be determined and used to calculate the velocity of the UWB transmitter (or an object that includes that UWB transmitter). Speed (or velocity) and location determination from UWB ranging may be checked against, and in some cases processed with, speed and location determined via other mechanisms in order to establish vital train location, speed, and direction.

[0084] In an example implementation, PTCS-2 systems may be configured for supporting anchor location related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for locating anchors (or wayside devices). In this regard, as noted above, PTCS-2 based train control systems may incorporate anchors as wayside devices, with these anchors being installed along the track. The anchors may be installed at distances determined by the topography of the track at any given location—e.g., anchors may be installed closer together around a curve then they will be on a long straight section of track. The anchors may be used primarily as fixed points for UWB ranging for the purposes of location, direction, and speed determination.

[0085] In an example implementation, PTCS-2 systems may be configured for supporting train control system operation related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for determining its position using UWB functions—e.g., by using frequent UWB range measurements between an UWB radio of the PTCS-2 based carborne unit (e.g., installed at the front of the train) and fixed UWB anchors (serving as, e.g., absolute references) along the track. For example, the distance to a particular anchor may be measured using two-way time of flight timing measurements. Train reports and queries may be routed via the DCS wireless link, such as to other wayside devices and/or system servers, such as the ATS console for train tracking.

[0086] In various instances, trains may report such information as position, speed, direction of travel, and health status to a central server, and may do so periodically—e.g., approximately every second. In some instances, PTCS-2 equipped trains may be configured such that PTCS-2 based carborne units (particularly the lead units) of each train queries the server to determine the nearest PTCS-2 equipped train ahead. The PTCS-2 based carborne units (particularly the lead unit) in the cab of each train queries the train ahead using vital messaging protocol, confirming its position and length, and queries the appropriate solid-state interlocking controllers (SSIC) to confirm

the wheel count for the zone ahead matches the reported occupancy. The lead cab also determines the limit of the safe route ahead from the SSIC interrogation.

[0087] In an example implementation, PTCS-2 systems may be configured for supporting train control commissioning related functions. For example, following the installation of the PTCS-2 based train control system, the PTCS-2 based carborne units may be commissioned with train-specific data. For example, the car number hosting each PTCS-2 based carborne unit is stored into the unit (e.g., entered into non-volatile memory of that unit). In addition, the companion car number from the opposite end of the unit may also be stored. In this manner, the PTCS-2 based carborne units on each end of a unit may know the car number of the other cab which are part of the semi-permanently coupled multi-car unit.

[0088] In an example implementation, PTCS-2 systems may be configured for supporting train control initialization related functions. In this regard, when a PTCS-2 based train control system is first installed or is initialized, the system may have no awareness of such information as location. This may occur at power up and may potentially occur due to other events during operation, such as where multiple anchors are not responsive. Thus, train control initialization may be performed, where the PTCS-2 based carborne unit may send a broadcast UWB message for all UWB devices (e.g., PTCS-2 anchors) within its wireless range, to announce its presence and identification information. Once the UWB responses from the UWB devices (e.g., anchors) are received, the PTCS-2 based carborne unit commences an individual range measurement with each responding UWB device.

[0089] For the inner cars of a multi-car train, at least some of the UWB responses will be from another car, and not from an anchor (or wayside unit). For example, a PTCS-2 based carborne unit installed on inner car may receive a response from the adjacent cab of the coupled unit, which will include a range measurement and its car number. The resulting range measurement between those UWB devices will be in short

range (e.g., within several feet, with the actual value being dependent upon the mounting location of the UWB antennas). This may allow the PTCS-2 based carborne unit to determine that they are installed on inner cars. In some instances, range results corresponding to anchors may be geometrically compared using the anchor database to determine if the range responses are consistent with a single location along the track (including an acceptable, predefined tolerance). Accordingly, if the range results are consistent for a single location, the train controller's system location state changes from unknown to known. Otherwise, the train control system continues to attempt to find a location solution.

[0090] In an example implementation, PTCS-2 systems may be configured for supporting train control initialization: consist length and configuration. For example, once a train controller (e.g., PTCS-2 based carborne unit) determined its location using UWB range measurements to wayside anchors, each cab queries its companion unit cab for its location or the car number of its provisionally identified inner cab. Responses which return inner cab responses result in additional queries to the companion unit cab for its location. When all responses include confirmed locations or inner cab identifications, the geometry of the data is analyzed to determine the provisional consist length. This provisional length becomes an established value when movement is detected (e.g., by changes in location reporting by UWB ranging). If locations have changed and the measured length of the consist is consistent (e.g., cars that appeared to be coupled remain in the same proximity with movement of the train), the train length and car number configuration is established and reported by the respective end cabs. This configuration is periodically verified.

[0091] In an example implementation, PTCS-2 systems may be configured for supporting broken consist detection related functions. For example, train controllers (e.g., PTCS-2 based carborne unit) may periodically confirm the integrity of the consist. End cabs query the other end cab in the train consist (e.g., using the wireless data communication system along the wayside) and confirm the reported location is

consistent with the expected train length. Inner cabs range to the opposite unit and confirm that the distance is consistent with the expected (short) separation. If a parted consist is detected, each train controller reports its status and position over the DCS.

[0092] FIGs. 6A-6C illustrate various example performance assessments of ultra-wideband (UWB) communication within an existing transit system, used in a train control system, in accordance with the present disclosure.

[0093] As noted above, one of the components (and functions related thereto) in the PTCS-2 based system is UWB precision range measurement radio. Further, UWB radios may be configured for use in data transfers. However, the disclosure is not so limited, and in some instances, other technologies may be used for handling data transfer functions (at least for transferring large amount of data), using other (non-UWB) radios for those functions, with the UWB radios/components being used exclusively for ranging and the minimal data transmissions necessary to support ranging operations. Notwithstanding, as the charts shown in FIGs. 6A-6C illustrate, corresponding to RF surveys performed in intended deployment locations, both above and below ground, enhanced performance may be achieved with PTCS-2 based systems, to confirm that PTCS-2 based solutions may be suitable for the intended applications in transit systems. For example, as illustrated in chart 610 in FIG. 6A, consistent ranges out to about 600 meters or approximately 2,000 feet may be achieved, as shown in the UWB range chart 610.

[0094] Further, where UWB is used for communication of data, different message structures may be used, as illustrated in charts 620 and 630 in FIG. 6B. In this regard, charts 620 and 630 illustrates tests of different message structures to evaluate the difference in the signal to noise ratio between decreased or “short coded” messages and increased message loads or “long code” messages. In this regard, very little difference is detected between the two which allows for improving data back haul

performance. Nonetheless, as noted above, non-UWB components may typically be used for data transfer/data backhaul.

[0095] Charts 640 and 650 shown in FIG. 6C illustrate that effects of ambient conditions may be minimal with use of UWB communications. For example, performance may be assessed based on RF ambient environment, including inside and outside of tunnels as illustrated in charts 640 and 650. In this regard, as shown in the chats, the tunnel environment has less RF noise present than the control environment (ambient or control noise outside of tunnel), and at the frequencies used for UWB, there was no destructive interference present.

[0096] FIG. 7 illustrates various example anchor positions when deploying, within an existing transit system, a train control system, in accordance with the present disclosure.

[0097] In this regard, as shown in FIG. 7, with respect to anchor position, experiments have been made in determining optimum anchor height and distance from tunnel structures such as metal and concrete columns. Optimal installation positions may be determined at various locations in transit systems. For example, optimal installation position may be determined at each location based on testing, such as based on ranging and signal-to-noise (S/N) analysis testing.

[0098] The proposed systems and/or solutions offer many key benefits. For example, with respect to performance, train spacing may be reduced by eliminating traditional fixed blocks and replacing them with anchor based moving blocks, where the length of the blocks dynamically changed based upon operating speed and conditions. Spacing may be adjusted based upon factors such as loading, schedules and may be optimized by the inclusion of support for future needs (e.g., AI linkage).

[0099] Also, additional safety measures such as the use of UWB for collision avoidance also offer redundant methods for determining train spacing such that

additional safety factors such as empty blocks required in fixed block train control systems may be eliminated.

[0100] In some implementations, redundant integrated sensing technologies may be used to further enhance safety. Such redundant integrated sensing technologies may be combined through "sensor fusion" to allow for protection for trains, passengers, and workers. Thus, at any point in operation, several parallel systems are in operation, as shown in FIG. 8, which illustrates use of redundant integrated sensing technologies in a train control system, in accordance with the present disclosure.

[0101] In addition to safety, this redundant operation also allows for simpler integration into our safety case, as having multiple, basic, redundant systems in place simultaneously, allows for a lower cost and higher performing system with improved availability as a failure of one aspect of the system is covered by another.

[0102] Another key benefit is the full integration of worker protection systems, with both the workers and train operator receiving warnings. The on-board equipment may also be programmed to enable an auto-braking event in the event that speed and or distance to worker rules are violated.

[0103] Another key benefit is reliability: Key sub-systems utilize duplicate components which operate on 50% alternating duty cycles which improves system availability without adversely affecting the safety case due to a multiple system approach.

[0104] Another key benefit is compatibility: The modular components and rack approach in the train-borne (or carborne) equipment allows for local customization of hardware and software for seamless system integration without comprising or adversely affecting overall system operation. Wayside components are also designed for full integration with existing assets, using a similar approach.

[0105] Another key benefit is cost: installation cost may be reduced drastically, as existing wayside assets may be left in place, the train to wayside communication is

wireless, and the train-borne (or carborne) components are compact such that they may be installed into existing areas, located near the interfaced components on the train, without requirements for additional power.

[0106] The Train-centric approach also may eliminate the cost of a back-office control hub, although it is designed such that a cloud-based link may be opened anyplace with an internet connection.

[0107] Another key benefit is installation advantages: time required for installation is drastically reduced in that the system may be installed in an accretive manner with assets being activated as they are installed. The entire system operates on separate wayside anchors, requiring only a power supply connection (and, optionally, a fiber optic data connection) which lends itself to shorter installation times, with minimal service interruptions.

[0108] The anchor approach also reduces maintenance effort and costs. Conventional CBTC systems use track-mounted transducers for train positioning detection. Mounting assets such as these on the track structure complicates periodically required track maintenance, such as “tamping” (realigning the track), railroad tie replacement, and rail replacement. Additional care and maintenance procedural steps are necessary when the transducers exist on the track. For example, transducers may be removed for maintenance, and then not reinstalled in the exact same location, potentially adding significant error and uncertainty to the determination of train position. An additional complication is that temperature changes and vibration result in movement of the track-mounted transducers, adding additional error to positioning.

[0109] Many transit systems operate trains at least 20 hours a day, such that time for service activities is very limited on the wayside, especially when installing new equipment. To this end, all wayside devices are designed to be customized such that existing mounting brackets, wiring and other interfaces are developed such that they

arrive on the site ready to install with as many operations such as wire harnesses provided as sub-assembly, ready for installation.

[0110] The PTCS-2 based systems may be configured to respond in a fail-safe manner to all known failure modes of its components. In this regard, the response(s) may be implemented using the industry best practice. For example, the PTCS-2 based systems may be configured to support safety related functions that conform to such industry references as MIL-STD-882C, IEEE 1483-2000, and American Railway Engineering and Maintenance-of-Way Association (AREMA) Signal and Communications Manual Part 17. Safety related functions in PTCS-2 based systems may also be adapted for compliance with international standards, such as European Committee for Electrotechnical Standardization/International Electrotechnical Commission (CENELEC/IEC). Configuring the safety related functions may be done based on qualitative and quantitative safety assurance analyses.

[0111] FIG. 9 illustrates an example safety program flow chart for creating safety profiles (cases) for use during operation of a train control system, in accordance with the present disclosure. Shown in FIG. 9 is flow chart 900, representing an example process for creating safety cases (profiles), which may be implemented by PTCS-2 based systems—e.g., by designing and/or configuring various components of such systems, such as the PTCS-2 based carborne units and/or the PTCS-2 based anchors.

[0112] In this regard, creating the safety cases may comprise defining and/or setting data and/or actions for monitoring and handling safety (hazard) conditions. As shown in FIG. 9, this may be done by performing preliminary hazard analysis (PHA) 910 and generating functional fault tree (FFT) 912, such as based on assessment of system specification 902, known rail system hazards 904, and safety program plan for PTCS-2 906. This may allow performing system hazard analysis (SHA) 930, and correspondingly, operating and support hazard analysis (O&SHA) 934 and subsystem hazard analysis (SSHA) 934. Also, hazard logging 936 may be performed. Further, the

subsystem hazard analysis (SSHA) 934 may allow for performing failure modes and effects analysis (FMEA) 938. The process may further comprise performing, based on subsystem hardware/software (HW/SW) detailed design 920, a platform analysis 924, and generating subsystem safety assurance concepts (SAC) 922. The PTCS safety case(s) may then be generated 940.

[0113] FIG. 10 illustrates example message and information exchange flow chart in a transit systems that utilizes PTCS-2 based components, in accordance with the present disclosure. Shown in FIG. 10 is chart 1000, illustrating message and information exchange in a rail systems configured for utilizing PTCS-2 based components and/or functions.

[0114] In an example use scenario illustrated in chart 1000, dispatcher route input 1002 may be provide the ATS system 1004, which may also obtain vital information from the solid-state interlocking controller (SSIC) 1008. The SSIC 1008 may obtain information from axle counter via axle counter interface 1018.

[0115] The ATS system 1004 may generate an ATS movement request 1006, which may be provided to the Interface Server 1010, which may in turn provide it to the carborne unit 1012. The Interface Server 1010 may also communicate back with the ATS system 1004, such as to provide information obtained from the carborne unit 1012 (e.g., regarding handling of the ATS movement request 1006).

[0116] The carborne unit 1012 may request and obtain vital information, such as from the wayside message interface (WMI) 1014 and/or from other carborne unit(s) in other train(s) ahead 1016. The carborne unit 1012 may then use any information pertinent to functions performed thereby (particularly based on the route provided by the dispatcher), by applying vital processing 1020 of the obtained information, from all sources.

[0117] In various implementations, PTCS-2 systems may be configured to provide various functions within the train and/or within the transit system as a whole.

Some of these functions may be "enforcement" functions—that is, functions related directly to enforcement for vital train protection, while other functions may not be enforcement functions—i.e., not directly related to enforcement for vital train protection. Nonetheless, some of these non-enforcement functions may be relevant to and/or be used during enforcement scenarios. For example, while the location determination function (described below) may not be a train control enforcement function per se, it may be vital to and may be used in support of such enforcement functions as speed enforcement, train separation, temporary speed restrictions, etc.

[0118] In an example implementation, PTCS-2 systems may be configured for supporting location determination related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) to continuously tracks the train's location (e.g., based on the location of the PTCS-2 based carborne unit, which correlates to the train's location) within its operating territory (e.g., within the transit system). Use of such function may enable the train to localize its vital location while in motion or while stopped. Location in the operating territory for vital train control functionality may require determination of location along the track, identification of the specific track occupied by the train, and the direction of the train. Absence of any of these may prevent the ability of a PTCS-2 equipped train to localize. Likewise, loss of any of these following localizations will result in the PTCS-2 equipped train losing location and degrading to a reduced mode of operation.

[0119] In an example implementation, PTCS-2 systems may be configured for supporting determination of location along the track related functions. In this regard, PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) to determine the train's location along the track using such mechanisms as UWB ranging against one or more fixed wayside devices and/or legacy track-mounted axle counters. For example, the PTCS-2 based carborne unit may be configured to use UWB ranging as the primary method of determining the train's location along the track. It is noted here that "legacy" as used herein and in other parts of the disclosure with respect to the

axle counters refers to the fact that these devices are already used for train control, and not that they are legacy in that they already physically exist or are deployed in the transit systems—i.e., these axle counters may be installed as part of the deployment of the PTCS-2 system, to provide support to various functions of the system as auxiliary wayside devices (e.g., providing supplemental train control information, as well as a backup in the event of an UWB train control failure).

[0120] The track database, which is stored on the PTCS-2 based carborne unit, includes the locations of fixed ranging devices — e.g., railway signals and wayside devices (or anchors). By ranging against these fixed devices, the PTCS-2 based carborne unit may accurately determine the train's distance from the wayside device and location on the track map. Alternatively, if UWB ranging is unavailable, the PTCS-2 based carborne unit may use legacy infrastructure, such as legacy axle counters, to acquire degraded location on the track map. In some instances, however, the axle counters may be added with and/or included into the PTCS-2 system for the express purpose of providing an auxiliary wayside system (e.g., as back-up system).

[0121] In an example implementation, PTCS-2 systems may be configured for supporting identification of track related functions. This is shown in FIG. 11, which illustrates example use scenario for utilizing PTCS-2 based system for track identification, in accordance with the present disclosure. Shown in FIG. 11 is train 1110, which incorporates PTCS-2 based carborne unit 1120 for operating within a PTCS-2 based transit system, which may incorporate wayside units or anchors 1130.

[0122] In this regard, in instance where the train 1110 is in a single track territory, then determination of location along the track may be enough to vitally determine location. However, if the train 1110 is in an area with two or more tracks, track identification may need to be determined to establish the train location. In such instances, the PTCS-2 based carborne unit 1120 may be configured to use various mechanisms for identifying the specific track occupied by the train 1110, such as using

one or more of: 1) UWB ranging against multiple (e.g., three or more) fixed wayside units 1130—that is, trilateration as shown in FIG. 11; 2) traversal of a track-mounted legacy axle counters 1140, as shown in FIG. 11; 3) traversal of a converging switch (to single track; and 4) using a single anchor, in some situations and/or under certain conditions, as mentioned above—e.g., when a train slowly passes by a close anchor, thus achieving a minimum distance measurement which can only be achieved by a train operating on the track associated with that anchor (e.g., as determined using an available track database (map)).

[0123] For example, if the PTCS-2 based carborne unit 1120 is in range of three or more fixed ranging devices (wayside units 1130), the PTCS-2 based carborne unit 1120 may use trilateration based measurement and calculations to determine the position with enough accuracy to vitally identify the current track. However, where trilateration is not possible—e.g., if the number or quality of fixed ranging devices doesn't permit trilateration, track identification may be determined by other means, such as based on detection of a wayside UWB anchor (when passing it), traversing a fixed and valid legacy axle counter 1140, and/or by traversing a converging switch when the converging leg is the beginning of single track. Relatedly, the PTCS-2 based carborne units may be configured to perform direction determination functions. For example, as shown in FIG. 11, the PTCS-2 based carborne unit 1120 uses UWB ranging against one or more fixed wayside units to determine the direction of the train 1110. Direction determination requires movement of the train 1110. If one or more wayside ranging devices are available, the PTCS-2 based carborne unit 1120 may use changes in range measurements during train movement to determine the train direction.

[0124] In an example implementation, PTCS-2 systems may be configured for supporting establishing and maintaining train location with protection envelope related functions. This is shown in FIGs. 12A and 12B, which illustrates example use scenarios for utilizing a PTCS-2 based system for establishing and maintaining train location with protection envelope, in accordance with the present disclosure. Shown in FIG. 12 is

train 1210, which incorporates PTCS-2 based carborne unit 1220 for operating within a PTCS-2 based transit system.

[0125] In this regard, the PTCS-2 based carborne unit 1220 may be configured to maintain train location related information, comprising both a "perceived actual location" and a "worst-case forward location." For the perceived actual location, the PTCS-2 based carborne unit 1220 may determine the perceived actual location based on processing of all available location inputs, to determine the most likely train location at a given point in time. Example location inputs to the location processing algorithms may include: UWB ranging against one or more fixed wayside devices, legacy axle counters, GPS signals, etc. The worst-case forward location may be a range ahead of the perceived actual location, determined to create a virtual protection envelope, as shown in FIG. 12A. In this regard, enforcement functions of the train control system may be configured and/or applied based on the protection envelope—i.e., the worst-case forward location.

[0126] The distance between the perceived actual location and worst-case forward location may be a function of a default safety buffer, the number and quality of location inputs available at any point in time, and the current speed of the train. In other words, the worst case forward location, and thus the protection envelope, may be determined based on measurement and/or calculations that account for messaging related delays, movement of train, and other possible errors in the system (e.g., measurement errors). Thus, as the train speed increases or location inputs degrade (e.g. loss of UWB ranging) the protection envelope grows; whereas, when location inputs are recovered (e.g. UWB ranging) or the train traversal of a known fixed point, the protection envelope retracts.

[0127] In some instances, a configurable limit may be applied to the size of the protection envelope. If the protection envelope exceeds this limit the PTCS-2 based

carborne unit 1220 considers this loss of train location and downgrades to a reduced mode of operation until the location can be reestablished.

[0128] The determination of the protection envelope may also be configured to account for changes in the train's route, such as based on determined switch positions as illustrated in FIG. 12B. Thus, if the protection envelope traverses a diverging switch in an unknown position the track identification is lost. The PTCS-2 based carborne unit 1220 considers this loss of train location and downgrades to a reduced mode of operation until location can be reestablished.

[0129] In an example implementation, PTCS-2 systems may be configured for supporting speed determination related functions. This is shown in FIG. 13, which illustrates example use scenarios for utilizing PTCS-2 based system for speed determination, in accordance with the present disclosure. Shown in FIG. 13 is train 1310, which incorporates PTCS-2 based carborne units 1320 for operating within a PTCS-2 based transit system, which may incorporate wayside units or anchors 1330. In this regard, the PTCS-2 based carborne units 1320 may be configured to use UWB ranging against one or more fixed wayside devices to determine the train speed. For example, in order to use UWB ranging for speed determination, the PTCS-2 based carborne units 1320 may need executed multiple range measurements to two or more fixed wayside devices and effectively calculated the train speed as distance traveled over time.

[0130] In the example use scenario shown in FIG. 13, each of the two PTCS-2 based carborne units 1320, which are located at the two ends of the trains, may determine respective ranges (shown as range 1 and range 2) to corresponding wayside anchors 1330 from the two ends of the train. The train speed may be calculated for each fixed wayside device—e.g., by each of two PTCS-2 based carborne units 1320, the based on changes in two ranges (range 1 and range 2), and the train speed is determined as the maximum of the two speed measurements. To guard against speed

determination errors, variance between the two speed measurements exceeds a predefined threshold then speed determination is considered lost and the system downgraded to a reduced mode of operation. The threshold of variability between measured speeds may be configurable.

[0131] In an example implementation, PTCS-2 systems may be configured for supporting brake control related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for controlling train brakes, such as a means of providing enforcement in support of train protection and safety. Various mechanisms may be used for implementing such brake control. For example, the PTCS-2 based carborne unit may be configured to use an optional non-vital serial interface to the integrated brake system in the train. Using a non-vital serial interface, the PTCS-2 based carborne unit may send commands for various levels of braking, including full service brake. Alternatively or additionally, the PTCS-2 based carborne unit may be configured to use a mandatory vital discrete output, which may be used for vital application of full service or emergency brake. This may be done to provide more severe brake rate in the event the non-vital application may not achieve the required rate of deceleration.

[0132] In an example implementation, PTCS-2 systems may be configured for supporting train tracking related functions. In this regard, PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) to periodically broadcast the current location of the train, as the train traverses within its operating territory, to nearby wayside devices (e.g., via the Data Communication System (DCS) network). The wayside devices may in turn communicate the current train location, such as via the Wayside Message Interface (WMI), over a dedicated network (e.g., fiber network). In this regard, the WMI may maintain real-time tracking of all PTCS-2 equipped trains. In a large territory requiring more than one WMI, each WMI may be responsible for maintaining train tracking within its respective zone, and to coordinate handover of trains transitioning between zones with the adjacent WMI.

[0133] In some instances, the data transmission between the PTCS-2 equipped trains and the wayside devices, as well as between the wayside devices and the WMI incorporate defenses to ensure message authenticity, integrity, timeliness, freshness, and sequence.

[0134] If loss of communication occurs while a train is traversing the track, the WMI may lose the ability to vitally track that train's location. Thus, when this occurs, responsibility for tracking of the train may be handed over to a series of underlying legacy axle counters. Further, protection against an unequipped or malfunctioning PTCS-2 equipped train may commence exclusively using fixed block principals in accordance with the blocks established by the legacy axle counter.

[0135] In an example implementation, PTCS-2 systems may be configured for supporting target tracking related functions. In this regard, the PTCS-2 based carborne unit of a PTCS-2 equipped train may be configured to maintain a list of targets in the train's path as the PTCS-2 equipped train traverses the operating territory, with relevant data for each target. Items that may constitute "targets" include, but are not limited to, anchors (or wayside devices in general), signals, switches, station platforms, other PTCS-2 equipped trains, speed restriction boundaries, work zone boundaries, end of track bumpers, and territory boundaries. In this regard, with decentralized control each PTCS-2 equipped train may maintain the updated location of a train or trains in its "visibility zone"—that is, within the necessary distance ahead to ensure safety in worst case conditions, such that each train may calculate the maximum distance and track path it can travel safely. Such movement authority limit (MAL) may be shared with other trains as they continuously inquire to ensure that the MALs don't overlap and create an unsafe condition.

[0136] Each of the targets in the list may be associated with attributes to identify important information such as target type, location, health, operating status, etc. Targets that are permanent fixtures (e.g. anchors, signals, switches, etc.) may be

acquired by the PTCS-2 equipped train from a track database. Volatile targets (e.g. other PTCS-2 equipped trains, Work Zone boundaries, etc.) may be acquired via data communication with the targets, directly and/or indirectly (e.g., via the WMI). Targets with volatile attributes that contribute to operational safety (e.g. switch position, signal status, other PTCS-2 equipped train location or direction) may be set such that they may require periodic updates to ensure freshness. In this regard, updates may be acquired via data communication.

[0137] A PTCS-2 equipped train may be configured to treat targets with expired attributes in the most restrictive state applicable to that target type. The data transmission between the PTCS-2 equipped trains and the wayside anchors may incorporate defense measures to ensure message authenticity, integrity, timeliness, freshness, and sequence. Detected failures may result in treating the respective target in the most restrictive state applicable to that target type.

[0138] In an example implementation, PTCS-2 systems may be configured for supporting speed enforcement related functions. In this regard, a PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for determining and/or enforcing applicable speed limits. For example, there may be three primary types of speed limits enforceable by the PTCS-2 based carborne unit: 1) civil speed limits; 2) temporary speed restrictions; and 3) restrictive speed limits associated with degraded modes of operation. Civil speed limits may be captured in a track database (associated with a particular track). Temporary speed restrictions may not part of the track database, but rather are communicated to a PTCS-2 equipped train—e.g., from the WMI. When a PTCS-2 equipped train is operating in a degraded mode of operations (e.g. pre-initialized, loss of location, en route failure), a configurable restrictive speed, may be allocated to degraded mode.

[0139] In some instances, the PTCS-2 based carborne unit may maintain a list of all speed limits applicable to the determined location and may enforce the most

restrictive of those. While enforcement of the most restrictive speed is a vital function, determination of the most restrictive speed may not be. This is also true for temporary speed restrictions and operation in degraded modes. In an example use scenario, acquisition of temporary speed limits may be initiated by the dispatcher entering information into the ATS system. The ATS may then send the speed restriction message to the WMI. The WMI may send a vital message to all trains and the carborne system applies vital logic to implement the restriction. When operating in a degraded mode, enforcement of the associated speed limit is a vital function, depending on the reason for being in a degraded mode it is possible for there to be a more restrictive speed limit that the PTCS-2 based carborne unit is unable to acquire.

[0140] The PTCS-2 based carborne unit may enforce the most restrictive speed limit it has for the determined train location. Speed enforcement may be configured for using configurable overspeed allowance, prior to automatic enforcement. Thus, if the determined train speed exceeds the speed limit, but not the overspeed allowance, the PTCS-2 based carborne unit may provide an indication (e.g., audible and visual warning) to the train operator of pending enforcement. This provides the train operator with the opportunity to comply before automatic enforcement is executed after a configurable time delay. If the determined train speed exceeds the configurable overspeed allowance the PTCS-2 based carborne unit automatically enforces by brake application.

[0141] Enforcement application may occur by vital application of full service or emergency braking, or alternatively may be configured to apply the full service braking or a less severe rate of braking using non-vital means. The PTCS-2 based carborne unit may be configured to, when using the non-vital means of enforcement, monitor the deceleration rate and apply vital enforcement if the desired configurable deceleration rate is not met. The PTCS-2 based carborne unit may be configured to release enforcement brakes once the determined train speed complies with the determined

speed limit (or slower by a configurable margin), or to hold the enforcement brakes until the train has come to a complete stop.

[0142] In an example implementation, PTCS-2 systems may be configured for supporting signal enforcement related functions. In this regard, PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for enforcing signals, such as based on a list of signals in the train's path, which may be maintained by the PTCS-2 based carborne unit. For example, as a PTCS-2 equipped train traverses the operating territory, when the train approaches signals (e.g., indicated in the list), the PTCS-2 based carborne unit may establish wireless communication with each signal and/or wayside devices at or near the signals, such as to acquire the signal's current status and other information. In some instances, the data transmission between the PTCS-2 equipped trains and the signals (and/or wayside devices at or near the signals) may incorporate defenses to ensure message authenticity, integrity, timeliness, freshness, and sequence. The PTCS-2 based carborne unit may also use UWB ranging (e.g., the signal) to determine the distance from the train to the signal.

[0143] In some instances, with signals at interlocks, the signal state and interlock state may be monitored by the solid-state interlocking controller (SSIC) and associated legacy axle counters. When a train is approaching an interlock, it may receive vital information from the solid-state interlocking controller, such as via the WMI, as well as directly from the UWB equipped signal. Various handling criteria may be used in conjunction with signal enforcement. For example, an unhealthy or non-communicating signal, or one for which the status age exceeds a configurable threshold is treated as a stop signal. A signal for which the inconsistency between the signal's location determined via UWB ranging and the expected signal's location as calculated based on the determined train location and the signal location captured in the track database exceeds a predefined threshold is treated as a stop signal.

[0144] In an example use scenario, as a PTCS-2 equipped train approaches a signal it uses pertinent information (e.g., the train's determined location, train's speed, location and status of the signal, and applicable braking curve) to determine the point at which enforcement must occur in order to comply with the signal. The PTCS-2 based carborne unit may provide corresponding output to the operator—e.g., displaying a countdown of time remaining for the operator to reduce speed to comply with the signal. When the countdown reaches a configurable threshold, the system may provide an indication (e.g., audible and visual warning) to the train operator of pending enforcement. If the train is not in compliance before reaching the enforcement point, the PTCS-2 based carborne unit automatically enforces signal compliance, such as by brake application. Enforcement application may occur by vital application of full service or emergency braking, or alternatively, may be configured to apply the full service brake or a less severe rate of braking using non-vital means. If using the non-vital means of enforcement, the PTCS-2 based carborne unit will monitor the deceleration rate and apply vital enforcement if the desired configurable declaration rate is not met.

[0145] In an example implementation, PTCS-2 systems may be configured for supporting enforcement of train separation related functions. For example, as a PTCS-2 equipped train traverses the operating territory it maintains a list of other PTCS-2 equipped trains in its path and various attributes about the other train(s) (e.g. location, direction, speed & the freshness of this data). As a train enters a section of track, the train may obtain (e.g., via the WMI) identification information (e.g., Train ID) of trains ahead. As the train approaches other PTCS-2 equipped trains in its path, it establishes wireless communication with the other trains, to acquire the pertinent information associated therewith (e.g., train's location, speed, direction, and status), as determined by the other train). In this regard, "status" may include train consist length, and "location" may include the location of the front and rear of the train, so that the entire extent of the track occupied by the train is known. The PTCS-2 equipped train may determine the train ahead, and may monitor that train's location to ensure safe

separation. The data transmissions between the PTCS-2 equipped trains may incorporate defenses to ensure message authenticity, integrity, timeliness, freshness, and sequence.

[0146] In some instances, the PTCS-2 equipped train may be configured to take various measures in identifying and handling conditions affecting train safety. For example, an unhealthy or non-communicating train, or one for which the age of data exceeds a configurable threshold is treated as a failed train. In the event of a failed train, separation is maintained in accordance with fixed blocks, as established by underlying legacy axle counter track circuits, or by enforcing a stop for the current PTCS-2 equipped train until the location of trains in its path can be assured.

[0147] In some instances, the PTCS-2 equipped train uses its own direction, location, and speed with the known data about other PTCS-2 equipped trains in its path to calculate separation distance and closing speed. This information with the applicable braking curve for the train is used to determine the point at which automatic enforcement is required to safely maintain desired train separation. Much like with signal enforcement, the PTCS-2 based carborne unit displays to the operator a countdown of time remaining for the operator to reduce speed to comply with the train separation requirements before the system will apply automatic enforcement. When the countdown reaches a configurable threshold, the system provides audible and visual warning to the train operator of pending enforcement. This provides the train operator with the opportunity to comply before enforcement or at least prepare the train for enforcement if enforcement is unavoidable. If the train is not in compliance before reaching the enforcement point the PTCS-2 based carborne unit will automatically enforce by brake application.

[0148] Enforcement application may occur by vital application of full service or emergency braking, or alternatively may be configured to apply the full service brake or a less severe rate of braking using non-vital means. If using the non-vital means of

enforcement, the PTCS-2 based carborne unit will monitor the deceleration rate and apply vital enforcement if the desired configurable declaration rate is not met.

[0149] In an example implementation, PTCS-2 systems may be configured for supporting work zone protection related functions. In this regard, various rail related systems (e.g., ATS systems) may incorporate work zone protection, and PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for supporting such work zone protection. In an example use scenario, a dispatcher enters the work zone information. The ATS system generates a message (e.g., on an Interface Server) that is then sent to the WMI. The message may comprise such information as location related information (e.g., start and end) and timing related information (e.g., start and end times) of the work zone. The WMI sends the message to all trains. Each train, using UWB location information, may determine (e.g., by applying vital logic) if the message applies to that particular train. If the message does not apply the carborne system will continue to test message application until the work zone time expires. A separate message can be initiated by the dispatcher to end a work zone restriction immediately.

[0150] In an example implementation, PTCS-2 systems may be configured for supporting topographical track map (database) related functions. In this regard, PTCS-2 equipped train may be configured (e.g., via its PTCS-2 based carborne unit) for generating, maintaining, and/or updating track map (database), which may be used for other functions. The track database may comprise a map (e.g., topographical data) for the operating territory, including but not limited to: anchor locations, civil speed limits, switch location, signal locations, relative track grade, station platform locations, and end-of-track bumper locations. The track database may (or may not) include dynamic data, such as temporary speed restrictions, ranging results, train speed, etc. The track database may be loaded directly onto the PTCS-2 based carborne unit, such as by maintenance personnel (e.g., using PE 180, as shown in FIG. 1), or may be wirelessly loaded from a train control server (e.g., as part of departure test). The track database

may comprise several files. For added security and reliability, each file may include error detection and protection measures (e.g., cyclic redundancy check (CRC)), to ensure that any corruption is detectable. In some instances, the track database as a whole may similarly include error detection and protection measures—e.g., a dedicated CRC file that provides collective protection for the track database in its entirety.

[0151] Other embodiments of the invention may provide a non-transitory computer readable medium and/or storage medium, and/or a non-transitory machine readable medium and/or storage medium, having stored thereon, a machine code and/or a computer program having at least one code section executable by a machine and/or a computer, thereby causing the machine and/or computer to perform the processes as described herein.

[0152] Accordingly, various embodiments in accordance with the present invention may be realized in hardware, software, or a combination of hardware and software. The present invention may be realized in a centralized fashion in at least one computing system, or in a distributed fashion where different elements are spread across several interconnected computing systems. Any kind of computing system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software may be a general-purpose computing system with a program or other code that, when being loaded and executed, controls the computing system such that it carries out the methods described herein. Another typical implementation may comprise an application specific integrated circuit or chip.

[0153] Various embodiments in accordance with the present invention may also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to

perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

[0154] While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Attorney Docket No. 63154US02 METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 16/290,576 filed on March 1, 2019.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Richard C. Carlson Date (Optional) :

Signature:

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Attorney Docket No. 63154US02 METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 16/290,576 filed on March 1, 2019.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Marc Wayne Cygnus Date (Optional): 3-11-2019

Signature: Marc Wayne Cygnus

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Attorney Docket No. 63154US02 METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 16/290,576 filed on March 1, 2019.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Kurt Alan Gunther Date (Optional): 3/11/2019

Signature: Kurt Alan Gunther

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Attorney Docket No. 63154US02 METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 16/290,576 filed on March 1, 2019.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Sara Jo Woitel Date (Optional) :

Signature:

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2019-07-18
First Named Inventor	Carlson
Art Unit	
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5675190		1997-10-07	Morita	
	2	4302811		1981-11-24	McElhenny	
	3	4327415		1982-04-27	Rush et al.	
	4	4459668		1984-07-10	Inoue et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	9	8478463		2013-07-02	Knott et al.	
	10	8651433		2014-02-18	Ghaly	
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	Attorney Docket Number	63154US03

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	1	20140229096		2014-08-14	Carlson	
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	3	20110046845		2011-02-24	Kozlay	
	4	20080114519		2008-05-15	Defaux	
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	Attorney Docket Number	63154US03

	6	20100225527		2010-09-09	Talty	
	7	20040155760		2004-08-12	Grisham	
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	17	20060015224		2006-01-19	Hilleary	
	18	20080040023		2008-02-14	Breed, et al.	
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	28	20140191089		2014-07-10	Reichlin et al.	
	29	20140214248		2014-07-31	Yamada	
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	37	20130166114		2013-06-27	Baines et al.	
	38	20110006912		2011-01-13	Sheardown et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	39	20110152971		2011-06-23	Nghiem et al.	
	40	20140045547		2014-02-13	Singamsetty et al.	
	41	20160280240		2016-09-29	Carlson et al.	
	42	20170282944		2017-10-05	Carlson et al.	
	43	20140229096		2014-08-14	Carlson	
	44	20090326746		2009-12-31	Mian	
	45	20110075641		2011-03-31	Siriwongpairat et al.	
	46	20150344048		2015-12-03	Kemwein	
	47	20160046308		2016-02-18	Chung et al.	
	48	20170101116		2017-04-13	Shubs, Jr., et al.	
	49	20170113707		2017-04-27	Ghaly	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	50	20030028323		2003-02-06	Zeitler et al.	
	51	20100327125		2010-12-30	Braband et al.	
	52	20130046420		2013-02-21	Gottifredi et al.	
	53	20120296567		2012-11-22	Breed	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	102923158	CN		2013-02-13	Chen Gengtian		
	2	1417071	CN		2003-05-14	Sehnzhen Maishiwei Sci-Tech Co., Ltd.		
	3	1676375	CN		2005-10-05	Shantou Univ.		
	4	2012227260	AU		2014-04-17	Safemine AG		
	5	2015201462	AU		2015-10-08	Thales		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	6	03012470	WO		2003-02-13	Siemens Aktiengesellschaft		

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	PCT, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, in International application no. PCT/US2014/053900, dated February 18, 2015 (21 pages).	
	2	Chinese Office Action for Application No. 201710074449.6, dated January 17, 2019 (22 pages).	
	3	International Search Report and Written Opinion for PCT/US2018/045388, mailed October 18, 2018. (16 pages).	
	4	International Search Report and Written Opinion for PCT/US2016/023754, mailed August 8, 2016. (10 pages).	
	5	International Search Report and Written Opinion for PCT/US2018/049062, dated November 9, 2018. (13 pages).	
	6	Internatinoal Search Report and Written Opinion for PCT/US19/20385, mailed June 28, 2019. (15 pages).	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-07-18
Name/Print	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/80 (07-17)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no person is required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 23,446

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

[X] The address associated with Customer Number: 23,446

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: Metrom Rail, LLC
1125 Mitchell Court
Crystal Lake, IL 60014

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee.

Signature	Date 11-5-18
Name Richard C. Carlson	Telephone
Title Chief Operating Officer	

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

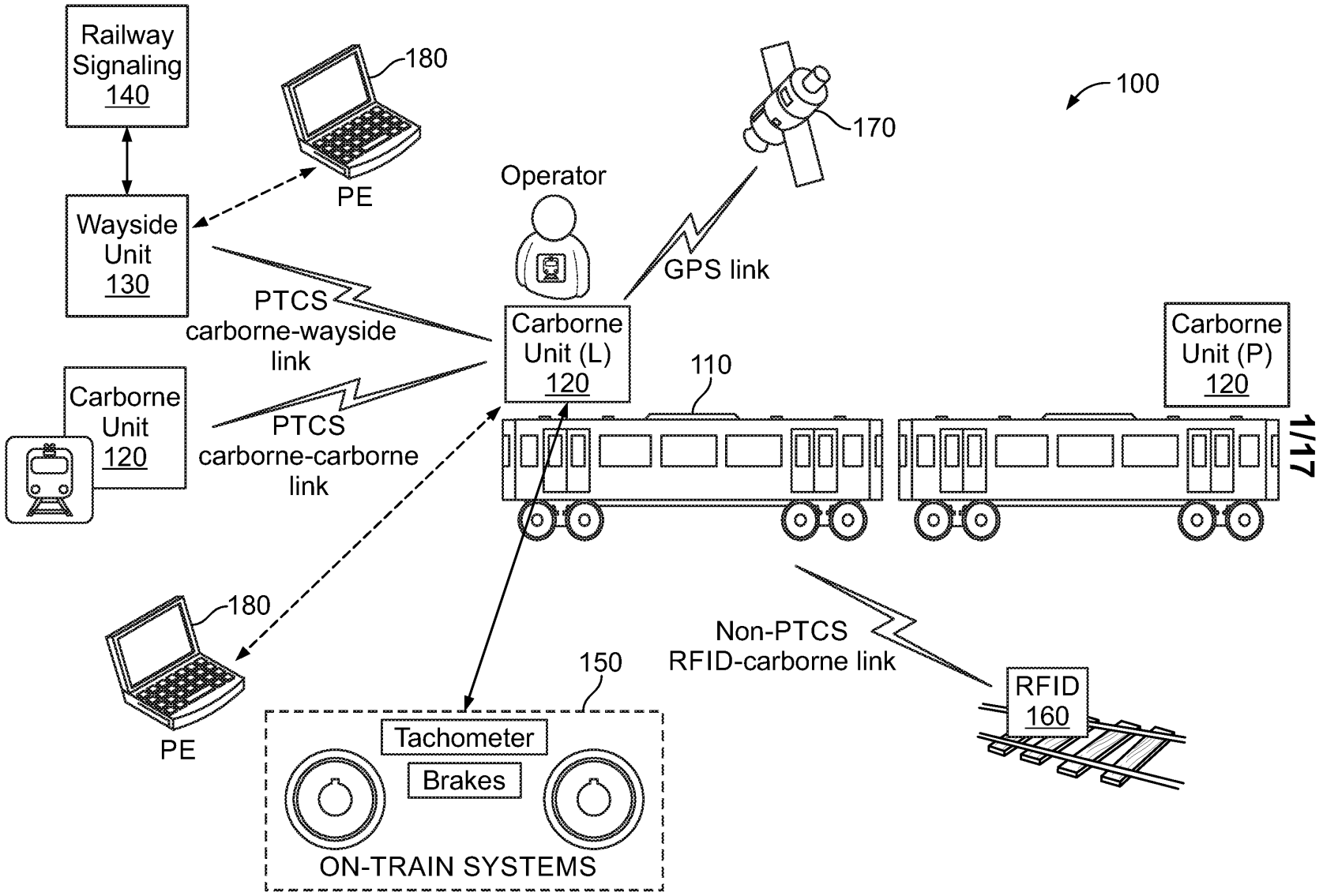


FIG. 1

Ex. 1002 - Page 91

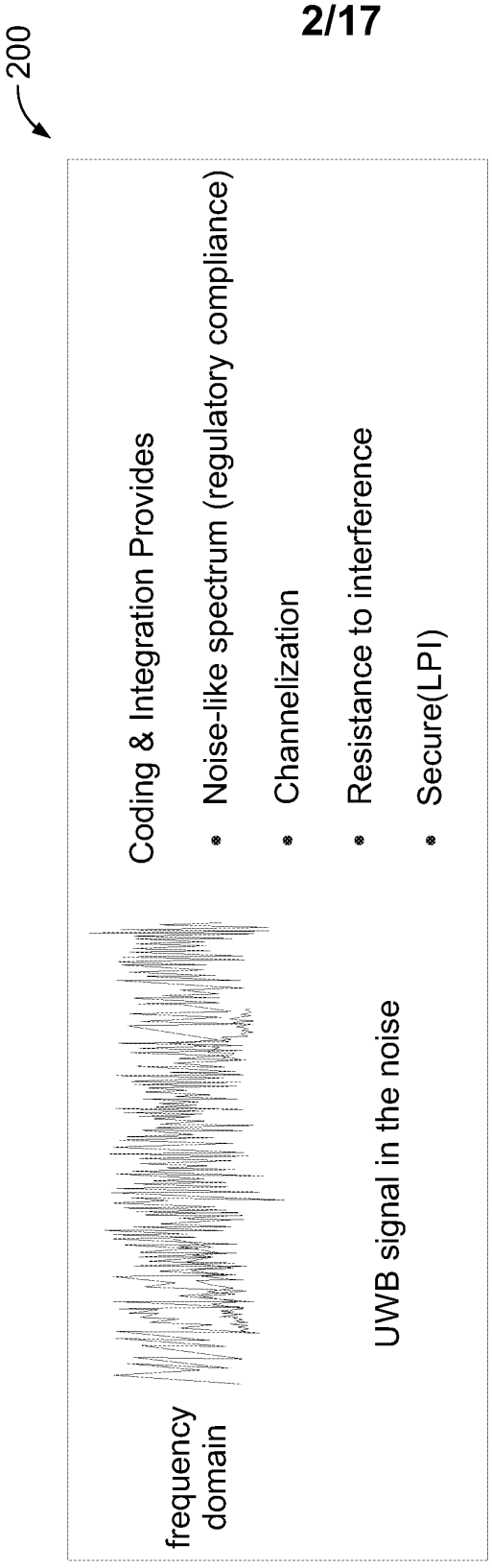

200
Coding & Integration Provides
Noise-like spectrum (regulatory compliance)
Channelization
Resistance to interference
Secure(LPI)
UWB signal in the noise
frequency domain

FIG. 2

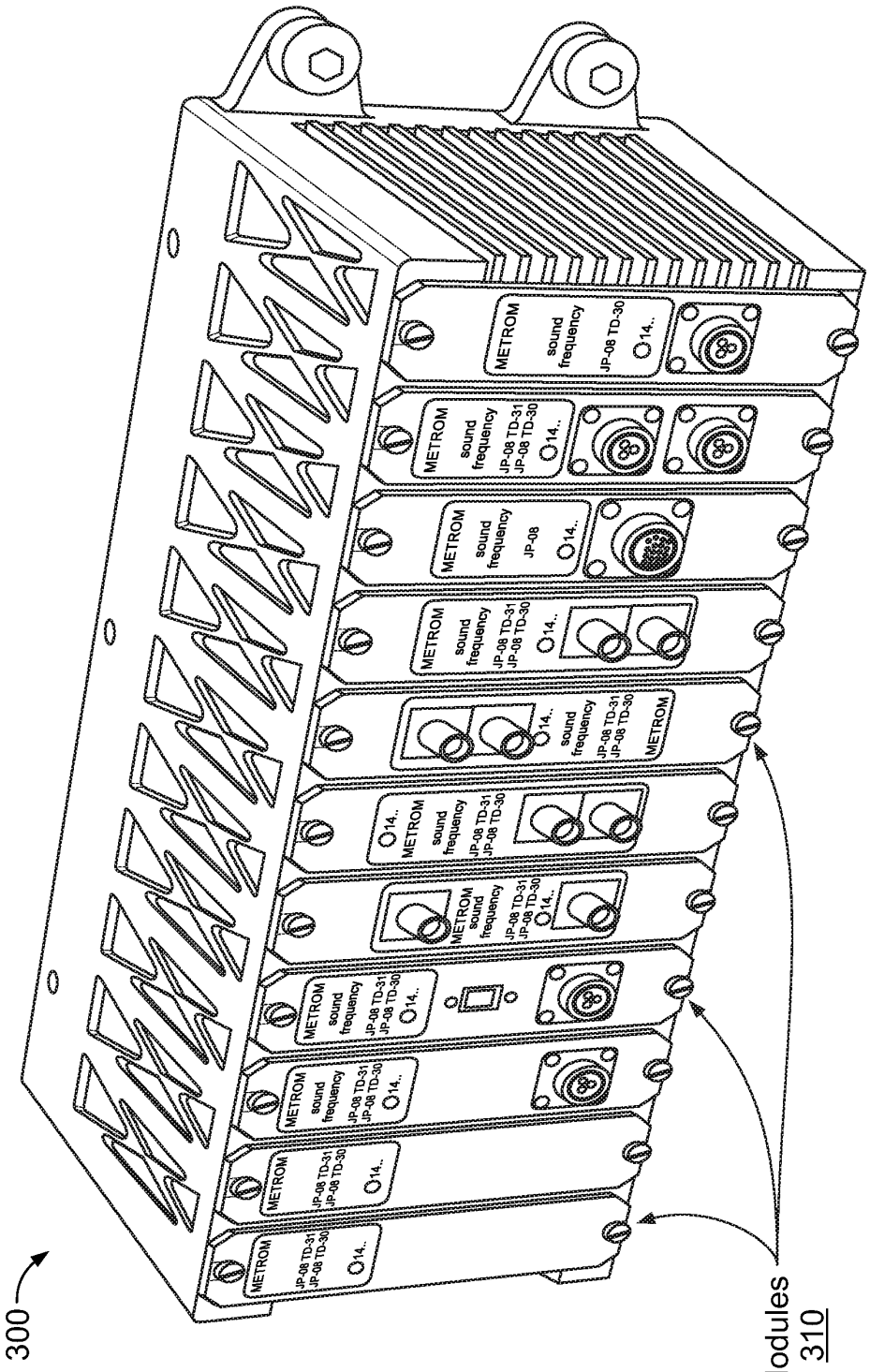

300
Modules
310
METROM
sound
frequency
JP-08 TD-31
JP-08 TD-30
JP-08
14..

FIG. 3

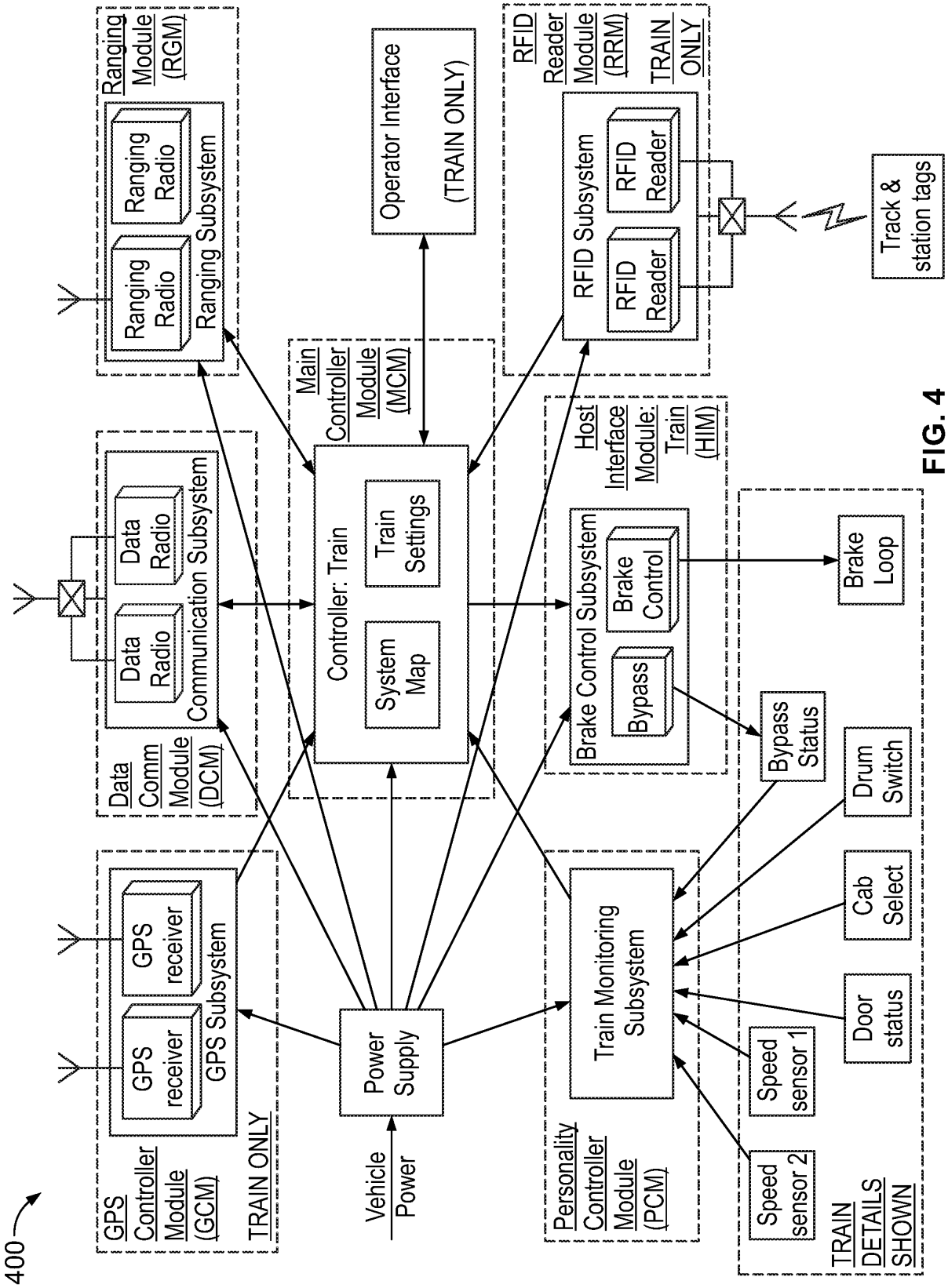

400
GPS Controller Module (GCM)
TRAIN ONLY
GPS receiver
GPS receiver
GPS Subsystem
Data Comm Module (DCM)
Data Radio
Data Radio
Communication Subsystem
Ranging Module (RGM)
Ranging Radio
Ranging Radio
Ranging Subsystem
Main Controller Module (MCM)
Controller: Train
Train Settings
System Map
Operator Interface
(TRAIN ONLY)
RFID Reader Module (RRM)
TRAIN ONLY
RFID Subsystem
RFID Reader
RFID Reader
Track & station tags
Host Interface Module: Train (HIM)
Brake Control Subsystem
Brake Control
Bypass
Brake Loop
Bypass Status
Drum Switch
Cab Select
Door status
Speed sensor 1
Speed sensor 2
Personality Controller Module (PCM)
Train Monitoring Subsystem
Power Supply
Vehicle Power
TRAIN DETAILS SHOWN

FIG. 4

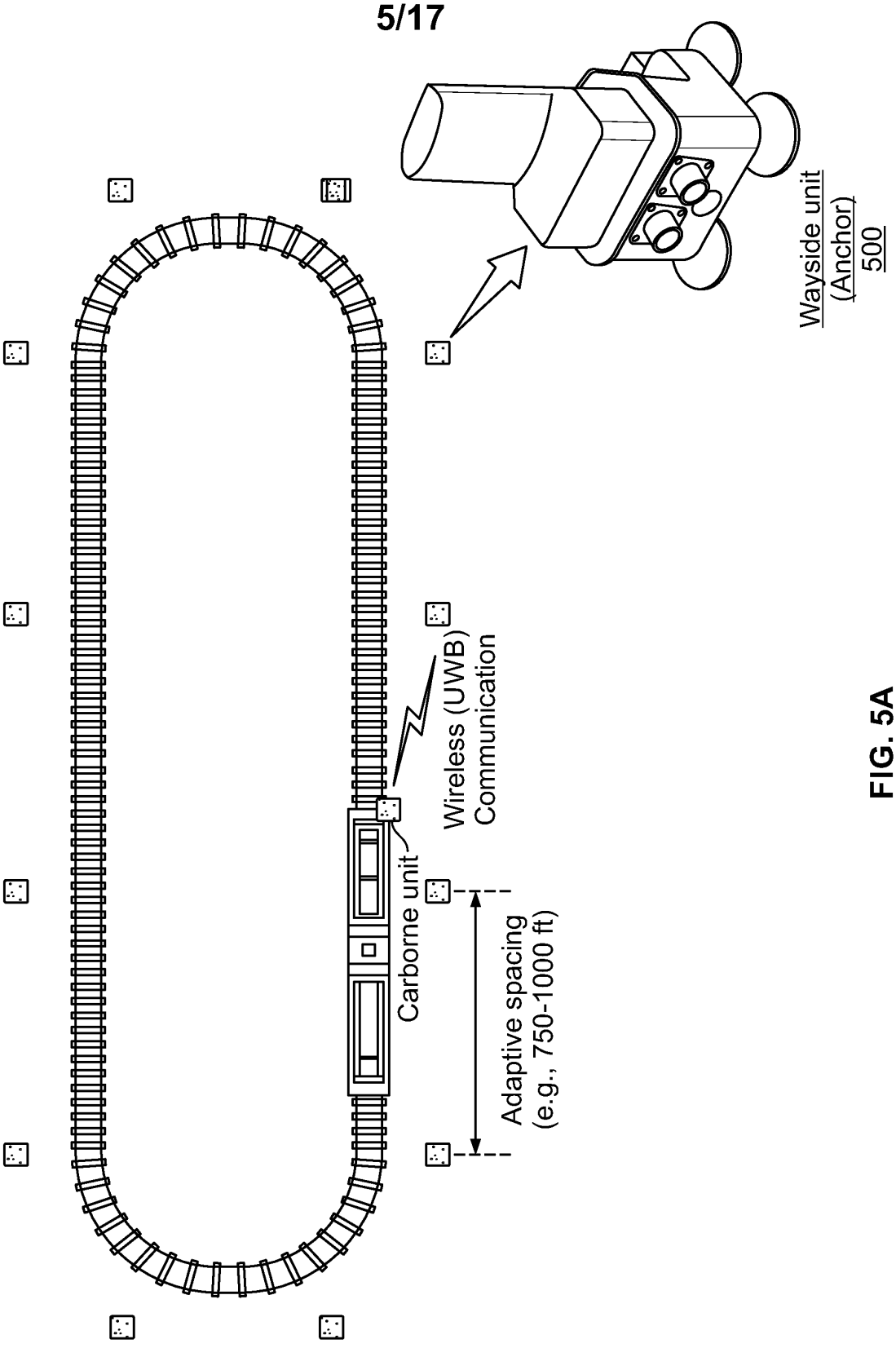

Wayside unit
(Anchor)
500
Wireless (UWB)
Communication
Carborne unit
Adaptive spacing
(e.g., 750-1000 ft)

FIG. 5A

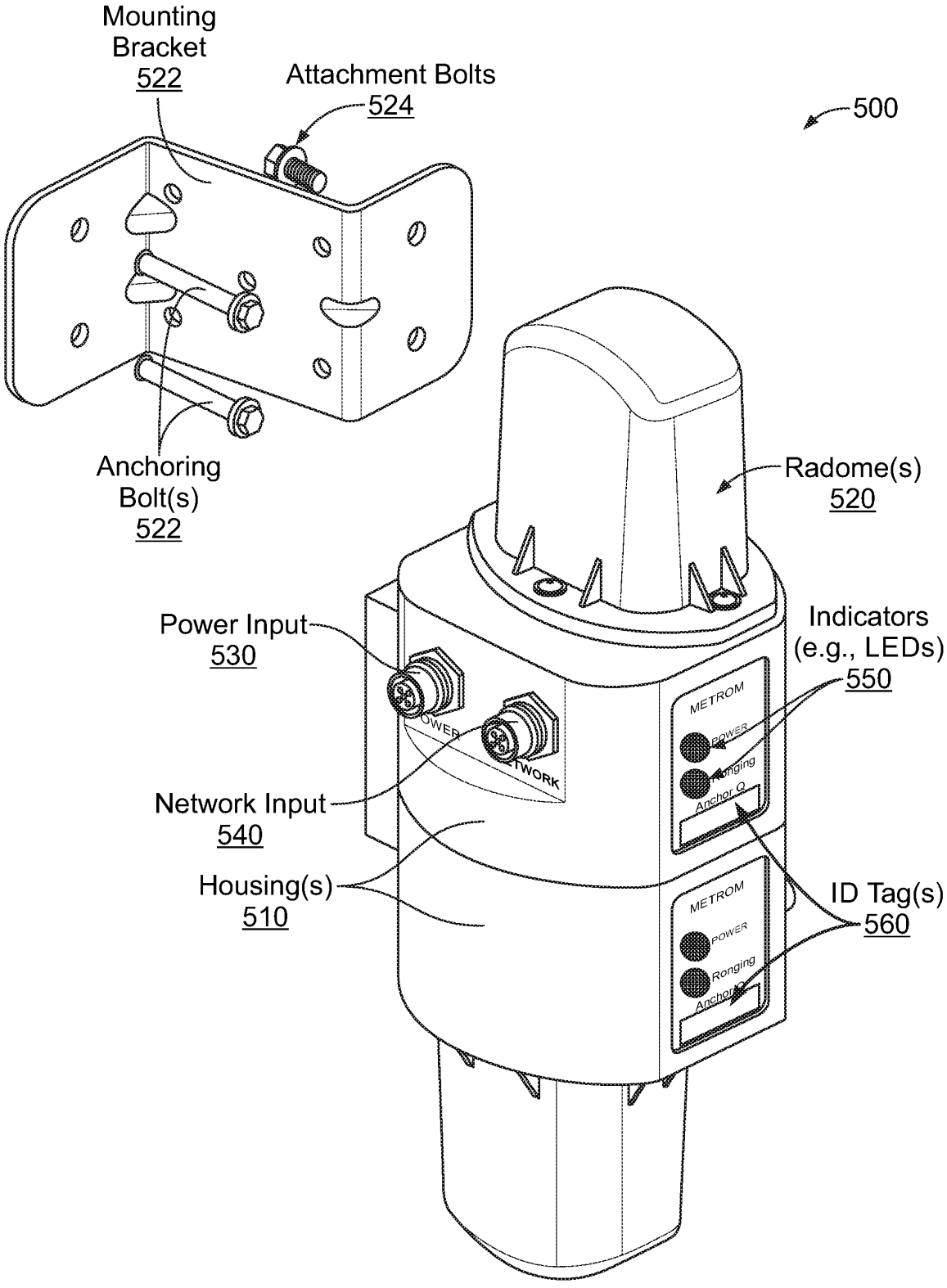

Mounting Bracket 522
Attachment Bolts 524
500
Anchoring Bolt(s) 522
Radome(s) 520
Power Input 530
Indicators (e.g., LEDs) 550
Network Input 540
Housing(s) 510
ID Tag(s) 560
METROM
POWER
Ranging
Anchor
METROM
POWER
Ranging
Anchor

FIG. 5B

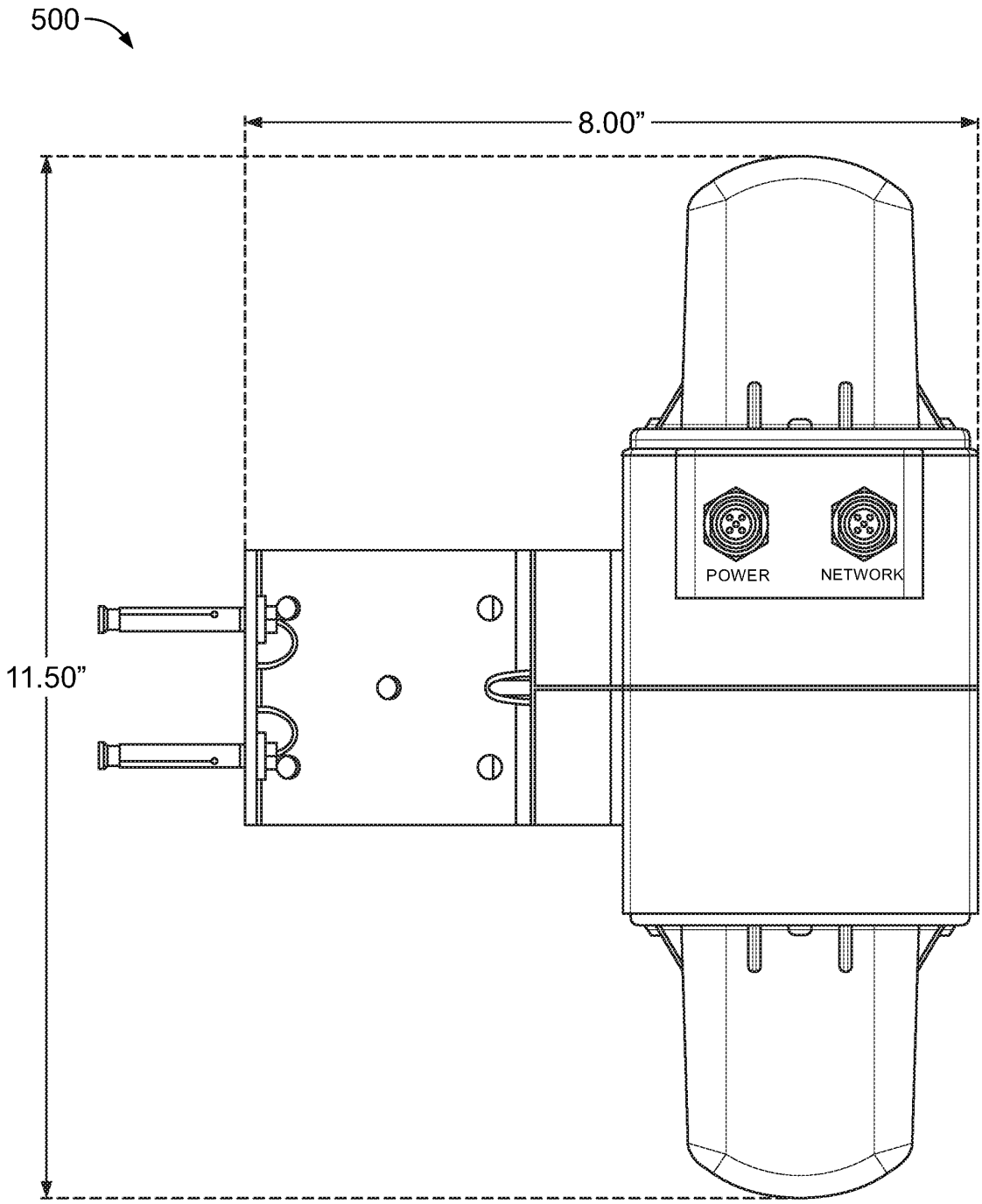


FIG. 5C

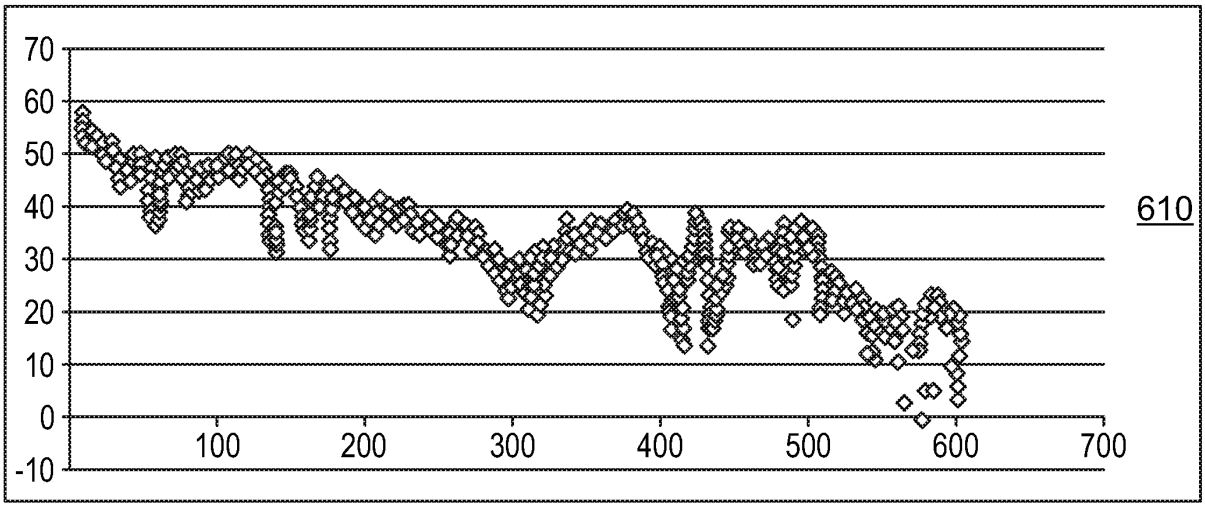

70
60
50
40
30
20
10
0
-10
100
200
300
400
500
600
700
610

FIG. 6A

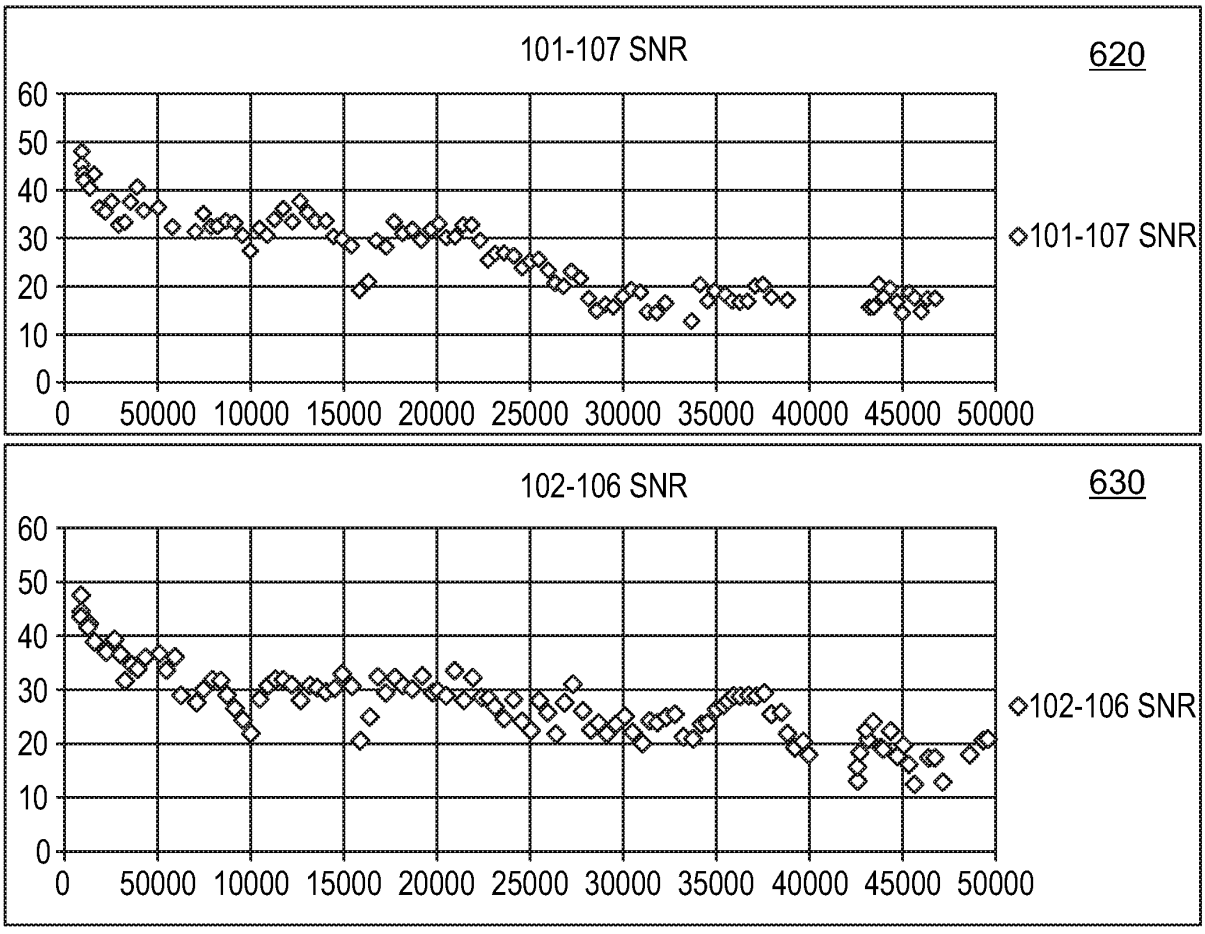

101-107 SNR
620
60
50
40
30
20
10
0
0
50000
10000
15000
20000
25000
30000
35000
40000
45000
50000
101-107 SNR
102-106 SNR
630
102-106 SNR

FIG. 6B

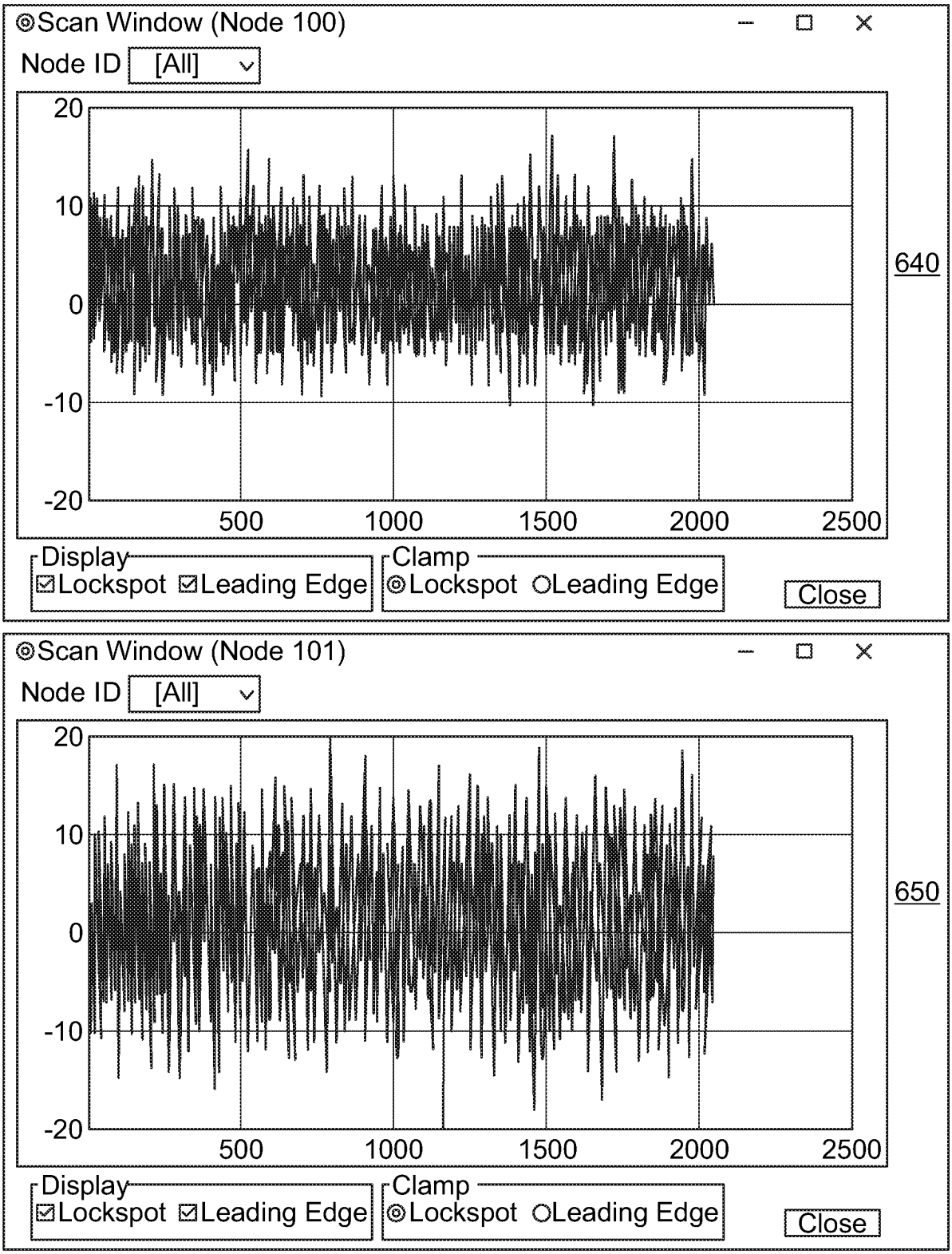

Scan Window (Node 100)
Node ID [All]
20
10
0
-10
-20
500
1000
1500
2000
2500
640
Display
Lockspot
Leading Edge
Clamp
Lockspot
Leading Edge
Close
Scan Window (Node 101)
Node ID [All]
20
10
0
-10
-20
500
1000
1500
2000
2500
650
Display
Lockspot
Leading Edge
Clamp
Lockspot
Leading Edge
Close

FIG. 6C

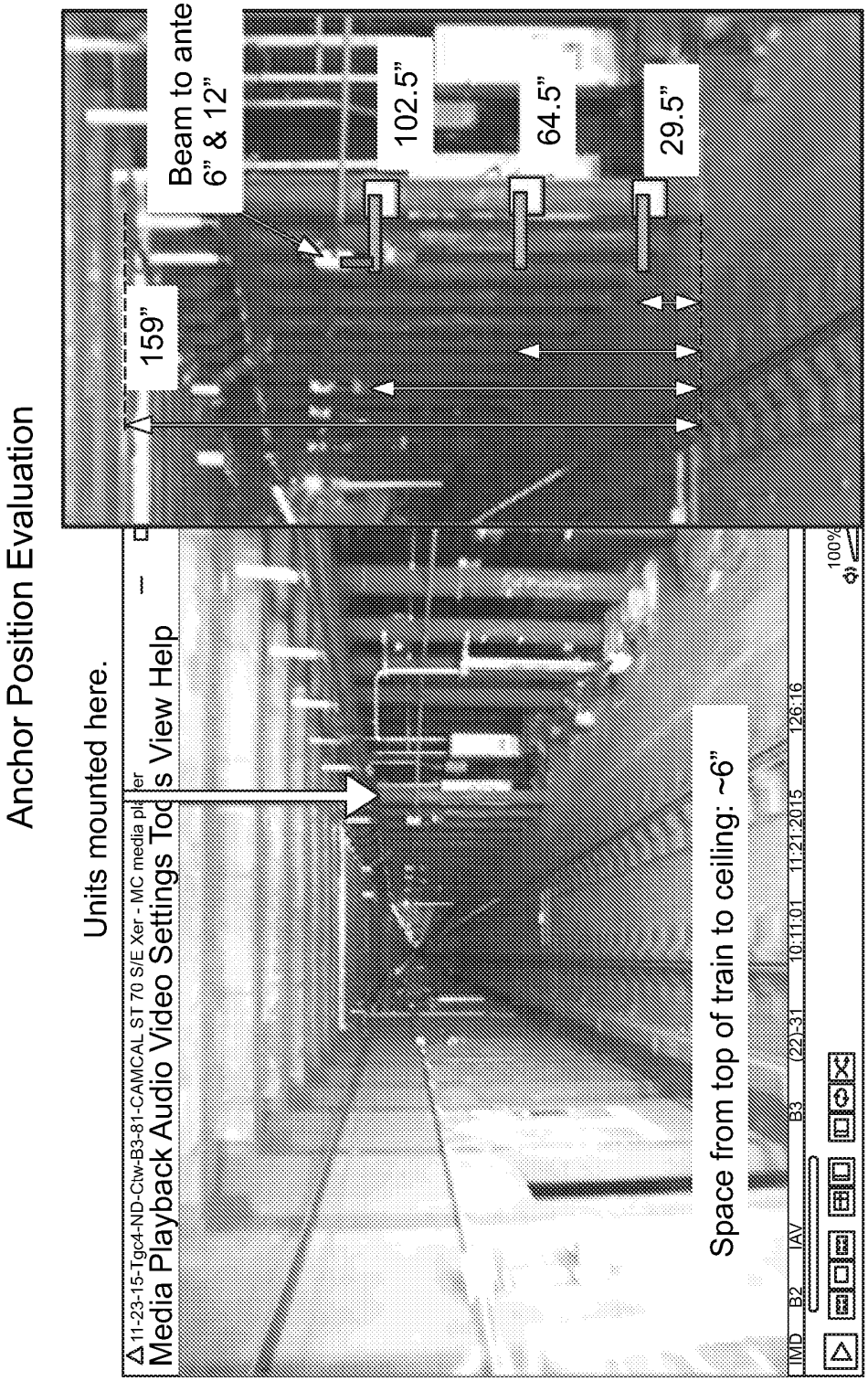
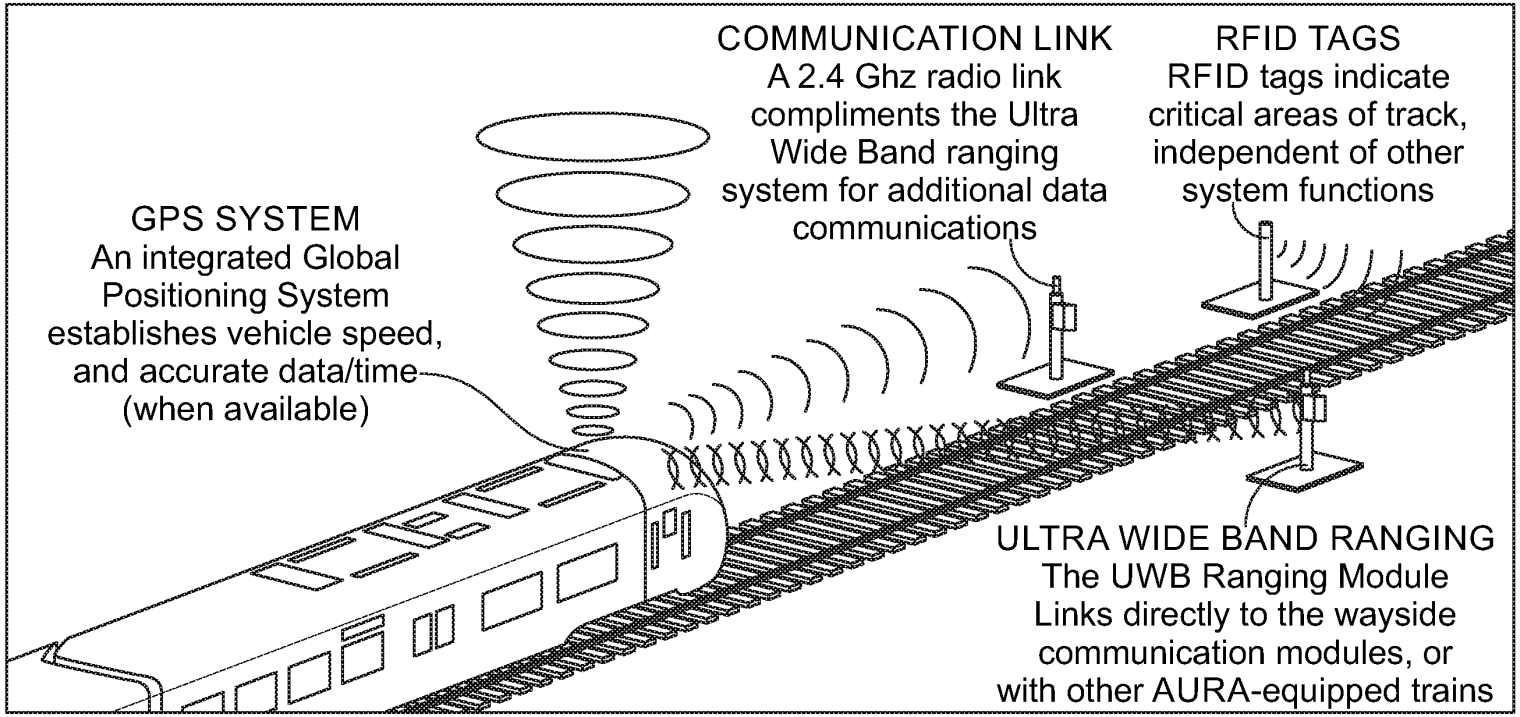

Anchor Position Evaluation
Units mounted here.
Beam to antenna:
6” & 12”
159”
102.5”
64.5”
29.5”
Space from top of train to ceiling: ~6”
11-23-15-Tgc4-ND-Ctw-B3-81-CAMCAL ST 70 S/E Xer - MC media pl
Media Playback Audio Video Settings Tod
s View Help
IMD
B2
IAV
B3
(22)-31
10:11:01
11:21:2015
126:16
100%

FIG. 7

PTCS Redundant Sensing Technologies



Sensor System	Primary Function	Additional Function
Ultra Wide-Band Transponder (UWB)	Distance Measurements	Data Con / Speed Determination
	Data Communication	GPS-based Distance Measurement
2.4 Ghz Spread Spectrum Radio	Track Location / Track info	Wheel Sensor Cal / Train Position / Range Verification
RFID	Train Position in Surface Track	
WAAS GPS		RTC Clock Cal / Diagnostics
Train Speed	Speed Measurements	Position Dead-reckoning

FIG. 8

Ex. 1002 - Page 101

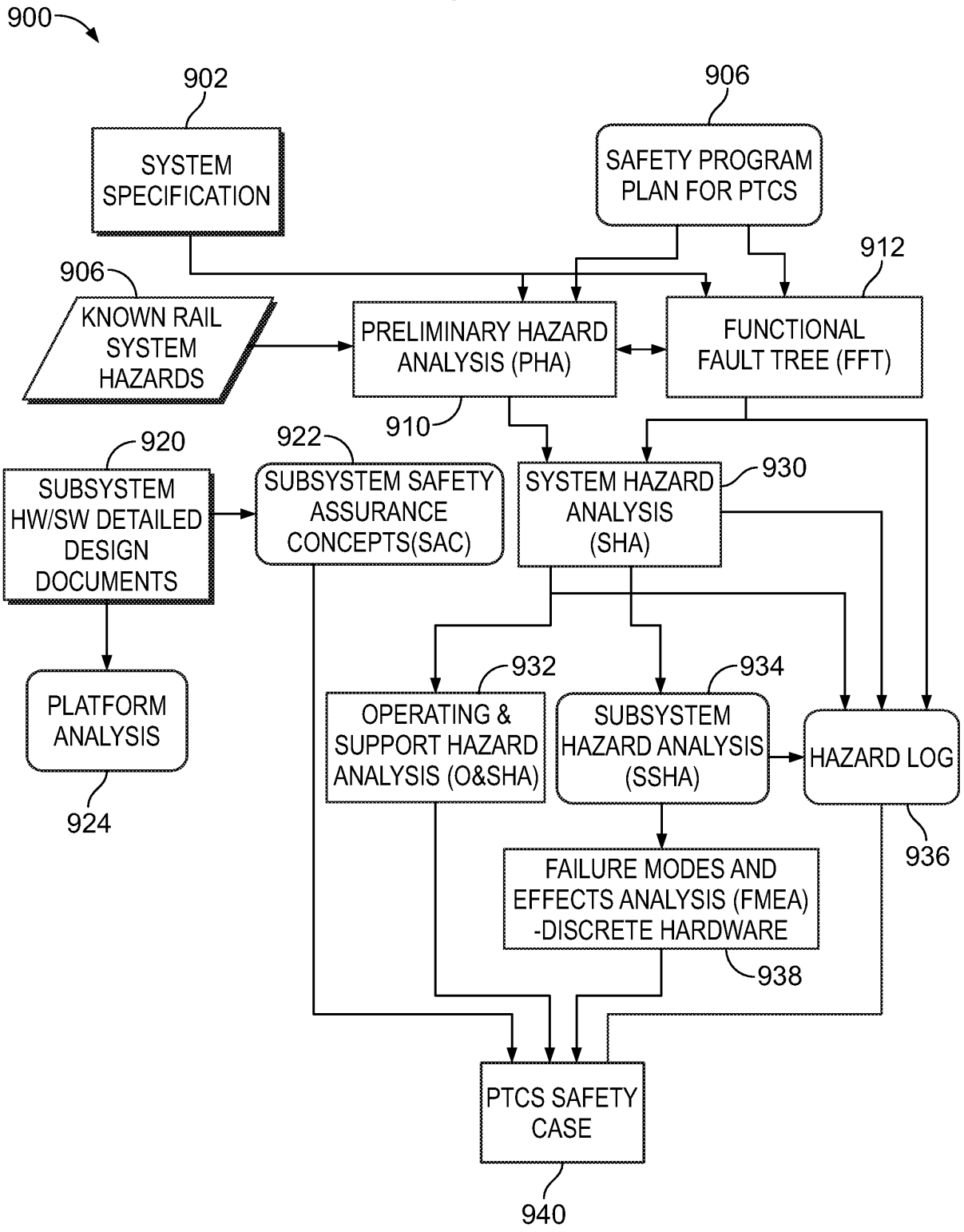

900
902
SYSTEM SPECIFICATION
906
SAFETY PROGRAM PLAN FOR PTCS
906
KNOWN RAIL SYSTEM HAZARDS
PRELIMINARY HAZARD ANALYSIS (PHA)
912
FUNCTIONAL FAULT TREE (FFT)
910
920
SUBSYSTEM HW/SW DETAILED DESIGN DOCUMENTS
922
SUBSYSTEM SAFETY ASSURANCE CONCEPTS(SAC)
SYSTEM HAZARD ANALYSIS (SHA)
930
PLATFORM ANALYSIS
924
932
OPERATING & SUPPORT HAZARD ANALYSIS (O&SHA)
934
SUBSYSTEM HAZARD ANALYSIS (SSHA)
HAZARD LOG
936
FAILURE MODES AND EFFECTS ANALYSIS (FMEA) -DISCRETE HARDWARE
938
PTCS SAFETY CASE
940

FIG. 9

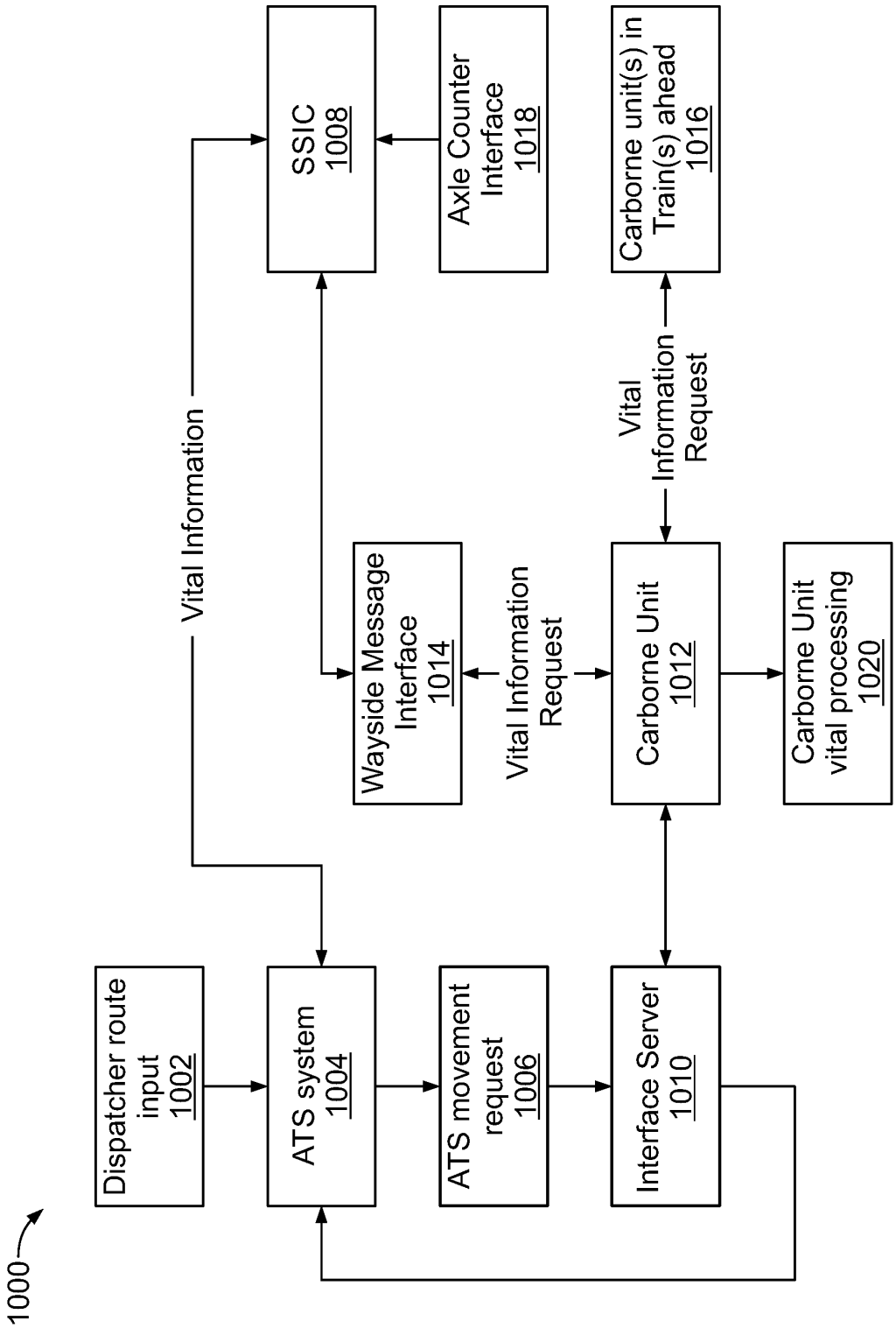

1000
Dispatcher route input 1002
ATS system 1004
ATS movement request 1006
Interface Server 1010
Carborne Unit 1012
Carborne Unit vital processing 1020
Wayside Message Interface 1014
SSIC 1008
Axle Counter Interface 1018
Carborne unit(s) in Train(s) ahead 1016
Vital Information
Vital Information Request
Vital Information Request

FIG. 10

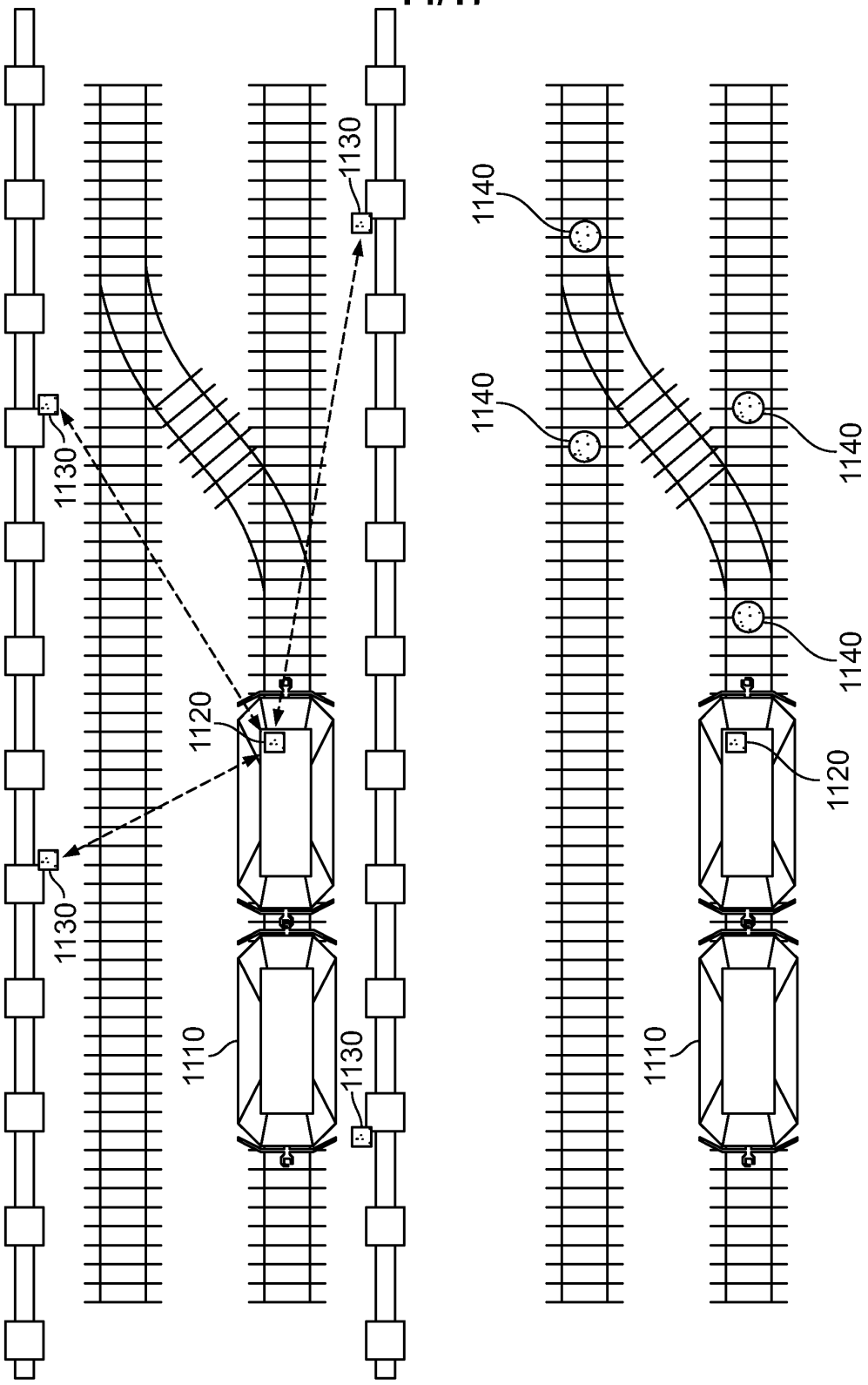


FIG. 11

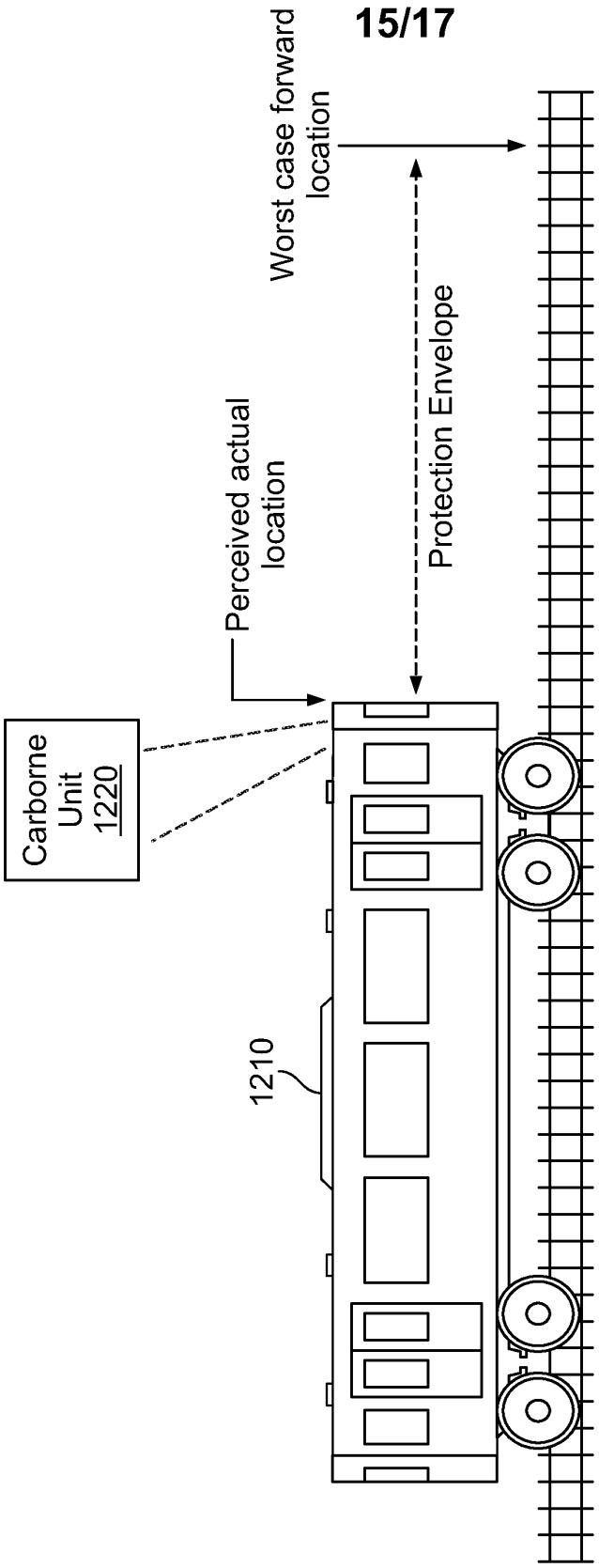

Worst case forward location
Protection Envelope
Perceived actual location
Carborne Unit 1220
1210

FIG. 12A

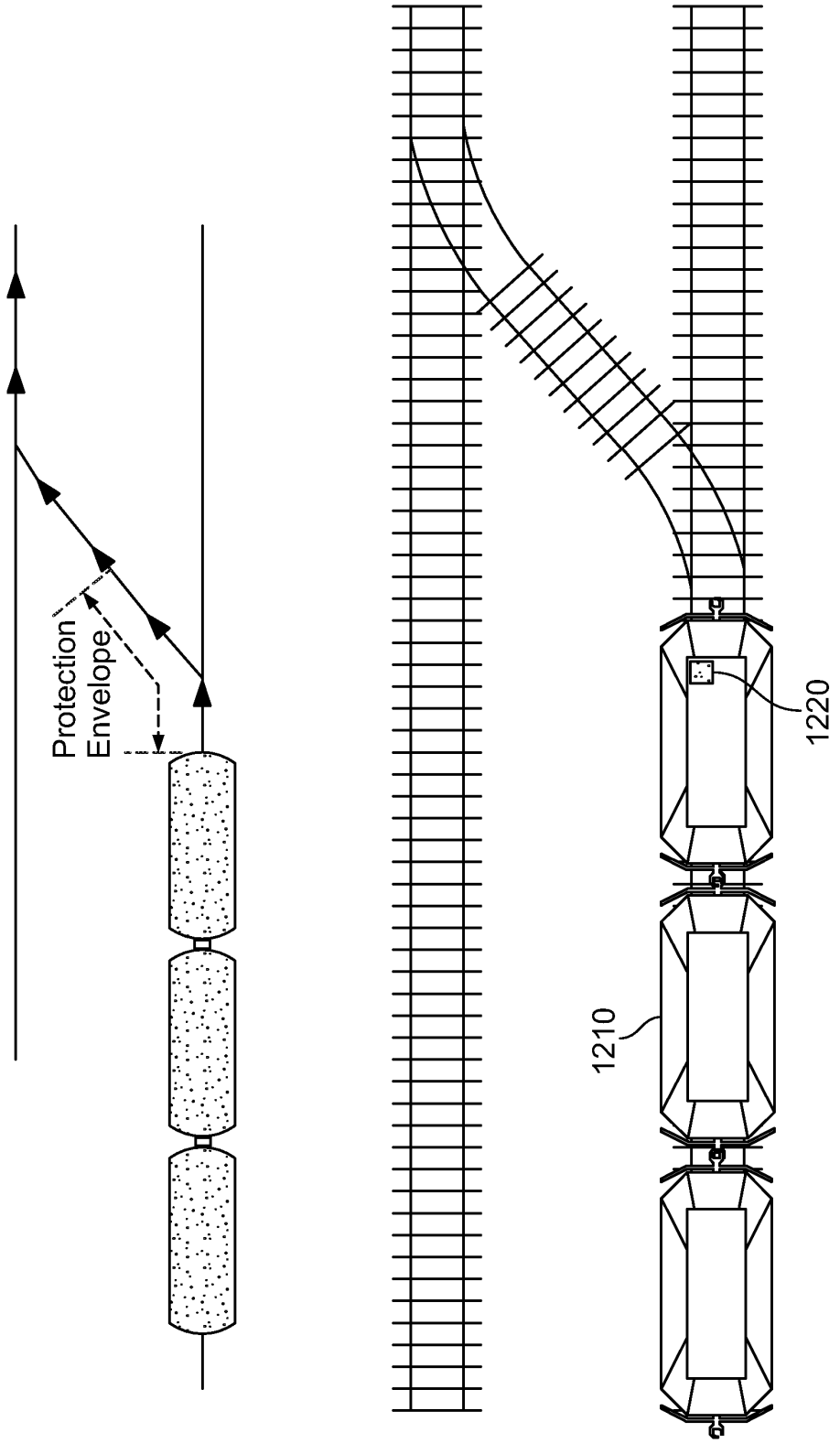


FIG. 12B

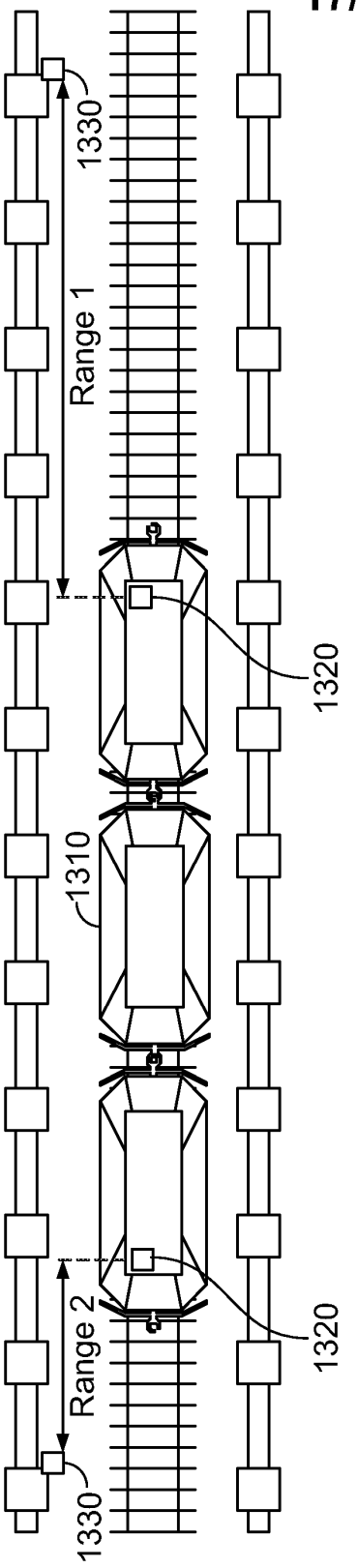


FIG. 13

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Filer:	Rami Naim Moussa/Elaine Maxson
Attorney Docket Number:	63154US03

Filed as Small Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
REQUEST FOR PRIORITIZED EXAMINATION	2817	1	2000	2000
Pages:				
Claims:				
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	2830	1	70	70
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2855**

Electronic Acknowledgement Receipt	
EFS ID:	36627884
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	18-JUL-2019
Filing Date:	
Time Stamp:	17:18:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2855
RAM confirmation Number	071919INTEFSW17192800
Deposit Account	130017
Authorized User	Elaine Maxson
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	63154US03_Track_1.pdf	121577 4a71b4d59e2d7188027b793a7991948bbe31b292	no	2
Warnings:					
Information:					
2	Application Data Sheet	63154US03_ADS.pdf	1256709 4cafae325b08ff284e270119b19df07c37bd3e38	no	9
Warnings:					
Information:					
3		63154US03_Application.pdf	261294 bfce0daf830ba3aa2937d1c2d0d45dab22f238c5	yes	55

Multipart Description/PDF files in .zip description

Document Description	Start	End
Abstract	55	55
Claims	50	54
Specification	1	49

Warnings:					
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4	Oath or Declaration filed	63154US03_Executed_Declaration_Carlson.pdf	363448 4999b1df2874a71c3ace5bb6cb18210ade2b0d1d	no	2
Warnings:					
Information:					
5	Oath or Declaration filed	63154US03_Executed_Declaration_Cygnus.pdf	365351 d7eb7bf2002690d7c57ca375947ea7f733b0c1f0	no	2

Warnings:					
Information:					
6	Oath or Declaration filed	63154US03_Executed_Declaration_Gunther.pdf	363617 28be21191e256902ad7235432155516f60671740	no	2
Warnings:					
Information:					
7	Oath or Declaration filed	63154US03_Executed_Declaration_Woitel.pdf	358364 94a8ba2e5017bd4e8250c4622c178dad20858345	no	2
Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	63154US03_SB08a.pdf	615421 fab1f784fecb2f998049474da141eb9f19d44a48	no	13
Warnings:					
Information:					
9	Power of Attorney	Executed_POA_General_Assignee_AIA-80_New_Address.pdf	252853 86b17cfaa9e9149c65bd25acf86bdacef3f55d85	no	2
Warnings:					
Information:					
10	Drawings-only black and white line drawings	63154US03_Drawings.pdf	1191576 2fbbfd99b38fe9fe932a00b22f40b89baff6202b	no	17
Warnings:					
Information:					
11	Fee Worksheet (SB06)	fee-info.pdf	40116 a93437ca3c44015ed93a0cfd3cbe57d0c222707c	no	2
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National Stage of an International Application under 35 U.S.C. 371

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PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Carlson
Art Unit	3659
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5675190		1997-10-07	Morita	
	2	4302811		1981-11-24	McElhenny	
	3	4327415		1982-04-27	Rush et al.	
	4	4459668		1984-07-10	Inoue et al.	
	5	4495578		1985-01-22	Sibley et al.	
	6	4538228		1985-08-27	Brearey et al.	
	7	4869557		1989-09-26	Gerum et al.	
	8	8200380		2012-06-12	Ghaly	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	9	8478463		2013-07-02	Knott et al.	
	10	8651433		2014-02-18	Ghaly	
	11	9134411		2015-09-15	Soderi et al.	
	12	6435459		2002-08-20	Sanderson et al.	
	13	5727758		1998-03-17	Penza et al.	
	14	5924651		1999-07-20	Penza et al.	
	15	5939986		1999-08-17	Schiffbauer et al.	
	16	6113037		2000-09-05	Pace	
	17	6145792		2000-11-14	Penza et al.	
	18	8650242		2003-11-18	Clerk et al.	
	19	7167082		2007-01-23	Stigall	

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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	20	7624952		2009-12-01	Bartek	
	21	8109474		2012-02-07	Bartek	
	22	8248263		2012-08-21	Shervey et al.	
	23	8344877		2013-01-01	Sheardown et al.	
	24	8786428		2014-07-22	Sheardown et al.	
	25	8952805		2015-02-10	Baines et al.	
	26	2475578		1949-07-05	Halstead	
	27	2762913		1956-09-11	Jepson	
	28	6208260		2001-03-27	West et al.	
	29	6232887		2001-05-15	Carson	
	30	5620155		1997-04-15	Michalek	

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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	31	5554982		1996-09-10	Shirkey et al.	
	32	5652570		1997-07-29	Lepkofker	
	33	5198800		1993-03-30	Tozawa et al.	
	34	9008854		2015-04-14	Breed	

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	1	20140229096		2014-08-14	Carlson	
	2	20120296562		2012-11-22	Carlson	
	3	20110046845		2011-02-24	Kozlay	
	4	20080114519		2008-05-15	Defaux	
	5	20060151672		2006-07-13	Heddebaut	

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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	6	20100225527		2010-09-09	Talty	
	7	20040155760		2004-08-12	Grisham	
	8	20030214417		2003-11-20	Peltz et al.	
	9	20120286563		2012-11-15	Lichterfeld et al.	
	10	20140046514		2014-02-13	Jennek et al.	
	11	20140214247		2014-07-31	Myokei	
	12	20150032302		2015-01-29	Foerster et al.	
	13	20150329130		2015-11-19	Carlson et al.	
	14	20150367822		2015-12-24	Jennek et al.	
	15	20050010338		2005-01-13	Kraeling et al.	
	16	20050110628		2005-05-26	Kernwein et al.	

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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	17	20060015224		2006-01-19	Hilleary	
	18	20080040023		2008-02-14	Breed, et al.	
	19	20100063656		2010-03-11	Knott et al.	
	20	20100268466		2010-10-21	Amutham	
	21	20110184621		2011-07-28	Bock et al.	
	22	20110234451		2011-09-29	Bock et al.	
	23	20120029740		2012-02-02	Bock et al.	
	24	20130138276		2013-05-30	Soderi et al.	
	25	20150060608		2015-03-05	Carlson et al.	
	26	20110172856		2011-07-14	Kull	
	27	20120126065		2012-05-24	Smith et al.	

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	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	28	20140191089		2014-07-10	Reichlin et al.	
	29	20140214248		2014-07-31	Yamada	
	30	20140263856		2014-09-18	Hann	
	31	20160339934		2016-11-24	Chung et al.	
	32	20130024054		2013-01-24	Katsuta et al.	
	33	20160221592		2016-08-04	Puttagunta et al.	
	34	20160200327		2016-07-14	Liu	
	35	20190054942		2019-02-21	Carlson	
	36	20100102954		2010-04-29	Radivojevic et al.	
	37	20130166114		2013-06-27	Baines et al.	
	38	20110006912		2011-01-13	Sheardown et al.	

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	Application Number	16515903
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	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	39	20110152971		2011-06-23	Nghiem et al.	
	40	20140045547		2014-02-13	Singamsetty et al.	
	41	20160280240		2016-09-29	Carlson et al.	
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	44	20090326746		2009-12-31	Mian	
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	48	20170101116		2017-04-13	Shubs, Jr., et al.	
	49	20170113707		2017-04-27	Ghaly	

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	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	50	20030028323		2003-02-06	Zeitler et al.	
	51	20100327125		2010-12-30	Braband et al.	
	52	20130046420		2013-02-21	Gottifredi et al.	
	53	20120296567		2012-11-22	Breed	

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	1	102923158	CN		2013-02-13	Chen Gengtian		
	2	1417071	CN		2003-05-14	Sehnzhen Maishiwei Sci-Tech Co., Ltd.		
	3	1676375	CN		2005-10-05	Shantou Univ.		
	4	2012227260	AU		2014-04-17	Safemine AG		
	5	2015201462	AU		2015-10-08	Thales		

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	Filing Date	2019-07-18
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	6	03012470	WO		2003-02-13	Siemens Aktiengesellschaft		

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	1	PCT, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, in International application no. PCT/US2014/053900, dated February 18, 2015 (21 pages).	
	2	Chinese Office Action for Application No. 201710074449.6, dated January 17, 2019 (22 pages).	
	3	International Search Report and Written Opinion for PCT/US2018/045388, mailed October 18, 2018. (16 pages).	
	4	International Search Report and Written Opinion for PCT/US2016/023754, mailed August 8, 2016. (10 pages).	
	5	International Search Report and Written Opinion for PCT/US2018/049062, dated November 9, 2018. (13 pages).	
	6	Internatinoal Search Report and Written Opinion for PCT/US19/20385, mailed June 28, 2019. (15 pages).	

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	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-07-30
Name/Print	Rami N. Moussa	Registration Number	69528

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(12) STANDARD PATENT (11) Application No. **AU 2012227260 B1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Method and device for generating proximity warnings

(51) International Patent Classification(s)
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(56) Related Art
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Abstract

Vehicles and other objects in a surface mine are equipped with monitoring devices (1,2,3) that derive own and foreign positions (P_1, P_2, P_3) and/or mutual distances (d_12, d_23, d_13) using time-of-flight measurements of radio pulses and/or using GNSS-receivers (20). Thus, the vehicle or object operator can be warned if the risk for a collision or dangerous approach is detected.

(Fig. 1)

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ORIGINAL COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title

Method and device for generating proximity warnings

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

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Technical Field

The invention relates to a method and device for generating proximity warnings, for example for use in a mining environment.

Background Art

Surface mines and similar sites or areas are generally operated by means of a large number of vehicles and staff. Some of the vehicles may be exceedingly large, heavy, and difficult to control.

It has been proposed to use GNSS-devices (GNSS = global navigation satellite system, such as GPS) on board of vehicles and other objects, such as cranes, to generate proximity warnings in order to reduce the risk of collisions between vehicles. Such a system is e.g. described in WO 2004/047047 and it is based on devices mounted to the objects. Each device comprises a GNSS receiver, a control unit deriving positional data using the signal of the GNSS receiver, a radio circuit for wireless exchange of the positional data with the other devices, and an output device for outputting proximity warnings.

Such systems allow the driver of a vehicle to obtain information on some of the obstacles nearby.

Disclosure of the Invention

Embodiments of the invention may provide a method and a monitoring apparatus of a similar type that enables improved safety and/or positioning accuracy, even in situations with poor or absent GNSS reception.

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According to the present invention there is provided a method for generating a proximity warning on an area, by means of a plurality of monitoring devices mounted on movable objects on said area,

wherein at least a first monitoring device at a first position and a second monitoring device at a second position each comprises a radio transceiver and a receiver for a radio based positioning system,

said method comprising steps of

- determining said first position of said first monitoring device by means of said receiver for said radio based positioning system of said first monitoring device,

- determining a first positioning accuracy of said determined first position by means of said first monitoring device,

- determining said second position of said second monitoring device by means of said receiver for said radio based positioning system of said second monitoring device,

- transmitting said determined second position by means of said radio transceiver of said second monitoring device,

- receiving said transmitted second position of said second monitoring device by means of said radio transceiver of said first monitoring device, and steps of

a) transmitting a first radio pulse by means of said radio transceiver of said first monitoring device,

b) receiving said first radio pulse from said first monitoring device by means of said radio transceiver of said second monitoring device,

c) transmitting a second radio pulse by means of said radio transceiver of said second monitoring device,

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d) receiving said second radio pulse by means of said radio transceiver of said first monitoring device,

e) measuring by means of said first monitoring device a first flight time between said transmitting of said first radio pulse and said receiving of said second radio pulse,

and wherein the method comprises a further step of

- deriving by means of said first monitoring device a first distance value between said first and said second monitoring devices using

* said measured first flight time,

* said determined first position of said first monitoring device,

* said first positioning accuracy of said determined first position, and

* said received second position of said second monitoring device,

and wherein the method comprises a further step of

- issuing by means of said first monitoring device a proximity warning as a function of said first distance value between said first and said second monitoring devices.

The invention also provides a method for generating a proximity warning on an area, by means of a plurality of monitoring devices mounted on movable objects on said area,

wherein at least a first monitoring device at a first position and a second monitoring device at a second position each comprises a radio transceiver and a receiver for a radio based positioning system,

said method comprising steps of

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- determining said first position of said first monitoring device by means of said receiver for said radio based positioning system of said first monitoring device,

- determining a first positioning accuracy of said determined first position by means of said first monitoring device,

- determining said second position of said second monitoring device by means of said receiver for said radio based positioning system of said second monitoring device,

- transmitting said determined second position by means of said radio transceiver of said second monitoring device,

- receiving said transmitted second position of said second monitoring device by means of said radio transceiver of said first monitoring device, and steps of

a) transmitting a first radio pulse by means of said radio transceiver of said second monitoring device, wherein said first radio pulse comprises a synchronized timestamp or wherein said first radio pulse is transmitted at a predefined synchronized time,

b) receiving said first radio pulse by means of said radio transceiver of said first monitoring device,

c) measuring by means of said first monitoring device a first flight time between said transmitting of said first radio pulse and said receiving of said first radio pulse,

and wherein the method comprises a further step of

- deriving by means of said first monitoring device a first distance value between said first and said second monitoring devices using

* said measured first flight time,

* said determined first position of said first monitoring device,

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* said first positioning accuracy of said determined first position, and

* said received second position of said second monitoring device,

and wherein the method comprises a further step of

- issuing by means of said first monitoring device a proximity warning as a function of said first distance value between said first and said second monitoring devices.

The invention also provides a monitoring device comprising

- a radio transceiver for transmitting and receiving a radio pulse,

- an interface for issuing a proximity warning,

- an analysis and control unit adapted and structured to carry out the steps of a method of the invention.

The invention also provides a computer program element comprising computer program code means for, when executed by a processing unit, implementing a method according to a method of the invention.

In embodiments there is provided a method for generating a proximity warning on an area (e.g., in a surface mine) is carried out by a plurality of monitoring devices which can be mounted on movable objects like vehicles, persons, etc. on said area. At least a first

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monitoring device at a first position and a second monitoring device at a second position each comprises a radio transceiver for transmitting and receiving radio pulses and position information. It should be noted here that the radio receiver is not necessarily a single device but can comprise a plurality of physical devices. The first and the second monitoring devices additionally comprise a receiver for a radio based positioning system such as a GNSS (e.g., GPS, Galileo, ...) each. The method comprises the following steps:

- A determination of a first position of the first monitoring device and a determination of a second position of the second monitoring device using the respective receivers for the radio based positioning system. The determined second position is then transmitted (advantageously together with a unique identifier of second monitoring device) by means of the radio transceiver of the second monitoring device such that other monitoring devices in range are aware of the second position. Specifically, the transmitted second position of the second monitoring device is received by means of the radio transceiver of the first monitoring device such that the first monitoring device knows about the second position.

The method comprises further steps of

a) A transmission of a first radio pulse by said radio transceiver of said first monitoring device. The first radio pulse advantageously comprises a unique identifier of the first monitoring device. Furthermore,

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this first radio pulse is advantageously a frequency chirped pulse (i.e., a radio pulse with a frequency modulation over time). Preferred frequencies of the first radio pulse are in the range between 0.3 and 6 GHz, particularly in the range between 868 and 928 MHz, in the range between 2 and 3 GHz, in the range between 2.3 and 2.5 GHz, or in the range between 5 and 6 GHz. Thus, the signal-to-noise ratio and radio range can be improved, e.g., also by means of suitable post-processing steps (e.g., correlation algorithms, filtering, etc.).

b) Then, the first radio pulse from the first monitoring device is received by means of said radio transceiver of said second monitoring device. Advantageously, suitable post-processing steps such as, e.g., filtering, are applied to the received radio pulse as it is obvious to the person skilled in the art.

c) Then, after processing, the second monitoring device transmits a second radio pulse (reply pulse) by means of its radio transceiver. As discussed above, the second radio pulse advantageously also comprises a unique identifier of the second monitoring device such that the first monitoring device is aware that the reply pulse originates from the second monitoring device. Furthermore, the second radio pulse is advantageously also a frequency chirped pulse. Preferred frequencies of the second radio pulse are in the range between 0.3 and 6 GHz, particularly in the range between 868 and 928 MHz, in the range between 2 and 3 GHz, in the range between 2.3 and 2.5 GHz, or in the range between 5 and 6 GHz.

d) Then, the second radio pulse is received by means of the radio transceiver of the first monitoring device, and - again - suitable post-processing is advantageously applied to the received radio pulse. As part of this, coarse (i.e., ± 20 degrees) relative bearing information can be derived, e.g., using at least one directional antenna. As discussed below, ambiguities in posi-

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tion determinations using, e.g., triangulation methods, can be resolved.

e) Then, the first monitoring device measures a first flight time t_TOF of the first and second radio pulses between the transmission of the first radio pulse (from its own radio transceiver) and the receiving of said second radio pulse which originates from the second monitoring device.

As an alternative to the bidirectional exchange of the first and second radio pulses as discussed above under the steps a) - d), an unidirectional transmission and receiving of a single first radio pulse is also possible:

a) The second monitoring device transmits a first radio pulse by means of its radio transceiver. This first radio pulse advantageously comprises a unique identifier of the second monitoring device such that the first monitoring device is aware that the first radio pulse originates from the second monitoring device. Furthermore, the first radio pulse is advantageously a frequency chirped pulse. Preferred frequencies of the first radio pulse are in the range between 0.3 and 6 GHz, particularly in the range between 868 and 928 MHz, in the range between 2 and 3 GHz, in the range between 2.3 and 2.5 GHz, or in the range between 5 and 6 Ghz.

b) Then, the first radio pulse is received by means of the radio transceiver of the first monitoring device, and - advantageously - suitable post-processing is applied to the received first radio pulse. As part of this, coarse (i.e., ± 20 degrees) relative bearing information can be derived, e.g., using at least one directional antenna. As discussed below, ambiguities in position determinations using, e.g., triangulation methods, can be resolved.

c) Then, the first monitoring device measures a first flight time t_TOF of the first radio pulse between the transmission of the first radio pulse (from the

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radio transceiver of the second monitoring device) and the receiving of said first radio pulse by means of the first monitoring device's radio transceiver. For this, the first radio pulse comprises a synchronized timestamp or equivalent time information. The term "synchronized timestamp" herein relates to a transmission timestamp attached to the radio pulse, wherein clocks of the first and the second monitoring device are synchronized. Such synchronized time information/clocks is/are advantageously derived by means of the receiver for the radio based positioning system, e.g., from information transmitted by GPS satellites. As an alternative to transmission timestamps, the first radio pulse can also be transmitted at a predefined synchronized time between the first and the second monitoring device. The term "predefined synchronized time" herein relates to a predefined transmission time of the radio pulse, wherein clocks of the first and the second monitoring device are synchronized.

In both scenarios, i.e., the bidirectional radio pulses scenario (ping-pong-scenario) and the unidirectional radio pulse scenario (pong-scenario), the method comprises the following further steps:

- The first monitoring device derives a first distance value d_12 or a value indicative of this distance value between said first and said second monitoring devices, i.e., between the first and the second positions. This is achieved using

  * said measured first flight time t_TOF and advantageously a known response delay of the second monitoring device in the ping-pong-scenario as described above. This known response delay is due to necessary processing steps in the second monitoring device between receiving the first radio pulse and transmitting the second radio pulse. Thus, the precision of the derivation of the first distance value d_12 can be improved.

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In addition to solely using radio pulse time-of-flight measurements as discussed above for deriving the first distance value d_12, also

* the determined first position of the first monitoring device and the received second position of the second monitoring device are used.

Both distance derivation schemes, i.e., the position based and the time-of-flight based scheme, are weighted and combined to improve the precision and/or reliability of the derivation of the first distance value d_12. One possibility of deriving the first distance value is based on the equation:

$$d\_12 = w\_TOF * d\_TOF + w\_POS * d\_POS$$

with d_TOF and d_POS being the time-of-flight based and the position based distance values, respectively, and with w_TOF and w_POS being associated weighting factors with w_TOF + w_POS = 1. The weighting factors can be fixed or changed on the fly, e.g., based on the reliability and/or accuracies of the respective position determinations (see below).

- Then, an, e.g., acoustic, tactile (vibrational), electric shock, or optical proximity warning or approach warning is issued to, e.g., a driver of a vehicle or an operator of an object as a function of said first distance value d_12. As an example, an acoustic beeping can be triggered as soon as the first distance value decreases below a threshold, e.g., 10 or 50 m. Another warning can be triggered as soon as, e.g., a current approach speed of the first monitoring device and the second monitoring device would result in an impact in less than a threshold time, e.g., 4 s.

In an advantageous embodiment, a first positioning accuracy of the first position of the first monitoring device is determined. The positioning accuracy of the first position as determined by the receiver for the

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radio based positioning system can vary, e.g., due to changing satellite reception levels and/or signal reflections. Thus, a reliability level or precision of the determined first position can be assessed.

In another advantageous embodiment, a second positioning accuracy of the second position of the second monitoring device is determined. As discussed above, the positioning accuracy of the second position as determined by the receiver for the radio based positioning system can also vary, e.g., due to changing satellite reception levels and/or signal reflections. Thus, a reliability level of precision of the determined second position can also be assessed. This second positioning accuracy is then transmitted by means of the radio transceiver of the second monitoring device. Then, the transmitted second positioning accuracy is received by the radio transceiver of the first monitoring device. Thus, the first monitoring device is aware of the accuracy/precision of the second position of the second monitoring device.

Then, preferably, the first positioning accuracy of the first position and/or the second positioning accuracy of the second position are used in the step of deriving the first distance value d_12 between the first and the second monitoring device. Thus, e.g., the above described radio-pulse time-of-flight contribution can be uprated (i.e., its weighting factor is increased) in the derivation of the first distance value d_12 in a case when one or both determined positions have a decreased reliability. In a border case, when the first and/or the second position cannot be determined at all, e.g., due to a lack of satellite reception, a fallback to solely using the time-of-flight based distance value derivation is also possible (i.e., with w_TOF = 1 in the above example). This improves the reliability of the proximity warning generation method.

In another advantageous embodiment, the proximity warning issued by, e.g., the first monitoring de-

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vice, comprises the second position of the second monitoring device. Then, an operator of a machine who receives the proximity warning is aware of the position of the second monitoring device and can take suitable action. Thus, the overall safety is increased.

In an advantageous embodiment, the derived first distance value d_12 between the first and the second monitoring devices is transmitted to all or selected other monitoring devices in range, such that these monitoring devices are aware of the distance value d_12 between the first and the second monitoring devices. Thus, a more complete "picture" of the spatial distribution of the monitoring devices on the area is derivable. Advantageously, using additional positional data from the receiver(s) for said radio based positioning system and, e.g., triangulation methods (see below), also position information of monitoring devices without a receiver for the radio based positioning system are derivable. Thus, the overall safety is increased.

As another aspect of the invention, a monitoring device comprises a radio transceiver for transmitting and for receiving a radio pulse. Furthermore, the monitoring device comprises an interface (e.g., an acoustic, tactile, e.g., vibrating, and/or optical user interface or - in another embodiment - a computer interface) for issuing a proximity warning as a function of the derived distance value(s). Furthermore, the monitoring device comprises an analysis and control unit which is adapted and structured to carry out the steps of a method as described. Specifically, the analysis and control unit can comprise a computer program element comprising computer program code means for, when executed by the analysis and control unit, implementing a method for generating a proximity warning as described.

Note:

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The described embodiments and/or features similarly pertain to both the apparatuses and the methods. Synergetic effects may arise from different combinations of these embodiments and/or features although they might not be described in detail.

The invention is further described by way of example only with reference to the accompanying drawings.

Brief Description of the Drawings

The invention and its embodiments will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings.

Fig. 1 schematically shows a surface mine 100 with a monitoring apparatus comprising three monitoring devices 1,2,3,

Fig. 2 shows a monitoring apparatus 1,2,3 comprising a radio transceiver 10, an interface 5, an optional receiver for a radio based positioning system 20, and an analysis and control unit 6.

Modes for Carrying Out the Invention

Definitions:

A "movable object" is any object that can change and is expected to change its position and/or orientation or configuration in space. It may e.g. be a truck or any other vehicle that moves from place to place and changes its orientation in respect to the general north-south direction, e.g., by steering, or it may be an object positioned at a fixed location but able to rotate about its axis or to change its physical configuration, e.g. by extending an gripper or shovel, in such a manner

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that the volume of safety space attributed to it varies in significant manner.

The term GNSS stands for "Global Navigation Satellite System" and encompasses all satellite 16 based navigation systems, including GPS and Galileo.

The term "radio based positioning system" stands for a GNSS or for any other type of positioning system using radio signals, such as a pseudolite system.

The term "monitoring apparatus" as used herein designates an assembly of monitoring devices distributed over several locations, with the single monitoring devices communicating with each other as described. Some of the monitoring devices are installed on movable objects while others may be installed at fixed locations, e.g., fixed obstacles.

The term "mounting a device to a person" can be understood as affixing the monitoring device to the person in such a manner that the person will carry it without requiring the use of his/her hands. For example, the term expresses that the monitoring device is affixed to a piece of clothing or equipment, such as a belt or a helmet, that the person is wearing.

The area:

Fig. 1 schematically depicts an area, such as a surface mine 100, to be monitored by the present system. Typically, such a site covers a large area, in the case of a surface mine, e.g., in the range of several square kilometers, with a network of roads (bold lines) and other traffic ways, such as rails. A plurality of objects is present in the mine, such as:

- Large vehicles, such as haul trucks 40, cranes, or diggers. Vehicles of this type may easily weigh several 100 tons, and they are generally difficult to control, have very large braking distances, and a large number of blind spots that the vehicle operator is unable to visually monitor without monitoring cameras.

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- Medium sized vehicles, such as regular trucks 50. These vehicles are easier to control, but they still have several blind spots and require a skilled driver.

- Small vehicles. Typically, vehicles of this type weigh 3 tons or less. They comprise passenger vehicles and small lorries.

- Trains.

- Individual persons 8, in particular pedestrians.

A further type of object within the mine is comprised of stationary obstacles, such as temporary or permanent buildings, open pits, boulders, non-movable excavators, stationary cranes, deposits, etc.

The risk of accidents in such an environment is high, specifically under adverse conditions as bad weather, during night shifts, etc. In particular, the large sized vehicles can easily collide with other vehicles, or obstacles.

For this reason, the mine is equipped with a monitoring apparatus comprising a plurality of monitoring devices 1,2,3 that allows to generate proximity warnings for the personnel of the site, thereby reducing the risk of collisions and accidents.

The monitoring apparatus:

Basically, the monitoring apparatus comprises a plurality of monitoring devices 1,2,3 that are affixed to fixed objects and/or movable objects and/or persons. Specifically, monitoring device 1 is affixed to haul truck 40 which is at position P_1, monitoring device 2 is affixed to truck 50 which is at position P_2, and monitoring device 3 is affixed to person 8 who is at position P_3. These components communicate in a wireless manner, in particular by radio signals by means of integrated radio transceivers 10. They are described in more detail in the following sections.

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In addition, the monitoring apparatus can comprise a central server (not shown), whose role is also explained below.

The monitoring devices:

As stated above, the monitoring devices 1,2,3 are affixed to different objects in the area.

In general, the larger the number of installed monitoring devices 1,2,3, the higher the safety level.

The monitoring devices 1,2,3 comprise an analysis and control unit 6, such as a microprocessor system, which controls the operations of the monitoring device and the communication with the other monitoring devices.

The monitoring devices 1,2,3 further comprise a radio transceiver 10 comprising a first and a second transceiver unit. The second transceiver unit comprises a digital transceiver for exchanging digital data such as position information, positioning accuracies, distance values, etc. with other monitoring devices 1,2,3. Due to the digitally exchanged signals, error detection/ correction algorithms can be used which increase the reliability of the data exchange. The radio transceiver 10, specifically its first transceiver unit, is also adapted to transmit and receive time-of-flight radio pulses and optionally timestamp information. By measuring a flight time of these radio pulses (e.g., first pulse P_TOF from first monitoring device 1 to second monitoring device 2, reply pulse R_TOF from second monitoring device 2 to first monitoring device 1) between two monitoring devices 1,2, a first distance value d_12 of a distance between the two monitoring devices, i.e., between the first position P_1 of the first monitoring device 1 and the second position P_2 of the second monitoring device 2 can be derived (dotted line and dotted circle segment).

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The monitoring devices 1,2 further comprises a GNSS receiver 20. Although it is called a GNSS receiver in the following, it can also be a receiver interoperating with any other radio based positioning system for determining its position. The present invention can be used on various types of radio based positioning systems.

Control unit 6 accesses a memory (e.g., RAM, ROM) that comprises programs as well as various parameters, such as a unique identifiers of the monitoring devices which is transmitted with each message over the radio transceiver. Thus, the identity or origin of the transmitted signals can be determined.

An interface 5, here, an acoustic and optical user interface 5 advantageously comprises an optical display 22 as well as an acoustic signal source 23, such as a loudspeaker. Furthermore, a tactile interface such as a vibrating unit (not shown) for alerting a user can be comprised in the interface 5.

The primary purpose of monitoring device 1,2,3 is to generate proximity warnings or approach warnings in case that there is a danger of collision between two or more objects. This is achieved by a two-step approach:

a) By receiving position signals through GNSS receiver 20, a position of the respective monitoring device(s) is determined. This position(s) is or are advantageously transmitted by means of the radio transceiver 10 to all the other monitoring devices 1,2,3 that are in range such that all monitoring devices 1,2,3 are aware of the respective positions, velocities, and probabilities for collisions.

b) By deriving distance values (e.g., d_12) between the monitoring devices 1,2,3 using position based and time-of-flight based measurements of radio pulses that are exchanged between the two monitoring devices. Again, advantageously, the distance values are exchanged with other monitoring devices 1,2,3 in order to calculate

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relative positions, velocities, and probabilities for collisions. The method for calculating relative positions is described in the next section, while further information about various aspects of the monitoring device follows later.

The advantage of using such a two-step approach is that proximity warnings or approach warnings can also be issued in a case where one or more of the monitoring devices 1,2,3 do not or only have poor GNSS reception and thus positioning accuracy and/or where one or more of the monitoring devices 1,2,3 are not equipped with a GNSS receiver 20.

In an advantageous embodiment, monitoring device 1,2,3 can also comprises an acceleration detector (not shown here). Acceleration values can also be transmitted by means of the radio transceiver 10. This acceleration detector can be used to reduce the energy consumption of the monitoring device. Since GNSS receiver 20 is one of the major power drains, GNSS receiver 20 can have a "disabled mode" where it is not operating and an "enabled mode" where it is operating. When analysis and control unit 6 detects an acceleration by means of the acceleration detector, it puts GNSS receiver 20 into its enabled state to obtain the current position of the monitoring device. Otherwise, it puts GNSS receiver 20, e.g., after a predetermined amount of time, into its disabled state. In addition to this, to account for the unlikely event that no acceleration is measured even though the monitoring device 1,2,3 is moving, control unit 6 can be adapted to put GNSS receiver 20 into its enabled state at regular intervals in order to perform sporadic position measurements.

In addition or alternatively to switching GNSS receiver 20 between a disabled an enabled state, other parts of monitoring device 1,2,3 can be switched between an idle and an active state in response to signals from the acceleration detector. In general terms,

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monitoring device 1,2,3 can have an "idle state" and an "active state", wherein, in said idle state, monitoring device 1,2,3 has a smaller power consumption than in said active state. Control unit 6 is adapted to put monitoring device 1,2,3 into its active state upon detection of an acceleration by the acceleration detector, while the monitoring device is, e.g., brought back to its inactive state if no acceleration has been detected for a certain period of time.

Monitoring device 1,2,3 advantageously comprises a rechargeable battery (not shown) for feeding power to its components. A battery charger comprises circuitry for charging the battery. The battery charger can draw power from at least one power source. Such power sources can, e.g., be

- a power plug for directly connecting monitoring device 1,2,3 to an external power supply;
- an inductive coupler comprising a coil adapted to generate electrical current from an alternating magnetic field generated by an external primary coil; such inductive power couplers are known to the skilled person; and/or
- a solar power supply mounted at the outer surface of the monitoring device 1,2,3 or in a separate unit electrically connected to the monitoring device 1,2,3.

Relative position determination:

If all monitoring devices 1,2,3 would have a GNSS receiver 20, the operation of the monitoring devices could be basically as in conventional systems of this type, such as, e.g., described in WO 2004/047047 and need not be described in detail herein.

In such a simple approach, each monitoring device 1,2, and 3 would obtain information about its respective position P_1, P_2, and P_3 derived from a signal from GNSS receiver 20. This data is stored in a "device

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status dataset". The device status dataset also contains a unique identifier (i.e. an identifier unique to each of the monitoring devices 1,2,3 used on the same area 100).

The device status dataset is then transmitted as a digital radio signal through radio transceiver 10. At the same time, the monitoring device receives the corresponding signals from neighboring monitoring devices and, for each such neighboring monitoring device, it calculates the relative distance d_xy (where x and y denote the index of the involved monitoring devices, e.g., d_12 relates to a distance between monitoring device 1 and monitoring device 2) by subtracting its own coordinates from those of the neighboring monitoring device.

In the present invention, however, the derivation of the distance values d_xy does not simply rely on the described position based procedure but also on a radio pulse flight time approach. Both distance derivation schemes are weighted and combined as described to improve the reliability and safety of the system, in particular in situations with poor GNSS reception.

Proximity warnings:

Proximity warnings can be generated by means of various algorithms. Examples of such algorithms are described in the following.

In a very simple approach, it can be tested if the absolute value of the relative distance d_xy is below a given threshold. If yes, a proximity warning can be issued. This corresponds to the assumption that a circular volume in space is reserved for each object. The radius of the circular volume attributed to an object can, e.g., be encoded in its device status dataset.

A more accurate algorithm can, e.g., take into account not only the relative position, but also the driving velocities and directions of the vehicles.

An improvement of the prediction of collisions can be achieved by storing data indicative of the

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size and/or shape of the object that a monitoring device 1,2,3 is mounted to. This is especially true for large vehicles, e.g., haul truck 40, which may have non-negligible dimensions. In a most simple embodiment, a vehicle can be modeled to have the same size in all directions, thereby defining a circle/sphere "covered" by the vehicle. If these circles or spheres of two vehicles are predicted to intersect in the near future, a proximity warning can be issued. It should be noted here that it is also possible to affix more than one monitoring device to an object which, e.g., enables the monitoring of orientations. These multiple monitoring devices on the same object would then, e.g., be configured not to exchange time-of-flight radio pulses with each other.

Instead of modeling an object or vehicle by a simple circle or sphere, a more refined modeling and therefore proximity prediction can be achieved by storing the shape (i.e. the bounds) of the vehicle in the dataset. In addition, not only the shape of the vehicle, but also the position of the GNSS-receiver 20 (or its antenna) in respect to this shape or bounds can be stored in memory.

In some cases, the signal strength of a received radio signal can be used to determine a range of distance where the monitoring device may be, thus improving warning accuracy in such a case. Hence, a first monitoring device receiving a signal from a second monitoring device assesses the signal strength of said signal and generates a proximity warning based on the assessed signal strength, in particular by comparing it to a maximum value.

Other functions:

In addition to issuing proximity warnings as described above, monitoring devices 1,2,3 can provide other uses and functions.

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In one embodiment, which is particularly useful if monitoring device 1,2,3 is worn on a person, the monitoring device 1,2,3 can issue a warning when it leaves the site or enters a "restricted area" of the site. This can, e.g., happen when a user of the monitoring device forgets to return the apparatus when leaving the site or tries to steal it, or when a user enters an area, such as a blast area, that is not safe for him.

This type of warning can be generated by executing the following steps:

1) In a first step, analysis and control unit 6 obtains the position of the monitoring device by means of GNSS receiver 20 or via time-of-flight triangulation (see below).

2) In a second step, analysis and control unit 6 compares this position to a predefined geographical area. This geographical area can, e.g., be stored in memory and describes the area where the monitoring device is allowed to be operated. If it is found that the position is not within the geographical area, the following step 3 is executed:

3a) A warning which can comprise one or more positions of monitoring devices is issued. This warning can, e.g., be displayed on a display or issued as a sound by acoustic signal source 23.

3b) Alternatively, or in addition to step 3a, the warning can be sent, e.g., by means of a cellular phone transceiver (not shown) integrated into the monitoring device 1,2,3 or by means of the radio transceiver 10 to a central monitoring system (i.e. a central server), together with the current position and identity of the respective monitoring device 1,2,3. Then, the warning can be displayed by the central server and brought to the attention of personnel that can then take further necessary steps.

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3c) Alternatively or in addition to steps 3a and/or 3b, the apparatus can be made unusable by blocking and/or destroying at least part of its functionality.

In general, a cellular phone network (or any other wireless network) can be used to transmit information from the monitoring devices 1,2,3 to the central server. As mentioned, this information can, e.g., comprise any warnings issued by the monitoring devices 1,2,3, and/or it may comprise the position of the monitoring device.

Another application of a cellular phone transceiver integrated into monitoring device 1,2,3 is to send messages from the central server to any monitoring device 1,2,3. Such messages are received the respective monitoring device 1,2,3 and displayed or brought to the operator's attention acoustically. This, e.g., allows to issue warnings, alerts or information to the person using the monitoring device 1,2,3.

The monitoring devices 1,2,3 can also be used for generating automatic response to the presence of a vehicle or person at a certain location. For example, when a pedestrian with a monitoring device approaches a gate, such as door of a building, that door can open automatically. Similarly, an entry light can switch to red or to green, depending on the type of object that a monitoring device is attached to, or a boom can open or close. This can be achieved by mounting a receiver device to a selected object (such as a door, a gate, boom or an entry light). The receiver device is equipped with a radio receiver adapted to detect the proximity of monitoring devices 1,2,3. When the receiver device detects the proximity of a monitoring device 1,2,3, it actuates an actuator (such as the door, gate or entry light) after testing access rights of the object attributed to the monitoring device 1,2,3. For example, the actuator may be actuated depending on the type of the object that the monitoring device is attached to and/or to its distance

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from the receiver. The type and/or distance information is transmitted as part of the device status dataset of the monitoring device 1,2,3.

Furthermore, the control unit of the monitoring device 1,2,3 can have an "alert mode", which can be activated by a user, e.g., by pressing an alert button on a keyboard of the monitoring device 1,2,3 and/or by voice control. It can, e.g., be used to indicate that the person using the monitoring device is in need of urgent help or needs all activity around it to be stopped immediately. The device status dataset comprises a flag indicative of whether the monitoring device is in alert mode. Another monitoring device receiving a device status dataset that indicates that the sender is in alert mode may take appropriate action. For example, the central control room operator can be informed, closeby machinery can be shut down, etc.

Persons on the site:

As mentioned above, the monitoring devices 1, 2, 3 can not only be mounted to vehicles in the area, but also to individual persons on the site. By using the same type of device for persons as well as vehicles, costs can be reduced. In such a situation, the monitoring device 1,2 mounted to vehicles can cooperate with the monitoring device 3 mounted to a person in such a manner that

a) the drivers of the vehicles are alerted of the presence of pedestrians, and/or

b) the pedestrians are alerted of the presence of the vehicles 40,50.

While option a) is the primary purpose of the present invention, option b) may also have its advantages, too.

In order to alert the drivers of the presence of a pedestrian, each pedestrian-mounted monitoring device can transmit a flag indicative of the fact that it is mounted to a pedestrian, e.g., as part of its device

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status dataset. Thus, all other monitoring devices in range are aware of this fact and can adapt their warning strategy accordingly.

Time of flight measurement/triangulation:

Under adverse conditions, e.g. when one or more satellite signals are partially or fully blocked by obstacles, GNSS receiver 20 of a given monitoring device 1,2 may not be able to reliably derive its position P_1,P_2, or the determined position P_1,P_2 will be inaccurate. In another situation, one monitoring device 3 may not equipped with a GNSS receiver 20 at all (therefore, GNSS receiver 20 is dotted in fig. 2).

Therefore, in order to improve the reliability and versatility of the proximity warning method, the monitoring devices 1,2,3 are adapted and structured for mutual time-of-flight distance derivation. For this, the monitoring devices 1,2,3 are equipped with radio transceivers 10 to perform a "time-of-flight (TOF) measurement and/or triangulation". This TOF measurement/triangulation allows to at least approximately determine the mutual distances and/or positions of several monitoring devices 1,2,3, even if the monitoring device 3 is unable to determine its position P_3 because of the lack of a GNSS receiver 20.

In the given example situation, a first position P_1 of the first monitoring device 1 and a second position P_2 of the second monitoring device 2 are determined using the GNSS receivers 20 of the respective monitoring devices 1,2. The first and second positions P_1 and P_2 are then transmitted by the monitoring devices 1,2 such that all monitoring devices 1,2,3 are aware of these positions P_1 and P_2.

Then, using a bidirectional exchange of TOF-pulses P_TOF and R_TOF (see above) between the first and the second devices 1,2 and using the first and second positions P_1 and P_2, the first monitoring device 1 de-

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rives a first distance value d_12 (dotted lines and circle segments in figure 1) between the first and the second monitoring devices 1,2. Then, this distance value d_12 is transmitted in a way that all monitoring devices 1,2,3 in range are aware of it.

As another step, by means of a bidirectional exchange of TOF-pulses P_TOF (i.e., a third radio pulse) and R_TOF (see above) between the second and the third monitoring devices 2,3, the second monitoring device 2 derives a second distance value d_23 (dotted lines and circle segments in figure 1) between the second and the third monitoring devices 2,3. It should be noted here that this distance value d_23 is not derivable because position P_3 is not (yet) known. Then, the distance value d_23 is also transmitted in a way that all monitoring devices 1,2,3 in range are aware of it.

As another step, by means of a bidirectional exchange of TOF-pulses P_TOF and R_TOF (see above) between the first and the third monitoring devices 1,3, the first monitoring device 1 derives a third distance value d_13 (dotted lines and circle segments in figure 1) between the fist and the third of the monitoring devices 1,3. The P_TOF pulse can be the first radio pulse which is also used for deriving d_12 as discussed above or it can be a fourth radio pulse. It should be noted here that this distance value d_13 is also not derivable from the respective positions because the third position P_3 is not yet known. Then, the distance value d_13 is also transmitted in a way that all monitoring devices 1,2,3 in range are aware of it.

Now, the monitoring apparatus (specifically all the monitoring devices 1,2,3 in range) are aware of P_1, P_2, d_12, d_13, and d_23. From this information, the position P_3 of the third of the monitoring device 3 is derived and optionally transmitted by means of the radio transceiver(s). An ambiguity between P_3 and an also possible "mirrored position P_3'" is resolved by means of

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a radio transceiver antenna with directional resolution, i.e., a direction sensitive antenna, in any of the monitoring devices 1,2,3.

Then, a proximity warning can be issued as a function of the first, the second, and/or the third distance values d_12, d_23, d_13 and/or optionally of the first, second, and/or third position P_1, P_2, P_3.

Thus, even without a GNSS receiver 20 in the third of the monitoring devices 3, the position P_3 is derivable which leads to higher reliability and increased safety of the monitoring apparatus.

Note:

The above mentioned steps of transmitting a determined position P_1, P_2, and/or P_3 of a monitoring device 1,2,3 by means of the radio transceiver 10 of the respective monitoring device 1,2,3 can comprise absolute position information, e.g., altitude, longitude, and latitude and/or relative position information with regard to a predefined position or regular grid points on the surface mine 100. Furthermore, an incremental position information transmission is possible as well in which only position changes are transmitted.

While there are shown and described presently preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

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The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for generating a proximity warning on an area, by means of a plurality of monitoring devices mounted on movable objects on said area,

wherein at least a first monitoring device at a first position and a second monitoring device at a second position each comprises a radio transceiver and a receiver for a radio based positioning system,

said method comprising steps of

- determining said first position of said first monitoring device by means of said receiver for said radio based positioning system of said first monitoring device,

- determining a first positioning accuracy of said determined first position by means of said first monitoring device,

- determining said second position of said second monitoring device by means of said receiver for said radio based positioning system of said second monitoring device,

- transmitting said determined second position by means of said radio transceiver of said second monitoring device,

- receiving said transmitted second position of said second monitoring device by means of said radio transceiver of said first monitoring device, and steps of

a) transmitting a first radio pulse by means of said radio transceiver of said first monitoring device,

b) receiving said first radio pulse from said first monitoring device by means of said radio transceiver of said second monitoring device,

c) transmitting a second radio pulse by means of said radio transceiver of said second monitoring device,

d) receiving said second radio pulse by means of said radio transceiver of said first monitoring device,

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e) measuring by means of said first monitoring device a first flight time between said transmitting of said first radio pulse and said receiving of said second radio pulse,

and wherein the method comprises a further step of

- deriving by means of said first monitoring device a first distance value between said first and said second monitoring devices using

* said measured first flight time,

* said determined first position of said first monitoring device,

* said first positioning accuracy of said determined first position, and

* said received second position of said second monitoring device,

and wherein the method comprises a further step of

- issuing by means of said first monitoring device a proximity warning as a function of said first distance value between said first and said second monitoring devices.

2. A method for generating a proximity warning on an area, by means of a plurality of monitoring devices mounted on movable objects on said area,

wherein at least a first monitoring device at a first position and a second monitoring device at a second position each comprises a radio transceiver and a receiver for a radio based positioning system,

said method comprising steps of

- determining said first position of said first monitoring device by means of said receiver for said radio based positioning system of said first monitoring device,

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- determining a first positioning accuracy of said determined first position by means of said first monitoring device,

- determining said second position of said second monitoring device by means of said receiver for said radio based positioning system of said second monitoring device,

- transmitting said determined second position by means of said radio transceiver of said second monitoring device,

- receiving said transmitted second position of said second monitoring device by means of said radio transceiver of said first monitoring device, and steps of

a) transmitting a first radio pulse by means of said radio transceiver of said second monitoring device, wherein said first radio pulse comprises a synchronized timestamp or wherein said first radio pulse is transmitted at a predefined synchronized time,

b) receiving said first radio pulse by means of said radio transceiver of said first monitoring device,

c) measuring by means of said first monitoring device a first flight time between said transmitting of said first radio pulse and said receiving of said first radio pulse,

and wherein the method comprises a further step of

- deriving by means of said first monitoring device a first distance value between said first and said second monitoring devices using

* said measured first flight time,

* said determined first position of said first monitoring device,

* said first positioning accuracy of said determined first position, and

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* said received second position of said second monitoring device,

and wherein the method comprises a further step of

- issuing by means of said first monitoring device a proximity warning as a function of said first distance value between said first and said second monitoring devices.

3. The method of any one of claims 1 or 2 wherein a frequency of said first radio pulse and/or of a or said second radio pulse is in the range between 0.3 and 6 GHz, particularly in the range between 868 and 928 MHz, in the range between 2 and 3 GHz, in the range between 2.3 and 2.5 GHz, or in the range between 5 and 6 GHz.

4. The method of any of the preceding claims wherein said first radio pulse and/or a or said second radio pulse is or are frequency chirped.

5. The method of any of the preceding claims comprising further steps of

- determining a second positioning accuracy of said determined second position by means of said second monitoring device,

- transmitting said second positioning accuracy of said determined second position by means of said radio transceiver of said second monitoring device, and

- receiving said transmitted second positioning accuracy of said second position by means of said radio transceiver of said first monitoring device.

6. The method of claim 5 wherein said received second positioning accuracy of said second position is used

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in said step of deriving said first distance value between said first and said second monitoring devices.

7. The method of any of the preceding claims wherein said proximity warning comprises said received second position.

8. The method of any of the preceding claims wherein said proximity warning comprises at least one of the group consisting of

- an optical warning,
- an acoustic warning,
- an electric shock, and
- a tactile warning, in particular a vibration.

9. The method of any of the preceding claims wherein said radio transceiver comprises a first transceiver unit for transmitting and receiving said first and/or a or said second radio pulse and wherein said radio transceiver comprises a second transceiver unit for transmitting and receiving

- said first and/or second position and/or
- said first and/or second positioning accuracy and/or
- said first distance value,

and in particular wherein said second transceiver unit comprises a digital transceiver.

10. The method of any of the preceding claims comprising a further step of

- transmitting by means of said radio transceiver of said first monitoring device said first distance value between said first and said second monitoring devices.

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11. The method of claim 10 wherein a third monitoring device at a third position comprises a radio transceiver, and

wherein the method comprises further steps of

- deriving by means of said second monitoring device a second distance value between said second and said third monitoring devices using a second measured flight time of a third radio pulse transmitted by said second monitoring device,

- transmitting by means of said radio transceiver of said second monitoring device said second distance value between said second and said third monitoring devices,

- deriving by means of said first monitoring device a third distance value between said first and said third monitoring devices using a third measured flight time of said first or of a fourth radio pulse transmitted by said first monitoring device,

- transmitting by means of said radio transceiver said first monitoring device said third distance value between said first and said third monitoring devices,

- issuing by means of said first, said second, and/or said third monitoring device a proximity warning as a function of said first, said second, and/or said third distance value between said first and said second, between said second and said third, and/or between said first and said third monitoring devices.

12. The method of claim 11 comprising further steps of

- transmitting by means of said radio transceiver of said first monitoring device said determined first position of said first monitoring device,

- determining by means of said first, said second, and/or said third monitoring device said third position of said third monitoring device using said first

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position, said first distance value, said second distance value, and said third distance value,

wherein an ambiguity of said third position is resolved using at least one directional antenna.

13. A monitoring device comprising

- a radio transceiver for transmitting and receiving a radio pulse,

- an interface for issuing a proximity warning,

- an analysis and control unit adapted and structured to carry out the steps of a method of any of the preceding claims.

14. A computer program element comprising computer program code means for, when executed by a processing unit, implementing a method according to any of the claims 1 to 12.

15. The method of any one of claims 1 to 12, for generating said proximity warning in a surface mine.

16. A computer program element as claimed in claim 14, the processing unit being an analysis and control unit.

17. A method for generating a proximity warning on an area substantially as hereinbefore described with reference to the accompanying drawings.

18. A monitoring device substantially as hereinbefore described with reference to the accompanying drawings.

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19. A computer program element substantially as hereinbefore described with reference to the accompanying drawings.

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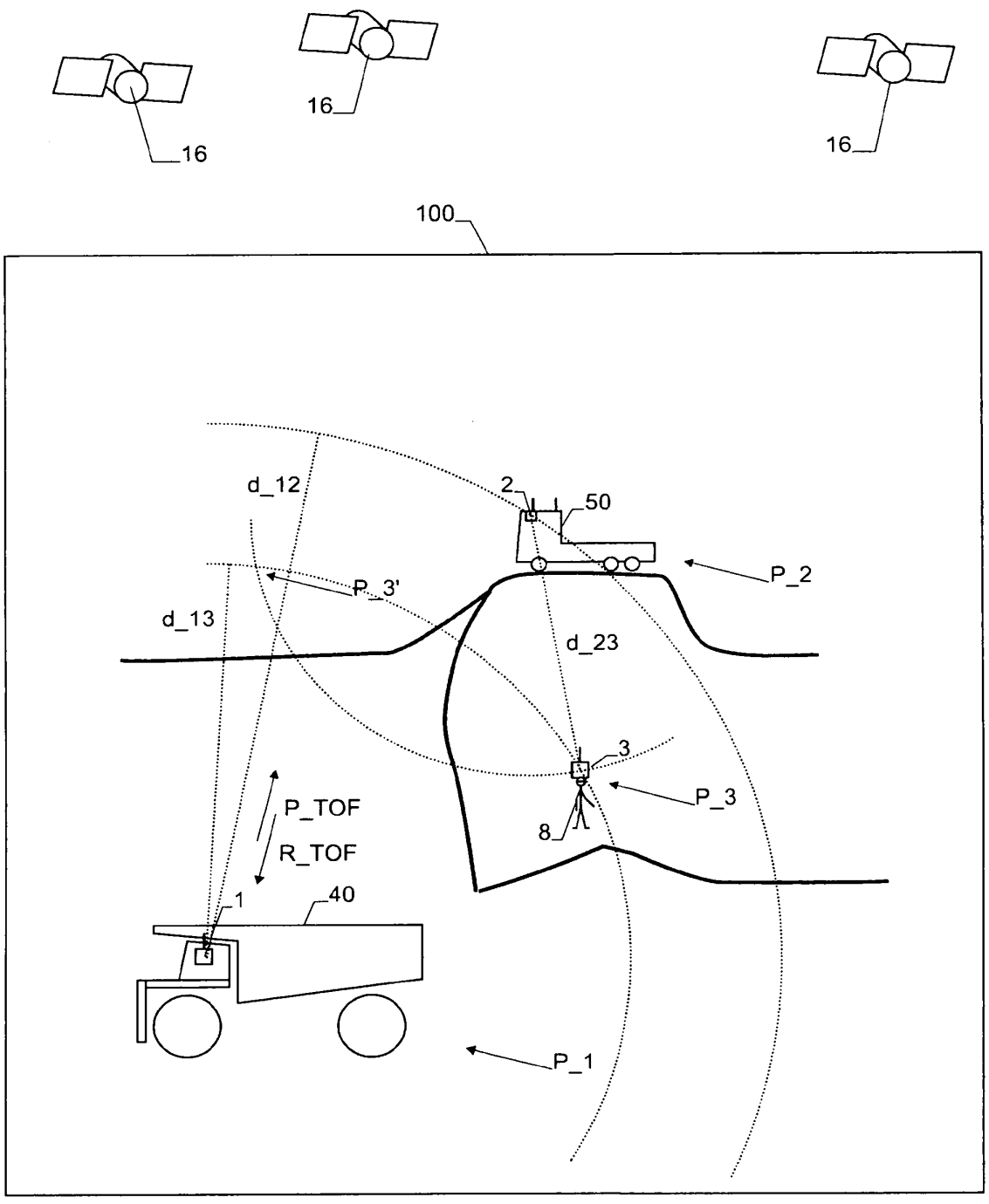


Fig. 1

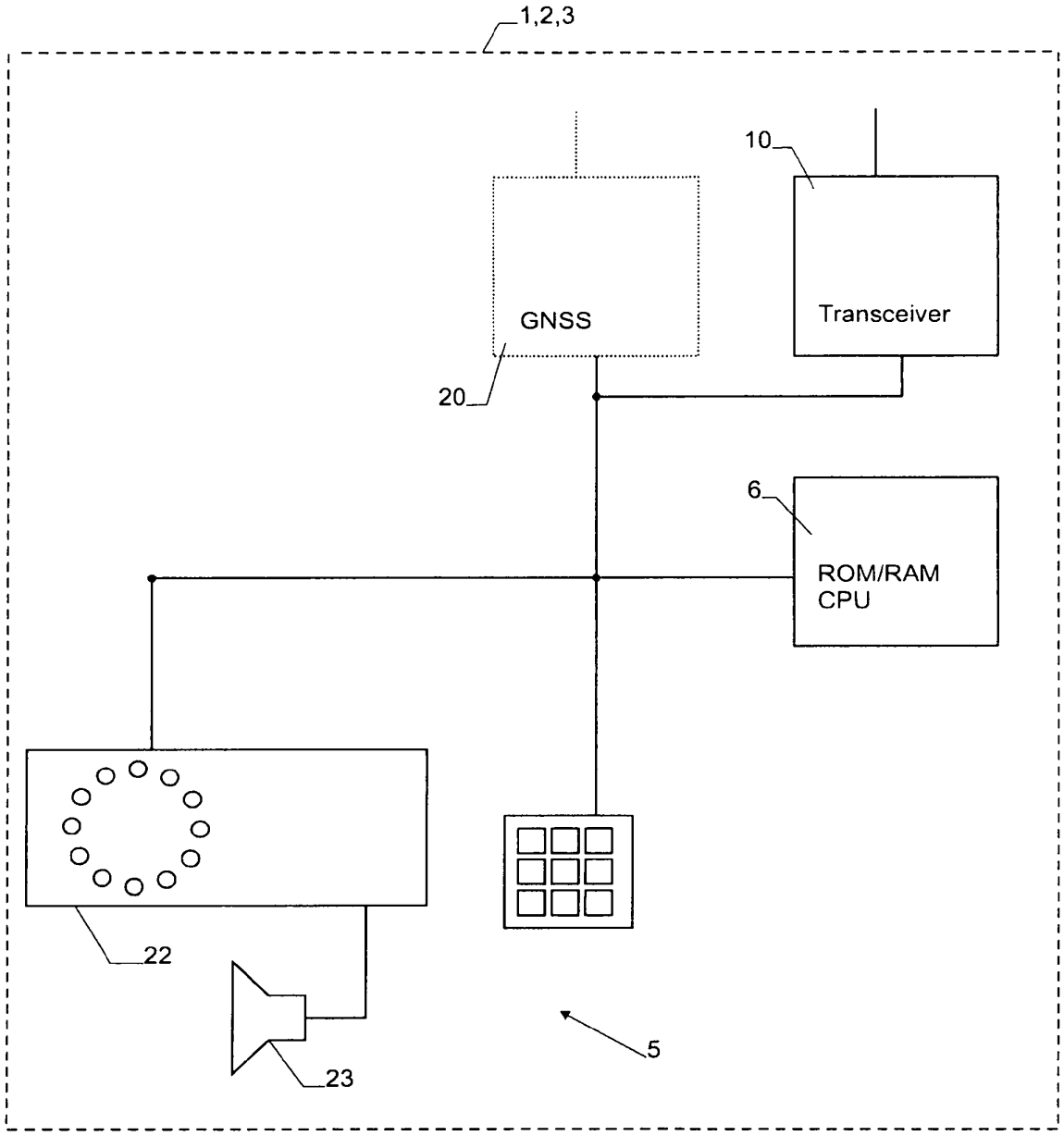


Fig. 2

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Abstract

The invention relates to a method implemented by computer for the management of a convoy comprising at least two vehicles (101 and 102), each of the at least two vehicles (101 and 102) comprising satellite positioning means (201) and vehicle-to-vehicle communication means (202), the method comprising the determination of the relative positioning of said vehicles (101 and 102), said determination comprising the measurement of the propagation time of a signal between vehicles (101 and 102) by the communication means (202), the clocks associated with the communication means (202) being synchronized via satellite positioning means (201) at a reference clock time. Developments comprise the communication between the vehicles (101 and 102) of various data (e.g. measurement uncertainties, signal-to-noise ratios, residual values), the determination of absolute locations, the use of an SBAS-type system, the use of differential GPS, the use of Doppler measurements for the turns or even the exclusion of a failing satellite. A computer program product and associated systems are described.

Figure 4

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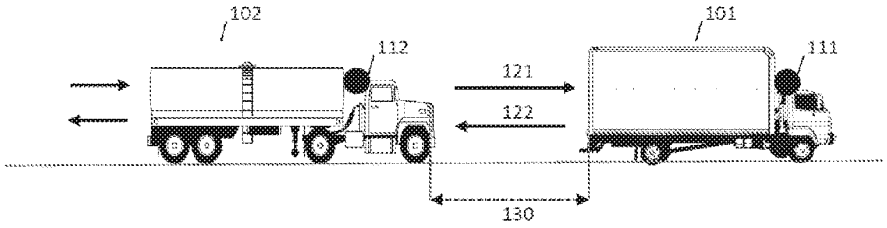


FIG.1

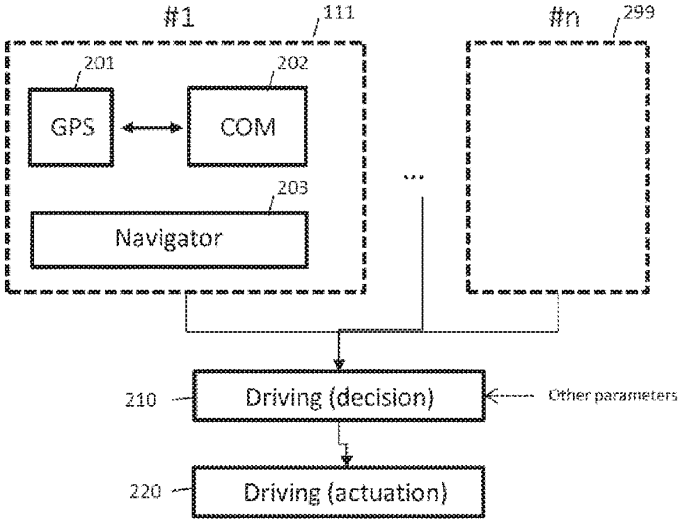


FIG.2

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DRIVING VEHICLES IN CONVOY

Field of the invention

[01] The invention relates to the field of signal processing and in particular that of the driving of vehicles in convoy.

Background

[02] The technical problem raised is that of tracking the positions of vehicles travelling in convoys. The lead vehicle can be driven by a driver. One or more vehicles of the convoy can be driven automatically. The distances observed between vehicles are typically of the order of ten or so metres. Since the reaction time of one vehicle to the next is linked to the measurement time and to the communication time between vehicles, reaction times of 0.1 second can be accessed. At 40 m/s (145 km/h), this corresponds to a minimum distance of 4 metres between pairs of vehicles (the distance has to be kept to the minimum to avoid the appearance of undetectable obstacles or events between two vehicles, for example an animal crossing the road).

[03] This technical problem arises mainly in the context of routine following. In critical conditions (emergency braking for example), the detection of the actions of the first driver and the reactions of the first vehicle can be done by means of sensors suited to these critical phases (notably odometers), conservative strategies then being able to be envisaged. However, these dedicated sensors do not have a resolution and a stability that is sufficient for routine measurements.

[04] The state of the art discloses very few methods that make it possible to solve this technical problem and the results are generally not satisfactory. For example, some techniques use artificial vision and/or ground marking following systems (for example RFID chips inserted into the roadway). These methods require heavy and costly instrumentation or are not flexible.

[05] One solution consists in synchronizing the clocks of the different vehicles, for example on their departure (and/or in compensating the drifts of these different clocks over time). The measurement of the communication times between the vehicles divided by the speed of light would then theoretically make it possible to deduce the separating distances

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between vehicles. In reality, this approach does not work, given the clock drifts that are commonly observed (the distance error is then around 10 or so metres).

[06] There is an industrial need for processes and methods that make it possible for convoys of vehicles to travel in safety, particularly outside of the major highways.

Summary

[07] In one aspect, the present disclosure combines the use of a positioning system (GPS or Galileo or other) and of an inter-vehicle communication system (which can generally be of any type).

[08] In one development, the clock synchronization can be performed by means of GPS access, which if necessary, gives a reference clock time and, what is more, one that is shared between the vehicles. This approach eliminates the problems resulting from any clock drifts.

[09] The present disclosure makes it possible to put in place robust automatic driving strategies (for example driverless) for convoys of trucks or of any other type of land vehicles (cars and/or trucks and/or motorbikes and/or buses, etc.).

[10] The present disclosure will also be advantageously applicable for certain situations concerning air traffic, for example for convoys of miniaturized drones intended for logistical operations and travelling in convoy in determined air corridors.

[11] Some aspects of the present disclosure can afford significant savings in terms of logistics and/or transportation (for example for heavy industries of mining industry type). The management of the fleets can be optimized and the safety of the transport can be reinforced.

[12] The vehicles (e.g. trucks) can be positioned or located by GPS (or, more generically, by GNSS system, a term which denotes all the satellite positioning systems, e.g. GPS, Galileo and others). In the rest of the description, the terms GPS, Galileo, or GNSS are used interchangeably.

[13] In one aspect, the GPS operates in standard or "absolute" mode (that is to say that each vehicle of the convoy independently determines its own positioning from the others).

[14] In another aspect, the GPS operates in differential mode (DGNSS). This differential mode is also called "relative mode" (via the broadcasting over the communication channel of data of DGPS type), that is to say that the positioning of a vehicle can be improved by virtue of the knowledge of the positioning of the other vehicles, which serve to enhance the accuracy of the positioning.

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[15] Additionally, it is also possible to instrument the vehicles (i.e. all or some of the vehicles of the convoy) by means of inertial systems (odometers for example), useful when the convoy passes through physical tunnels and/or areas in which the GPS reception is temporarily interrupted (in an urban traffic situation, reception of the GPS signal being prevented by the buildings and/or the vegetation, bad weather conditions, etc.).

[16] Also additionally, it is possible to complement the embedded instrumentation for all or part of the convoy. For example, one or more vehicles can have one or more radars installed, or even optical systems (computer vision for collision detection, the detection of pedestrians or of obstacles, for following white lines on the roadway, etc.).

[17] The communication channel can itself be used as additional measurement means to make the use of the GNSS more robust, in order to eliminate the risks of integrity (global or local) and of unavailabilities (tunnels for example). In addition, inertial measurements can be used.

[18] Among other advantages, the present disclosure makes it possible to remedy the long delay (6 seconds) required for the warning and the associated corrective actions of the SBAS augmentation systems of Egnos type, a delay which is generally too long for vehicles travelling on a road at high speed. The aspect described allow for robust and rapid detections of relative movements and therefore make it possible to maintain compliant situations (at least during this warning delay).

[19] Some aspects of the present disclosure make it possible to improve location performance levels (by the provision of additional differential measurements), integrity (via a GNSS-independent measurement means making it possible to reveal local or global non-integrities thereon), availability (when passing through tunnels for example, by maintaining accurate distance measurements, notably in the context of coupling with inertial sensors). These advantages are obtained without significantly increasing the installed hardware complexity, the GNSS processing and communication modules already being commonly available on the market.

[20] A method is disclosed, possibly implemented by computer, for the management of a convoy comprising at least two vehicles, each of the at least two vehicles comprising satellite positioning means and vehicle-to-vehicle communication means, the method comprising the determination of the relative positioning of said vehicles, said determination comprising the measurement of the propagation time of a signal between vehicles by the communication means, the clocks associated with the communication means being synchronized via satellite positioning means at a reference clock time.

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[21] The convoy comprises at least two vehicles, of any type (car, motorcycle, bus, truck, etc.). The convoy is a dynamic entity: a vehicle can leave the convoy, a vehicle can join a convoy, two convoys can merge (several vehicles can be considered as being a single vehicle in a systematic perspective, etc.).

[22] Measurement of the propagation time corresponds to the TOA (Time of Arrival). The measurement in itself is performed by the receiving vehicle, by means of the time value declared by the transmitting vehicle. The measurement of the propagation time (of a signal for example) between two vehicles gives access to the inter-vehicle distance information (the mutual relative speeds of the vehicles being negligible compared to the speed of light). It should be noted that, in the case where the convoy comprises more than two vehicles, a number of propagation times can be measured (between any two vehicles of a convoy, for example between the second and the seventh vehicle). Subsequently, these times can be subjected to statistical processing operations (e.g. associated with confidence intervals, etc.). Combinatorial optimizations or verifications can also be performed (for example, the propagation times from a given vehicle to respectively all the other vehicles of the convoy can be measured, the measurement from a vehicle A to a vehicle B compared to the measurement from a vehicle B to a vehicle A, etc.).

[23] The signal can be an electromagnetic signal or a light signal (for example one or more lasers). In some economical cases, the signal can be a sound signal (if necessary, the speed of propagation of sound is known as a function of the atmospheric pressure/altitude and the speed of the vehicles is not negligible compared to the speed of propagation of the signal). The specific features and limitations of the sound aspect render this particular aspect, but not without interest (inexpensive, it can also complement other aspects). Generally a signal of undulatory type can be used (microwave beam, visible light, IR, etc.). The communication means between vehicles can therefore be radio and/or light, e.g. laser and/or sound, etc. The redundancy of the signals makes the overall system robust.

[24] The synchronization of clocks is obtained via the satellite signal. Each vehicle has a clock time which is specific to it. According to certain aspects, the present disclosure aims to harmonize or adjust or synchronize the different clocks of the different vehicles forming the convoy. The method is therefore entirely a combination of means, acting in synergy (a result of one being reused by the other in a "cybernetic" loop).

[25] The "reference clock time" denotes the time after the comparison and the synchronization (real or virtual) of the different clocks of the different vehicles. This reference clock time ("common clock time" or even "synchronized clock time") serves as a reference for the computation of the propagation time or times of the signal between the vehicles, and is

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used in determining the relative positioning of the vehicles (positions in space of the vehicles relative to one another).

[26] Different variants of synchronization of the clocks are possible. The satellite positioning means can calibrate the synchronization for example. They can notably initialize a clock time and/or proceed with adjustments or synchronizations at regular or irregular intervals (periodic or intermittent or opportunistic or according to particular driving events for example).

[27] The "reference clock time" can therefore be readjusted from time to time (the reference can change). The reference clock time in particular can be used to time-stamp the signal transmitted between the vehicles (for example by the transmitting vehicle). One possible synchronization method can consist in resetting the clock of the communication means of one or more vehicles according to the satellite navigation clock ("clock calibration"), to construct a single clock ("real" synchronization). Another method can consist in keeping distinct clocks (the different communication modules each retain their clocks for example), but in measuring the deviation between the different clocks and in transmitting this deviation via the communication channel between the vehicles (the deviation being subsequently taken into account in computations of relative positioning, "virtual" synchronization). In fact, these methods and their many variants have in common the fact that an independent and external time reference is injected into the computation of relative positioning of the vehicles, which is reflected by the use of the expression "the communication means [are] synchronized via the satellite positioning means".

[28] In practice, because of the programmability (or non-programmability) of a clock embedded in a vehicle, the clock concerned can, de facto, be advanced or retarded (the delay or advance will be able to be stored). Alternatively, if a clock cannot be modified, its inclusion in a wider system will make it possible to neutralize its advance or its delay in the subsequent computations.

[29] The method described is suitable for the management of a convoy, generally. A vehicle can have a drive system (automatic driving, remote guidance, driving by a driver, assisted driving, etc.) or not have a drive system as such (if necessary, the vehicle mimics, imitates or reacts to the driving of one or more other vehicles of the convoy).

[30] In one development, the method further comprises the communication between the vehicles of the uncertainty associated with the reference clock time.

[31] The uncertainty of the clock time associated with a vehicle can be determined or computed or estimated or quantified. This uncertainty (of measurement of the clock times specific to each vehicle) refers to the reference clock time, common to the vehicles forming

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the convoy (or to at least a majority of them). A drift can be determined by means of independent sources for example (relative mode). A probability of drift can also be estimated without having to use a third-party source (absolute mode). A drift or a deviation can result from comparisons combining absolute and relative estimations. In one development, the vehicles (e.g. the communication means and/or the GNSS means) exchange this information concerning the measurement uncertainty associated with their clock. For example, at least two vehicles can share the information regarding the estimated quality of the calibration of their synchronization. In other words, a vehicle can cooperate with at least some of the other vehicles of the convoy by sharing or by communicating or by transmitting or by broadcasting the time measurement uncertainty information specific to it (knowing the reference time as defined collectively).

[32] In one development, the method further comprises the communication between the vehicles of information relating to the signal-to-noise ratios of the measurements from the satellite positioning means.

[33] In one development, the method further comprises the communication between the vehicles of information relating to the signal-to-noise ratio of the communication signal between the vehicles forming the convoy.

[34] The measurement error on the communication signal will be equivalent to an error on the clock.

[35] In one development, the method further comprises the communication between the vehicles of information relating to the measurement residual values on the signals received from the satellite positioning means.

[36] For a vehicle, a "satellite residual value" or a measurement residual value on the signals received from the satellite positioning means (e.g. measured for a vehicle/satellite pair) – corresponds to the deviation between the pseudo-distance *measured* (i.e. in reality) between this vehicle (e.g. its GNSS receiver) and the satellite concerned and between the pseudo-distance computed or expected between the position *finally estimated* of this vehicle and the satellite concerned.

[37] The concepts of "signal-to-noise ratio" and of "residual values" are distinct. It is possible to observe significant residual values for example because of a specular multiple path with no true attenuation of the signal-to-noise ratio.

[38] In one development, the method further comprises the determination of an absolute location of one or more vehicles forming the convoy.

[39] In addition to the relative positioning of the vehicles relative to one another, the method can predict the absolute location of one or more vehicles forming the convoy.

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"Absolute location" should be understood to mean the precise geographic situation of the vehicle or vehicles concerned.

[40] The absolute location can be obtained by means of the various GNSS coordinates received by the GPS vehicles, and by means of the different relative positionings of the vehicles relative to one another. In other words, it is possible to mutually corroborate the various information items, whether they are received or whether they are computed (GNSS information, relative position information, SBAS information, etc.). The different values can be subjected to statistical processing (such as computations of mean, standard deviation, weighting, equalization, interpolation, etc.).

[41] In one development, the determination of the absolute location advantageously uses the satellite residual values as previously described.

[42] In one development, the relative positioning of the vehicles is rid of the data received by a regional augmentation system of the satellite positioning means.

[43] A GNSS system can be the subject of a so-called regional improvement or augmentation or optimization. For example, the SBAS system corresponds to a regional augmentation of a GNSS system. Ordinarily used for aircraft (in landings), the application to land transportation is novel, all the more so in combination. The system concerned for example a) warns of scheduled service interruptions and b) communicates certain correctional terms to improve the position in the event of observed failures or malfunctions (delay of six seconds).

[44] In one development, the satellite positioning means are satellite positioning means operating in differential or relative mode.

[45] The satellite positioning means can operate according to two main modes. In "standard" operation, the location information is deduced from the reception of the satellite signals: in other words, the location depends only on the reception of the satellite signals and nothing more. In a so-called "relative mode" operation, the location is deduced from a number of receivers, which may or may not be in motion. According to certain aspects of the present disclosure, the location is performed by means of receivers which are all in motion. According to other aspects of the present disclosure, the location is performed by means of receivers, some of which are fixed (fixed receivers associated with the infrastructure for example) and some of which are in motion. The fixed references can therefore be non-vehicle references (pedestrian, infrastructure reference such as bridge, mast, building, differential GPS station, etc.).

[46] The differential or relative mode operation of the satellite positioning means, despite everything, remains entirely optional. If such a mode may be advantageous in terms of

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accuracy, it may, on the other hand, present contra-indications in certain situations. For example, when passing through physical tunnels, or areas of interference, the satellite signals may be interrupted. Consequently, the relative positioning can be performed only on the sole basis of the measurement of the propagation times between the embedded communication means.

[47] As a first approach, in a simplified, theoretical and reductive manner, it can be considered that the different combinations of means are associated with staged performance/cost ratios. The measurement of the propagation time between the communication modules requires apparatus that is inexpensive and supplies a fast first approximation of the relative positionings. The addition of a GNSS satellite positioning system makes it possible, via the synchronization of the clocks, to improve the accuracy of the relative positionings. Cumulatively, the sharing and the processing of the satellite residual values continue to improve the accuracy. Still cumulatively, the relative mode operation of the satellite positioning continues to increase the gains in terms of accuracy. Finally, the combination of all the means (DGPS, processing of the residual values, measurement of the propagation times between the communication modules) culminates in the best possible accuracy (while preserving reasonable hardware costs).

[48] The method advantageously exploits the use of a redundancy of the positioning systems. In particular, the processing of the residual values makes it possible to significantly augment the confidence in the determination of the configuration of the convoy.

[49] The redundancy of the positioning systems provides an additional advantage, in as much as it contributes to the robustness of the overall system. For example, if the embedded systems of a vehicle (for example a truck) start to drift or to become partially or progressively out of service, the rest of the convoy remains able to mitigate these particular inadequacies. Among other advantages, said redundancy allows for an increased reliability (minimization of the impact of the interfering factors, adaptation to the areas without GPS visibility such as tunnels).

[50] There is a redundancy of information between the communication means and the differential positioning means: the two means supply a relative positioning.

[51] In one development, the method further comprises the measurement of frequency of the communication means, the frequency measurement making it possible to detect turns of one or more vehicles.

[52] A Doppler measurement corresponds to the derivative of the signal reception frequency. In other words, the measurements associated with the propagation of the signal by the communication means make it possible to perform measurements of Doppler type.

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This type of measurement is suited to driving events of the type of change of lane, straight line departure or turn (following the curve of a road or motorway, urban intersections, etc.). In physical terms, because of the relative movement between the vehicles forming the convoy (for example when a truck turns), the frequency is modified between the vehicles. These measurements of frequency variation with the communication means make it possible to refine the tracking of the relative positioning of the vehicles in the turns.

[53] In one development, the method further comprises the calibration of the transmission frequency of the communication means by the satellite positioning means.

[54] The satellite positioning means can also be used to calibrate or to serve as a reference for the transmission frequency of the communication channel. This advantageous calibration remains entirely optional. The calibration of the transmission frequency by the GNSS is not essential. In effect, a relative stabilization of the transmission frequency is generally required to know an instantaneous turn accurately, but it is also possible to consider the variation of the reception frequency, in other words the derivative of the reception frequency, or the Doppler derivative, as metric of turn detection and of measurement of the curvature thereof. This can amount to assuming that the initial received frequency measurement was made in a straight line, without having any absolute means of checking on the measurement itself (but it is possible to check that the movement is indeed performed in a straight line by tracking the GPS position, or even better by the inertial sensors on the vehicle or vehicles).

[55] The GNSS data are advantageously combined to complement the measurements of the communication channel. The clock synchronization makes it possible to achieve reliable measurements of the variations of distance between vehicles, including if the speed of the vehicles changes. The management of the turns can also benefit from GNSS-provided contributions although to a lesser extent compared to the management of separating distances in a straight line. It should be noted that a resetting of the rotation curvature radii can be performed by a manoeuvre consisting in pairing vehicles side by side (or almost, modulo a minimum safety distance) for a few seconds, and do so for example every ten or so kilometres.

[56] In one development, the method further comprises the measurement of the received power by one or more of the communication means.

[57] The received power measurement can, in certain cases, usefully corroborate the distance estimations for the determination of the relative positioning of the vehicles forming the convoy. The received power decreases at $1/r^2$, r being the distance between the vehicles concerned. If the transmission power is known and the received power is measured, it is

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possible to deduce the distance therefrom. In an environment of urban type with reflections and electromagnetic diffusions, the effects of humidity and other parameters mean that the decay is approximately $1/r^2$ modulo certain corrective factors. This optional aspect is therefore advantageous in certain cases.

[58] In one development, one or more vehicles forming the convoy share the same communication means and/or the same positioning means.

[59] It is possible to accept into the convoy vehicles that do not have, or that partially have, the apparatus required by the method. In particular, it is possible to envisage different configurations allowing for the implementation of one or more steps of the method. For example, one or more vehicles can share one and the same communication means. Gateways or "bridges" can for example enable an under-instrumented vehicle to join the convoy. For example, by means of a connection provided by a mobile telephone, GPS information, possibly degraded, can be shared with the other vehicles of the convoy. Similarly, a vehicle without positioning means can be authorized within a convoy provided that complementary means are implemented (for example a reversing radar installed in the vehicle in front can mitigate an insufficiency of positioning means). Generally, a convoy according to the present disclosure comprises at least two vehicles instrumented according to the present disclosure, that is to say each comprising communication means and satellite positioning means operating in combination (e.g. synergistically). Ideally, all the vehicles of the convoy are instrumented according to the present disclosure. In a "degraded" aspect a majority of vehicles is instrumented according to the present disclosure and a minority of non-instrumented vehicles is incorporated in the convoy. A convoy can in effect incorporate vehicles that are not instrumented according to the present disclosure or partially instrumented or differently instrumented. For example, a vehicle driven by a human driver can join the convoy. In this case, even in the complete absence of instrumentation, the driver or pilot (including remote driving) can maintain the safety distances with his or her neighbours (vehicle behind and vehicle in front). One or more vehicles can comprise (for example only) physical guiding means (e.g. "booms" of a few metres spacing the vehicles apart, with measurements of the drifts and appropriate servo controls for maintaining a substantially constant distance). Electronic guiding means (for example by laser measurement and with similar servo controls with the driving system) can also allow third-party vehicles to join the convoy. Inertial means (for example odometer) can be used. A vehicle may also comprise only one or other of the communication means and the GPS means.

[60] In one development, a vehicle is authorized to join or leave the convoy of vehicles.

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[61] The authorization to join or leave the convoy can comprise different sub-steps. For example, initially, the requesting vehicle can – for example and optionally – be authenticated (exchange of security certificates for example) with one or more vehicles of the convoy, which can vote to accept or reject the requesting vehicle. The criteria used can comprise taking into account the instrumentation available in the requesting vehicle (in itself or according to an overview of the system, that is to say according to what the requesting vehicle brings in terms of instrumentation).

[62] A vehicle can in certain configurations denote a plurality of vehicles considered jointly. A vehicle can therefore be a mobile entity, the perimeter of which can change. A vehicle can comprise a plurality of mobile entities. In other words, convoys can merge or split. Convoy coalescence phenomena can be observed, in relation to the technical characteristics and/or the performance levels (of the embedded instrumentation for example making it possible to perform one or more steps of the method).

[63] In one development, an absolute location information item is received from a fixed and authenticated source.

[64] When the convoy is moving, third-party information may add to the determination of the absolute positioning of the convoy. In order to avoid computer hacking scenarios (for example a compromised beacon sending false information or incorrect information to the different vehicles, or trying to saturate the communication means), one aspect of the present disclosure encrypts (optionally) the communication of information, and, cumulatively, organizes the exchange of security certificates in order to prove the authenticity of the third-party sources. For example, a beacon associated with a road bridge, the location of which is very accurately known, will be able to be authenticated with one or more vehicles forming the convoy, then exchange location information in an encrypted manner. In particular, the individual propagation times of the different vehicles to said beacon will be able to be measured, and subsequently come to corroborate or refine the location and/or the relative positioning of the vehicles forming the convoy. The communication can be unilateral (for example, the fixed beacon simply sends its location) but it can also be bilateral (the beacon can be invoked, can exchange security keys, can deliver information with different levels of accuracy depending on the authorization levels of the vehicles transmitting the requests, etc.).

[65] In one development, the method comprises the exclusion of a failing satellite for the determination of the positioning of a vehicle and/or for the estimation of the reference clock time.

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[66] In one development, a satellite may be revealed to be failing or defective (constantly or permanently, or for example over a given time interval). This failure may be declared (by an outside system, and therefore received by one or more vehicles forming the convoy) or determined by rights by one or more vehicles (for example after a vote or according to confidence thresholds or quantitative criteria, etc.). Subsequently, the embedded positioning means can disregard the failing satellite. The positioning means can be programmable or non-programmable: the exclusion of a satellite from the constellation can be performed at different levels. The satellite can be excluded by all or some of the embedded GNSS receivers. If a receiver is not programmable, the failing satellite will be taken into account for the determination of the location of the vehicle in which the receiver is embedded but this vehicle cannot participate in the estimation of the synchronized clock time. The convoy can decide "collectively" (majority vote or other schemes), according to the data received (raw GNSS data and/or residual values and/or signal-to-noise ratio) and the propagation times, that a satellite has a problem and to exclude it for a time from any clock estimation throughout the convoy. This exclusion process can for example be based on the observation that a particular satellite gives a strong residual value compared to the solution obtained with all the other satellites and the communication signals, and on all the receivers of the convoy. Compared to a regional augmentation system of SBAS type, this rapid elimination of a disturbed satellite adds the taking into account of the communication measurement, can be dealt with within detection delays that are substantially shorter than the six seconds of the SBAS (i.e. compatible with the driving of the convoy), and also makes it possible to take into account the possibility that the disturbed satellite is not a satellite but in fact a decoy on the ground. At regular intervals, the signal from said satellite can be tested by one or more vehicles so as to continue to disregard the satellite or in order to once again take it into account.

[67] A system is disclosed that comprises means for implementing any one of the steps of the method. In particular, the system can use satellite positioning means, communication means, computation means, information storage means, information display means. The communication means advantageously use a UWB modulation. The UWB modulation offers the advantage of allowing for a good propagation time measurement quality. The communication means in particular can be of GSM (2G), UMTS (3G), LTE (4G), CDMA2000, Tetra, UWB, Zigbee, Bluetooth, DSRC, Wifi, Wimax type.

[68] One, several or all of the steps of the method can be implemented by computer. A computer program product comprising code instructions makes it possible to perform any one of the steps of the method when the program is run on a computer.

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Description of the figures

[69] Different aspects and advantages of the invention will emerge in support of the description of a preferred but nonlimiting implementation of the invention, with reference to the figures below:

[70] Figure 1 illustrates a portion of convoy according to the invention;

[71] Figure 2 illustrates an example of equipment embedded in a vehicle of the convoy and instrumented according to the invention;

[72] Figure 3 shows a general and schematic view of the inputs/outputs of the navigator function embedded in a vehicle of the convoy according to the invention.

[73] Figure 4 stresses an aspect of the invention concerning the correction or the weighing provided by the analysis of the residual values.

Detailed description

[74] A "vehicle" according to the invention can be a truck (of any type, e.g. a pick-up truck or a heavy goods vehicle, etc.), a mobile robot (including aircraft), a motorcycle, a car.

[75] A "convoy" can be made up of vehicles of different types or else made up of vehicles that are substantially of the same model. A preferred application of the invention relates to convoys of trucks (train of heavy goods vehicles). A convoy can change over time: vehicles can join or leave a convoy that has been formed. A "convoy" is therefore a dynamic object, the composition of which is not fixed. Several convoys can merge together. A convoy can split up into several new convoys. The invention is advantageously applicable in these logistical "coalescence" situations.

[76] A GNSS (Global Navigation Satellite System) system covers all the satellite positioning systems, for example Glonass (Russian), GPS (American), Galileo (European), etc. The expressions "GPS" or "Galileo" or "GPS and Galileo" are used interchangeably and refer to all or some of the system generically called GNSS.

[77] The use of a GNSS system is problematical for the driving of convoys, or more generally for automatic driving applications. A GNSS system is typically affected by limitations linked to the number of satellites in the constellation in sight or operating correctly. The technical problem is in effect partly that of the integrity of the signal. This integrity can be lessened for various reasons: clock jump, satellites unavailable, natural or local interference of road tunnel type for example, presence of jammers which, although generally prohibited, could disrupt a location, etc.).

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[78] A GPS or Galileo receiver performs various operations, notably a correlation operation consisting in making the code received from the satellite and the code produced internally by the receiver coincide in time. The GPS or Galileo signal also makes it possible to measure a deviation between the undulations of the carrier of the received signal (the phase of the received signal) and the undulations of the carrier of the signal generated internally by the receiver (the face of the signal generated internally). The measurement by phase deviation confers great accuracy, less than 20 cm (by code and phase measurement accumulation). Some receivers can use a regional or local augmentation, for example for approach and landing phases in the air navigation applications. These receivers use, in addition to the Galileo GPS signals, an independent source of information to guarantee the service performance levels.

[79] The communication measurements are not used in the rare available prior art documents. GPS is not used in an urban environment. On motorways, the sky is generally open. In an urban environment, vegetation or buildings can hamper the GPS or Galileo reception, and this is all the more true when the accuracy has to be great.

[80] The GPS reinforcement systems of SBAS (Satellite-Based Augmentation System) type are – among other aspects – systems which can preventatively alert the users or the systems of scheduled interruptions or failures of GNSS systems. These alerts can comprise correction information to be added to the signals. The delay of this type of system is approximately six seconds ("time to alert"), which, in a convoy traffic situation constitutes a delay which is (much) too long. In fact, terrestrial transport means do not use the SBAS system.

[81] In one embodiment, a GPS in a standard mode is used. In another embodiment, the GPS is used in differential mode ("DGNSS"). The comparison of the transient times makes it possible to mutually position the receivers. Generally, the differential mode is used with at least one fixed receiver (the position of which is very accurately known, for example mounted on a mast for applications in agriculture). The instrumentation of the trunk roads with a multitude of such fixed GPS receivers is costly. Although it can be envisaged for motorways, this instrumentation is unrealistic for the secondary network. The differential mode according to the invention is performed mostly between receivers which are mobile, embedded in the vehicles. The use of fixed receivers is nevertheless not excluded.

[82] Figure 1 illustrates a portion of convoy according to the invention. Figure 1 shows two trucks, lead 101 and follower 102, separated by a distance 130.

[83] One vehicle communicates with the others (all the others, or with any part thereof, or with one or more of its followers and/or predecessors or even with any other of the convoy).

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[84] The propagation times between the vehicles are measured and compared (in fact between the antennas, the geometry of the vehicles, i.e. front and rear being known). To do this, a common clock time is required. Atomic clocks cannot realistically be embedded in each vehicle for cost reasons. The clocks of each vehicle must be and remain (relatively) synchronized: there is therefore a need for a reference clock.

[85] Synchronization on departure of the vehicles would be insufficient in most cases (because of the clock drifts, apart from the fact that that would also prevent a new vehicle from joining a convoy already formed). There is therefore a need for a reference clock and this clock is defined via the positioning system, which supplies a common clock time. Furthermore, according to the invention, a method is disclosed for maintaining and improving the accuracy of this common clock time (the concepts of time and of location are linked, modulo the movement of information accessible via measurement means, for example inertial).

[86] The geometry of the vehicles (front, rear, lateral dimensions, height) is known for each vehicle (it is predefined), as is the geometry between the communication antenna and the GPS antenna. This implicit information is incorporated in the computations. This information is not essential (in as much as corrective measures can be applied, for example by means of external or independent modules).

[87] In one embodiment, the convoy comprising a number of vehicles has no driver (i.e. all the vehicles are driven automatically. In another embodiment, one or more vehicles are driven by a human driver. For example, only the lead vehicle is driven manually (and/or semi-automatically). In the context of such convoys, the first truck with a driver can be responsible for the actual driving, with, notably, the choice of the directions at the intersections, the choice of the lane on a multilane highway, and the detection of unforeseen obstacles (possibly assisted by automatic means of radar type). According to this embodiment, the first truck can transmit, via a dedicated communication channel, the road information to the following trucks, and so on, the following trucks being responsible for automatically reproducing the actions of the first and for maintaining a predetermined relative position.

[88] Figure 2 illustrates an example of equipment embedded on at least one vehicle of the convoy. The communication system between the trucks is used as additional measurement means, complementing the GNSS (and possibly inertial units). These measurements offer the advantage of being completely independent of the GNSS (therefore not subject to the same events), of being instantaneous, of being between successive vehicles, and of not requiring additional equipment (the inter-vehicle communication channel in any case being necessary for the critical situations (emergency braking for example)).

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[89] For this, two measurement elements are considered: the measurement of TOA (Time Of Arrival) for maintaining the distance, and the measurement of FOA (Frequency Of Arrival) for following on a bend. The invention favours, for this communication channel, the use of an OFDM modulation of mobile 4G type for its good TOA/FOA measurement quality on short communications in direct line of sight, and subject to a standardized definition of a synchronization carrier.

[90] The TOA relates to the distance (between vehicles). In the case of the turns, visual means (image recognition or similar) are possible, but it is advantageous to make use of the communication channel, that is to say, without complicating the use of the GPS channel/signals. In the case of a turn, the Doppler changes (FOA) since the relative position of the vehicles changes (if the vehicles are in a state of relative immobility, the Doppler is zero).

[91] Measurements of TOA and/or FOA are received/transmitted, by one or more vehicles. Statistical processing operations can be performed (averages, standard deviations, per pair of vehicles, or according to any other scheme, for example between vehicles numbered 3 and 17 and 18, etc.).

[92] Apart from the lead vehicle 101 which can optionally contain other equipment, a vehicle according to the invention (for example 102) comprises a GNSS receiver 201 (optionally with the capacity to supply position measurements to one or more other vehicles, so that the latter can produce differential locations), interacting with a communication receiver/transmitter 202 (for example of mobile 4G OFDM or UWB type) capable of dating and accurately measuring the frequency of the received signals. Optionally, one or more vehicles also have one or more inertial sensors and/or odometers (cycle counters or similar) to facilitate the following of trajectory over the short and medium term. Still optionally, radar and/or optical means (robotic vision, infrared, etc.) complement the embedded instrumentation.

[93] In one embodiment, one or more GNSS receivers can be compatible with the reception of integrity data by ground network or by SBAS in order to limit in time the degraded mode operation on the communication channel. It is, for example, possible to envisage considering that, if the communication channel 202 has detected a problem on a GNSS satellite and that this problem has not been reported by the SBAS system (if it is in sight) after 30 seconds (5 times the nominal *Time To Alert*, and notably more than the duration of a multiple path in a non-urban environment, there is an inconsistency and it is preferable to put in place driving strategies (stopping, slowing down, relative distance separating the trucks, etc.) pending a consolidation of the knowledge of the situation.

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[94] The trucks generally communicate between successors (other communication schemes will be disclosed hereinbelow), the position of the communication antennas on each truck having to be known accurately. The communication between the trucks can be performed by any known means (e.g. CB, Wifi, Bluetooth, 3G, 4G, LTE, Wimax, UWB). The communications are preferably local, i.e. from point to point, but the communications with greater latency times are not necessarily excluded (for example DVB).

[95] Positioning information sources – other than the GPS or Galileo positioning system – can advantageously be used. Such information can be used in combination (e.g. to enrich the algorithms) or in such a way as to complement or be added to or juxtaposed with (to reduce the uncertainties, using correlation to improve the determinations of position, etc.). Such information can be optional in certain cases (navigation can do without such information) or be required when more deeply integrated in the algorithmic determination of the position. In certain cases, such information can also be substituted for (i.e. replaced with) the GPS information, wholly or partly. These sources can, for example, be information from GSM base stations accessed as the convoy moves, from other satellite systems, from data from Bluetooth, 2G, Edge, 3G, 4G, LTE or 5G, UWB networks, from data from Wifi networks through which the convoy passes, from data extracted from the roadway (for example RFID chips or according to other contactless technologies, inserted into sensors or probes present in the roadway), from information or confirmations supplied by aircraft or drones, from data sent by the vehicles travelling on the opposite or adjacent lanes, derived from other triangulation methods, etc. Different confidence levels (e.g. statistical interval of uncertainty or qualified levels of credibility of the sources, etc.) can be associated with the different information sources. Different methods (e.g. equalization and/or weighting and/or interpolation, optionally and for example taking into account the inertial units, etc.) can then be implemented to determine a resultant location.

[96] On the received communication signals, the communication module in each truck performs a TOA/FOA measurement. The TOA measurement will mainly serve to maintain the distance, the FOA measurement to assess a turn speed in the case of a bend or of a change of lane.

[97] These measurements are then compared with the absolute and differential GNSS measurements to eliminate any inconsistency, then these measurements are combined with the validated GNSS measurements to obtain a hybridized location solution. The residual value information collected on completion of the integrity checking and combination steps are stored in messages to the other trucks, the idea being that, if one truck has locally detected an inconsistency on a satellite, it may be advantageous to advise the other vehicles of the

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convoy to check this satellite more particularly and, if at all possible, avoid making use thereof.

[98] The contributions of the communication channel or module 202 to the location are therefore manifold. The communication channel or module or box 202 transmits, between the vehicles (or some of the vehicles), DGNSS (differential) data, GNSS integrity data evaluated by each vehicle (possibly able to be recombined in overall integrity mode in the case where the observations of each vehicle agree on an overall source of error, for example of GNSS failure type), and differential location residual value data (which can serve notably – in the case where the GNSS integrity is consolidated – to reset the synchronizations of the time references of the communication modules). The location, the availability and the integrity are improved (partly because of the contributions deriving from the additional differential TOA/FOA measurements).

[99] All of the information deriving from the navigators 111 to 299 (and other parameters possibly received from external navigation systems) is taken into account so as to provide a decision aid for the driving of the convoy. The actual driving 210 can correspond to rules concerning one or more vehicles and chosen from the list comprising stop on a hard shoulder and/or reduce speed and/or accelerate and/or sound alert and/or light alert and/or restore driving controls to the human driver, etc.

[100] The driving aid system 210 interacts with a set of actuators, that is to say mechanical means of action for the driving. The actuators can supply information in return and modify the driving decisions (if, for example, a vehicle steering is defective, the driving decisions can be modified thereby).

[101] Figure 3 shows a general and schematic view of the inputs/outputs of the navigator function embedded in a vehicle of the convoy. The reception and the processing of the signals for a vehicle are presented.

[102] The synchronization of the clocks on the communication channel corresponds to one aspect of the invention. This synchronization is required to perform the TOA/FOA measurements, and is even so nominally performed by virtue of the calibration by a GNSS receiver, which creates a dependency of the TOA/FOA measurements with respect to the GNSS location and is detrimental to the integrity. According to one implementation of the invention, the synchronization of the clocks of the communication channel is advantageously controlled by the navigator block and not directly by the GNSS receiver. This approach makes it possible to incorporate in the synchronization control all the integrity information which has been able to be lifted elsewhere (transmitted by communication or evaluated locally), the elements added by the inertial sensors, and apply the necessary smoothings and

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circumventions to the measurement errors (for example by implementing resynchronization only in the periods when enough GNSS satellites of quality are visible, and by adjusting the overall strategies of speed and of separation between vehicles in case of long periods without resynchronization).

[103] Figure 4 underscores one aspect of the invention relating to the correction or the weighting provided by the analysis of the residual values. Each vehicle makes a correction to the GPS time. Not only does it make this correction, but each vehicle declares the planned correction and communicates it to all the other vehicles. It is therefore possible to detect the defective channels, or the systematic biases. The vehicles can take into account the residual values.

[104] Figure 4 underscores an aspect of the invention concerning the correction or the weighting by RAIM (Ranging or Receiver Autonomous Integrity Monitoring) function. In the same way as the relative positioning of the vehicles of the convoy can be determined more accurately by means of the residual value computations, a function commonly available on the GPS receivers can advantageously be made to contribute. There are different types of GPS or Galileo receivers. These receivers can be instrumented with an integrity monitoring function. The technique called RAIM (Ranging Autonomous Integrity Monitoring) enables the receivers to autonomously detect the appearance of a malfunction or of a performance degradation of a defective satellite. The simplest receivers are designed to receive a single frequency from the GPS satellites (signal L1 C/A) or Galileo satellites (signal E5a or L1). They are generally equipped with ten or so reception channels to acquire all the GPS or Galileo satellites in sight. The more complex receivers can receive two frequencies (bi-frequency) from each satellite of the two constellations (GPS/Galileo combined receivers). In as much as the combined use of the independent GPS and Galileo constellations reinforces the reliability of the positioning, such combined receivers using the RAIM technique allow for accurate locations.

[105] The determinations of the relative positions of the vehicles in the convoy can be improved by the use of this RAIM function available in the receivers, or more generally by the implementation of algorithms of RAIM type. This type of algorithm makes it possible to check the state of the signals received from the constellations of satellites. It signals the possibility of an unacceptable position error when an inconsistency in the set of distance measurements transmitted by the satellites is detected. This function is unavailable when the number of satellites received is insufficient or their geometry is unfavourable. According to the RAIM function, a receiver can therefore autonomously determine the appearance of a malfunction or of a performance degradation of a satellite for example. The RAIM is a

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technique or a function or a method used by certain receivers to determine whether the information received from the satellite is incorrect, by the observation of six other satellites. The doubtful information can be rejected by the receiver and is not generally used for the computation of a position. The RAIM is a computation technique, which can be implemented in the computer of the receiver for example, to detect the appearance of a degradation of the accuracy of the distance measurement originating from one satellite out of all the visible satellites. It relies on the availability of an excess of measurements from the satellites by virtue of the fact that the GPS Galileo constellations almost permanently offer more than 4 satellites in sight. The receiver can establish a number of positioning solutions, according to a number of combinations of satellites comprising 4 or more satellites. Through the comparison of the results supplied (notably by comparison of the signals between the different satellites and by analysis of the dispersion), the RAIM algorithms can identify the presence of a defective distance measurement from a satellite. It is thus possible to detect errors originating from a satellite as well as atmospheric effects or other local interference factors affecting the reception of the signals from a satellite. Simply put, five satellites make it possible to detect an anomaly and six satellites make it possible to isolate a faulty satellite (in order to exclude it from the positioning computation).

[106] In fact, each input parameter in the navigator can be monitored. Generically, the deviation between the measurement (e.g. the position) actually observed (i.e. as determined by all the other vehicles) and the simulated measurement (i.e. determined by the vehicle according to its own embedded systems such as odometers, inertial systems, etc.) is determined.

[107] In one embodiment, the RAIM is shared between the vehicles. The residual values are broadcast to the other vehicles. The residual value and integrity information from the other trucks can be used as weighting for the GPS or Galileo measurements, in the same way as the RAIM can correct them.

[108] Figure 4 also underscores another aspect of the invention concerning the redundancy of such information, adding an advantageous robustness to the overall convoy driving system. According to one aspect of the invention, the redundancy of the navigators embedded in each of the vehicles, or at least in one of them, makes it possible to improve the robustness of the overall system. For example, if one vehicle encounters problems with its positioning system and/or its communication system with the other vehicles, said other vehicles have the copy of the last state of the navigator of the defective vehicle and can consequently take measures that are appropriate to the situation. For example, by means of an extrapolation of the trajectory and of the speed of the defective vehicle, the head of the

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convoy can, for example, accelerate while the end of the convoy can slow down so as to increase the separating distance.

[109] Other examples of reaction are possible (stop on the hard shoulder, establish communication by means of other emergency channels, sound and/or light emission, etc.). The methods and systems described aim to correct the clock times. In a particular embodiment, this correction can be achieved by redundancy. According to this embodiment, each truck permanently resets the time and the positions of all the other vehicles. If one vehicle is defective, the other vehicles will see that said vehicle is not responding and a predefined logic can be implemented (slow-downs, accelerations, etc.), possibly by actuating other means (visual or proximity sensors, radars, etc.). A systematic redundancy offers the advantage of standardization, i.e. economies of scale. The same equipment is deployed in all the vehicles.

[110] In another embodiment, the redundancy is partial. In other words, certain vehicles in the convoy have identical (redundant) copies of the image of the overall system while others do not hold it, or do so only partially. These particular vehicles can, for example, accompany the convoy by virtue of other means (for example only radar detection means or by proximity detectors). Mechanisms for authenticating or authorizing vehicles "within" the convoy can be implemented. For example, version information on the embedded systems can inform as to the compatibility (or the incompatibility) with the methods or systems herein described.

[111] In addition, measurements can also be carried out on the communication channel between non-successive trucks. Typically, the signals transmitted by the truck 1 can not only serve as a measurement medium for the truck 2, but also for the trucks 3, 4, 5, etc.; and, similarly, those transmitted by the truck 2 can serve the trucks 1, 3, 4, 5, etc. Given the propagation effects, it is to be expected that these measurements lose accuracy with distance, but they can, however, constitute a useable complement to avoid drifts by error build-up from one truck to another, notably with bends or turns.

[112] Initially, the problem can be resolved with the use of a differential GPS system coupled to a communication channel. However, this solution can, despite everything, present residual integrity defects (disturbance of the GNSS signal at the global level (satellite failure for example) or at the local level (multiple paths for example). For an application that is also critical in terms of safety, it is therefore advantageous to hybridize the method described with the use of other sensors (or probes, as opposed to actuators).

[113] One possible class of sensors corresponds to that of the inertial sensors. An inertial sensor makes it possible to remedy some of the limitations of the GNSS (passage under a bridge for example) but it presents the defect of a medium and long-term drift that is relatively

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great and above all unpredictable (typically, the drifts of the inertial sensors of each of the trucks of the convoy may be different, which means that, in the case of differential location based on these sensors, each will drift differently, which can lead to final distances between the first and the last truck greater for example than the length of the total line). This type of sensor does not make it possible to follow the mutual relative positions of the vehicles. Used to complement the methods and systems described, one or more inertial sensors make it possible to improve the robustness and the accuracy of the positioning of the vehicles. In the case where inertial measurements are available, they add a third source of information which contributes to the consistency analyses and to the location of the vehicles. These measurements can be particularly useful in the case of lengthy GNSS unavailabilities (tunnels for example).

[114] Other types of sensors can also be used in combination, for example sensors of radar or optical type. The sensitivity of these sensors to the weather (notably rain) makes them difficult to use as an all-weather solution. They also have a fairly long reaction time (compared to DGPS for example) and a high equipment cost. Finally, they generally require a relative control of attitude, which is fairly difficult to implement in physical terms. The techniques based on radar therefore allow for complementary improvements, but improvements which remain generally limited and are currently associated with high costs.

[115] The present invention can be implemented from hardware and/or software elements. It can be available as computer program product on a computer-readable medium. The medium can be electronic, magnetic, optical or electromagnetic.

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Claims

1. A method implemented by computer for the management of a convoy comprising at least two vehicles, each of the at least two vehicles comprising satellite positioning means and vehicle-to-vehicle communication means, the method comprising the determination of the relative positioning of said vehicles, said determination comprising the measurement of the propagation time of a signal between vehicles by the communication means, the clocks associated with the communication means being synchronized via satellite positioning means at a reference clock time.

2. The method according to claim 1, further comprising the communication between the vehicles of the uncertainty associated with the reference clock time.

3. The method according to claim 1 or 2, further comprising the communication between the vehicles of information relating to the signal-to-noise ratios of the measurements from the satellite positioning means.

4. The method according to any one of claims 1 to 3, further comprising the communication between the vehicles of information relating to the signal-to-noise ratio of the communication signal between the vehicles forming the convoy.

5. The method according to any one of claims 1 to 4, further comprising the communication between the vehicles of information relating to the measurement residual values on the signals received from the satellite positioning means.

6. The method according to any one of the preceding claims, further comprising the determination of an absolute location of one or more vehicles forming the convoy.

7. The method according to any one of the preceding claims, the relative positioning of the vehicles being rid of the data received by a regional augmentation system of the satellite positioning means.

8. The method according to any one of the preceding claims, the satellite positioning means being satellite positioning means operating in differential mode.

9. The method according to any one of the preceding claims, further comprising the measurement of frequency of the communication means, the frequency measurement making it possible to detect turns of one or more vehicles.

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10. The method according to any one of the preceding claims, further comprising the calibration of the transmission frequency of the communication means by the satellite positioning means.

11. The method according to any one of the preceding claims, further comprising the measurement of the received power by one or more of the communication means.

12. The method according to any one of the preceding claims, one or more vehicles forming the convoy sharing the same communication means and/or the same positioning means.

13. The method according to any one of the preceding claims, a vehicle being authorized to join or leave the convoy of vehicles.

14. The method according to any one of the preceding claims, an absolute location information item being received from a fixed and authenticated source.

15. The method according to any one of the preceding claims, comprising the exclusion of a failing satellite for the determination of the positioning of a vehicle and/or for the estimation of the reference clock time.

16. Computer program product for implementing one or more of the steps of the method according to any one of Claims 1 to 15.

17. A system comprising means for implementing the steps of the method according to any one of Claims 1 to 15.

18. The system according to Claim 17, the communication means using a UWB modulation.

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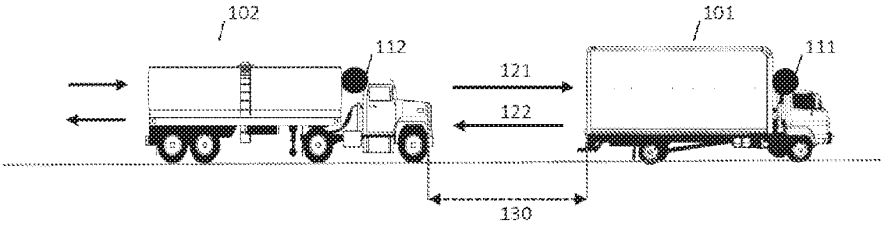


FIG.1

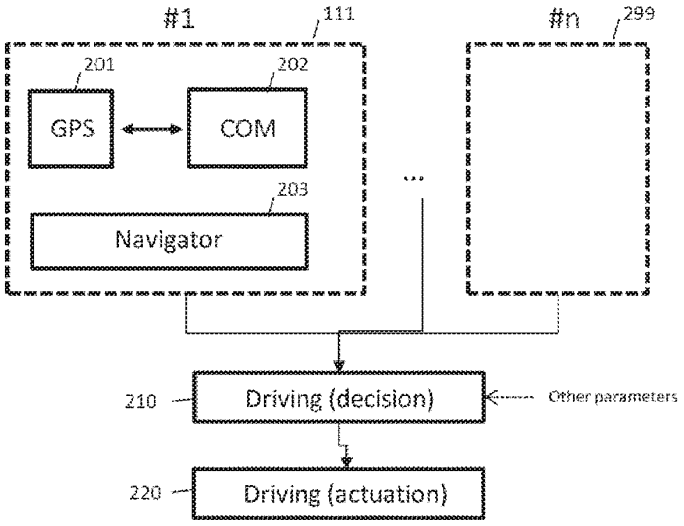


FIG.2

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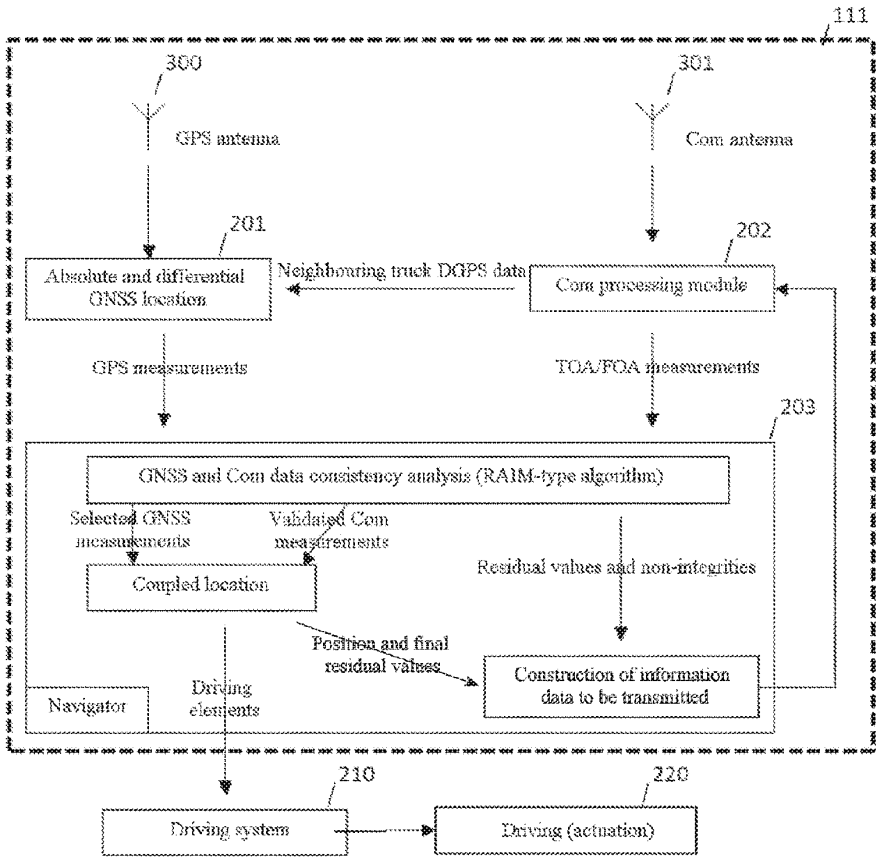


FIG.3

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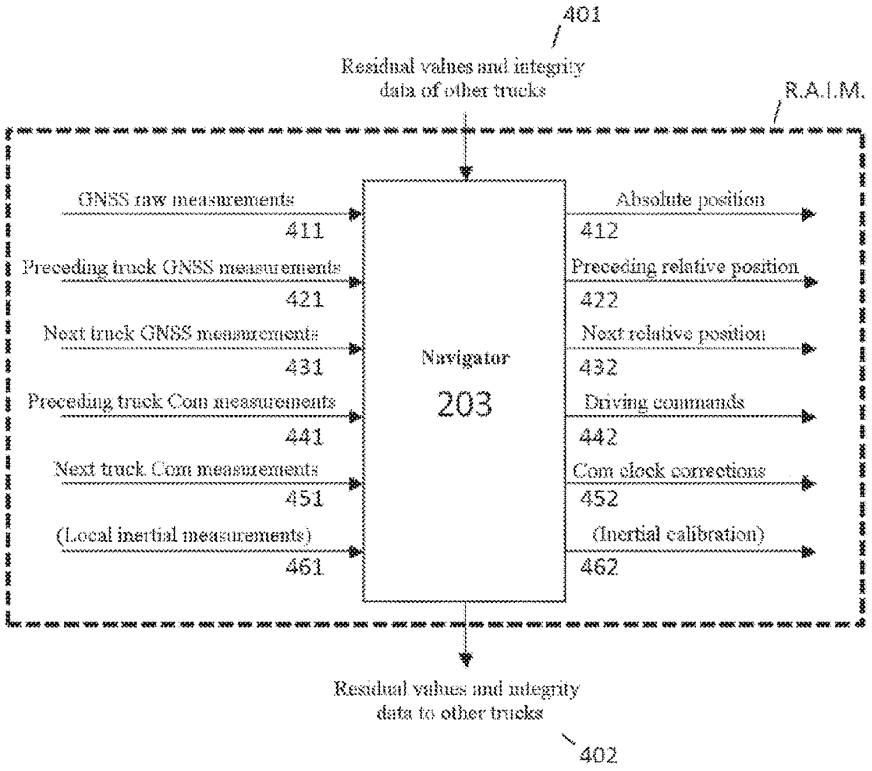


FIG.4

Espacenet

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Detector for detecting moving speed and safety interval of vehicls

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- cooperative:

Application number: CN2001134492 20011106

Priority number (s): CN2001134492 20011106

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Abstract of CN1417071 (A)

The present invention relates to a vehicle safety, and especially to a detector for detecting moving speed and safety interval of vehicles. The detector consists of power supply, microprocessor, electronic switches, amplifiers, detector circuit, A/D converter and ultrahigh frequency vibrator circuit to constitute emitter circuit and receiver circuit. The detector can calculate the relative distance the vehicle should keeps to some moving object based on the practical speed and sends out warning signal timely. It has fixed emitting and receiving microwave frequency set, can avoid interference effectively and detect the speed of the vehicle and safety distance.

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权利要求书 2 页 说明书 12 页 附图 6 页

[54] 发明名称 一种用于检测车辆移动速度与安全间距的检测装置

[57] 摘要

本发明涉及车辆的附加安全装置，确切地说是一种用于检测车辆的移动速度和安全间距的检测装置。 本发明由电源装置、微处理器、电子开关一、电子开关二、电子开关三、前置放大器一、前置放大器二、功率放大器、放大器、带通放大器、检波电路、A/D 转换器和超高频振荡电路组成，构成发射电路和接收电路。 本发明能以车辆移动之实际速度为计算基础，计算车辆与对应移动物体所应保持的相对间距，并适时地提出警示，而且设定发射和接收的固定微波频率，并通过有效的装置避免干扰，能很好地起到检测车速和安全距离的作用。

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1 一种用于检测车辆移动速度与安全间距的检测装置，包括有微波天线，蜂鸣器及其驱动电路，其特征在于本发明由电源装置、微处理器、电子开关一、电子开关二、电子开关三、前置放大器一、前置放大器二、功率放大器、放大器、带通放大器、检波电路、A/D 转换器和超高频振荡电路组成；电源装置提供动力，电子开关一、功率放大器、前置放大器一、超高频振荡电路构成微波发射电路，电子开关二、前置放大器二、放大器、带通放大器、检波电路、A/D 转换器和电子开关三构成检波电路，微处理器和电源装置、电子开关一、电子开关二、电子开关三、超高频振荡器、蜂鸣器的驱动电路、车速信号源连接。

2 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述微处理器与放大器一之间设置有反馈电路，可补偿回波信号增益过大或不足的问题，增加回波信号的稳定度。

3 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述微处理器还可以连接输入界面，如输入键盘，用以达成命令输入之用，可使用键盘做为输入装置，并以其输入的数字做为开始起动回波检测之起始速度，自动激活本发明的检测车辆速度与报警功能。

4 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述放大器设置两个，放大器一位于前置放大器二和带通放大器之间，并与反馈电路连接，放大器二设置在带通放大器与检波电路之间。

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5 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述电源装置包含汽车蓄电池及电源转换电路，电源转换电路用以将电源输出的电压转换为本发明所需的范围；

6 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述微处理器还可以连接引擎启动电路，以作为启动本发明之条件。

7 如权利要求 1 所述的用于检测车辆移动速度与安全间距的检测装置，其特征在于所述电子开关一和该功率放大器、电源、微处理器、电子开关二、微波天线连接，受微处理器控制，做为传送信号及接收信号之开关电路。

一种用于检测车辆移动速度与安全间距的检测装置

技术领域

本发明涉及车辆的附加安全装置，确切地说是一种用于检测车辆的移动速度和安全间距的检测装置。

背景技术

车辆的安全距离检测，随着现代生活中汽车的增多和人们自我安全意识的增强，越来越引起人们和汽车生产厂家的重视，汽车生产厂家也倾向于在汽车内安装以提起人们注意的车辆安全间距的检测装置。现今市场测量汽车的安全距离的产品，一般采用的技术有超声波测距、电磁波雷达测距、光波测距等三种。

超声波测距是利用超声波产生器不间断地发射出 40Kz 超声波，遇到障碍物后会反射成为反射波，待超声波接收器接收到反射波信号，并将其转换为电信号，信号值反映间距的大小，当车辆的间距低于预定的安全值时，该装置就会自动产生报警信号，提醒驾驶者注意。但是超声波测距因使用低频率 40Kz 作为发射波，使用距离范围最高至 10 米左右的范围，检测距离太小，一般只适合使用于倒车的距离检测，像车辆在行驶时的安全间距却不适合使用该装置。

光波测距是利用发射光波后遇到目标物反射回来反射光，检测发射光和反射光的相隔时间，利用两者之间的时间差计算车辆与目标物的距离。光波测距是使用光束向前方照射，并利用前方车辆（目标物）后部

反光镜的反射光，透过受光装置检测其距离。因此所有车辆后面必须安装反光镜，否则效果将会大打折扣，而且会产生很大的误差，显然在所有的车辆后部安装反光镜是不可能的；同时，遇到其他的障碍物没有反光时，安全检测距离的装置就变得毫无用处。

所以，目前最受到驾驶者和车辆生产厂家所接受的是电磁波雷达测距装置，它是利用电磁波发射后遇到障碍物反射的回波，对其不断检测，检测结果转换成电信号，传输给控制器，由控制器对比信号的强弱，并计算前方障碍物的相对速度和距离，经过分析判断，当信号与预定的车辆安全距离所对应的相符合或者强于预定信号时，蜂鸣器就会不断地发出报警声音，对驾驶者构成危险的目标进行警告。

由于现今市场的电磁波雷达测距都使用固定距离检测的方式，无论汽车行驶时速多少，都必须保持在所设定的距离或以上，如果低于设定距离以下，则驾驶人必然听见警报，即使驾驶者了解情况并做了相应的安全措施，也会如此，这样会造成驾驶者不胜其烦，极其容易分散注意力。因为有此不便，故使用此微波雷达测距方式的车辆只有在高速行驶时，驾驶者才会启动车上微波测距雷达。在车速较低的情况下，如在城市内或者交通繁忙的区域，反而达不到预期的作用，而这对大多数驾驶者来说是经常遇到的情况。

因此，上述的电磁波雷达测距装置效果并不理想，无法在车辆的低速行驶状态下为大多数驾驶者使用。

发明内容

本发明的目的提供一种用于检测车辆移动速度与安全间距的检测装置，该装置在车辆高于一定的速度时自动启动该装置，检测车辆与障碍

物的间距，并以车辆的实际速度为基础，当间距低于实际速度相应的安全距离时，该装置能够自动报警。

本发明的另一个目的是驾驶者可以自己设定启动该装置的预定速度，以方便驾驶者根据自己的驾驶习惯和交通状况设定最低的开启本发明的车辆速度。

本发明的另一个目的是当一移动体高速该装置接近时，当移动体超出所设定的距离或/和速度对应值时，该装置可向车辆驾驶者本身发出警示，以提早做好闪躲的准备，并向该移动体发出声光音效的警示，以通知该移动体减缓速度并拉大安全间距。

一种用于检测车辆移动速度与安全间距的检测装置，包括有微波天线，蜂鸣器及其驱动电路，其特征在于本发明由电源装置、微处理器、电子开关一、电子开关二、电子开关三、前置放大器一、前置放大器二、功率放大器、放大器、带通放大器、检波电路、A/D 转换器和超高频振荡电路组成；电源装置提供动力，电子开关一、功率放大器、前置放大器一、超高频振荡电路构成微波发射电路，电子开关二、前置放大器二、放大器、带通放大器、检波电路、A/D 转换器和电子开关三构成检波电路，微处理器和电源装置、电子开关一、电子开关二、电子开关三、超高频振荡器、蜂鸣器的驱动电路、车速信号源连接。

微处理器与放大器一之间设置有反馈电路，可补偿回波信号增益过大或不足的问题，增加回波信号的稳定度。

微处理器还可以连接输入界面，如输入键盘，用以达成命令输入之用，可使用键盘做为输入装置，并以其输入的数字做为开始起动回波检测之起始速度，自动激活本发明的检测车辆速度与报警功能。

放大器设置两个，放大器一位于前置放大器二和带通放大器之间，并与反馈电路连接，放大器二设置在带通放大器与检波电路之间。

电源装置包含汽车蓄电池及电源转换电路，电源转换电路用以将电源输出的电压转换为本发明所需的范围；

微处理器还可以连接引擎启动电路，以作为启动本发明之条件。

电子开关一和该功率放大器、电源、微处理器、电子开关二、微波天线连接，受微处理器控制，做为传送信号及接收信号之开关电路；

电子开关二和该前置放大器二、电源、微处理器、电子开关一、微波天线连接，受微处理器控制，做为传送信号及接收信号之开关电路；

电子开关三和该 A/D 转换器、电源、微处理器连接，受微处理器控制，将完成转换之回波检测的数字讯号经此开关电路输入至微处理器；

前置放大器一和该电源、超高频振荡器、功率放大器连接，做为发射检测讯号的小信号放大之用；

前置放大器二和该电源、电子开关二、放大器一连接，做为接收回波讯号的小信号放大之用；

功率放大器和该电源、电子开关一、前置放大器一连接，做为发射检测信号的功率放大之用；

放大器一和该电源、前置放大器二、反馈电路、带通放大器连接，做为回波信号的一级放大之用；

放大器二和该电源、检波电路、带通放大器连接，做为回波信号的二级放大，并做为灵敏度调整之用；带通放大器和该电源、放大器一、

放大器二连接，带通频率仅能让信号为 24.125GHz 的回波频率能通过此放大器，以抑制其它的噪声通过，避免产生讯号干扰的情形；

反馈电路和该电源、放大器一、微处理器连接，此电路可补偿回波信号增益过大或不足的问题，增加回波信号的稳定度。

检波电路和该电源、放大器二、A/D 转换器连接，此电路功能为将 24.125GHz 的混波信号过滤，只剩下所需要的低频回波信号通过。

A/D 转换器和该电源、检波电路、电子开关三连接，其将模拟信号转变为可供微处理器处理的数字信号。

超高频振荡器和该电源、前置放大器一、微处理器连接，其负责产生 24.125GHz 的固定频率，做为检测信号发射的载波之用。

输入界面和该电源及微处理器连接，用以达成命令输入之用，可使用键盘做为输入装置，以其输入的数字做为开始起动回波检测之起始速度，并自动激活本发明之避撞雷达警示功能。

输出界面系以驱动电路与蜂鸣器构成，和该电源及微处理器连接，用以达成声音输出之功能；

微处理器先检测引擎起动电路是否起动，如果车辆引擎是起动的状态，则开始检测车速信号源之车速，并与键盘输入之设定速度做程序运算比较。

当车速信号源之车速高于键盘输入之设定速度时，则微处理器便自动激活本发明之雷达警示功能，同时微处理器会控制超高频振荡电路产生预先设定的固定发射频率，例如 24.125GHz，经过前置放大器一、功率放大器，放大其检测信号，并增强检测信号的发射功率，此时微处理

器打开电子开关一的开关，同时关闭电子开关二及电子开关三，检测信号的电磁波就经由微波天线发射出去。

这时微处理器的定时器归零重新计时，并关闭电子开关一的开关，同时停止超高频振荡电路的运作及打开电子开关二和电子开关三的开关，准备接收发射波碰到障碍物而产生的回波检测信号。

如果所接收之回波检测信号的时间，超过微处理器的定时器规定时间或在规定时间内未接收到回波检测信号，即表示移动车辆与障碍物之间距超过所设定的距离，则雷达警示功能不动作，蜂鸣器亦不响。

当微波天线接收到回波检测信号，经过电子开关二、前置放大器二，将其信号放大输入至放大器一，如果障碍物是在近距离处，此时回波检测信号将非常强，故微处理器会自动打开反馈电路，以抑制放大器一之增益，可增加信号稳定度。

回波检测信号经过带通放大器时，带通频率仅能让信号为预先设定的固定发射频率相同的回波频率能通过此放大器，如固定发射频率为 24.125GHz 时，带通放大器只让 24.125GHz 的回波频率通过，而过滤其它不必要的频率，再经过放大器二放大其信号。

因所有的零件都有误差，会使得产品灵敏度不一致，可使用灵敏度调整来补正此问题。

当回波检测信号通过检波电路时，此检波电路的功能是将与固定发射频率相同频率的混波信号过滤，只剩下所需要的低频回波信号通过，再送到 A/D 转换器，转换成数字信号输入至微处理器运算处理。

微处理器接收到回波检测信号后，立即停止定时器计时，并记录该时间，再以接收到回波检测信号的时间总和，运算转换成与车辆间之距

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离，并与车辆的车速信号源之实际速度为计算基础，计算比较车辆与对应移动物体所应保持的相对间距，如果检测距离等于或者小于所应保持的相对间距，则微处理器输出音频信号至驱动电路，使蜂鸣器作动发出警示。

于车辆后方安装本发明时，本发明的微处理器可以与车辆的尾灯和喇叭连接，当移动体以高速向本发明后方接近时，若移动体超出所设定的距离和/或速度对应值时，本发明除可向车辆本身发出警示，以提早做好闪躲的准备外。还可以向该移动体发出声、光的警示，以通知该移动体减缓速度并拉大安全间距。

上述之电源，其可为任意电源，以直接使用汽车电池作为电源为较佳。

上述之电子开关，其可为超高频电子开关或集成块。

上述之功率放大器、放大器、前置放大器、带通放大器、A/D 转换器等，其可为超高频差动放大器或集成块。

上述之超高频振荡电路，其可为公知之超高频振荡电路。

本发明具有由于有车速信号源引入微处理器，使车辆移动在高于所设定的速度时，自动激活本发明，启动检测车辆速度和安全间距之装置，能够根据自身车速来检测调整安全间距，并对低于相对本身车速的安全距离发出警告，防止追撞，车辆于高速移动时，本发明能以车辆移动之实际速度为计算基础，计算车辆与对应移动物体所应保持的相对间距，并适时地提出警示，而且设定发射和接收的固定微波频率，并通过有效的装置避免干扰，能很好地起到检测车速和安全距离的作用。

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本发明具有使用者自行输入能自动开启防撞系统车辆移动最低速度的功能，以使车辆在移动中速度高于此速度时，自动开启本发明的检测车辆行驶速度和安全距离的功能，车辆移动中速度若低于此速度则自动关闭该功能，使得车辆驾驶者能够根据自己的驾驶习惯和路况随时调节最低的启动检测速度，避免预定的检测速度和间距引起的不必要的警报。

本发明具有当一移动体以高速向本发明接近时，当移动体超出所设定的安全距离和／或速度对应值时，本发明可向车辆本身发出警示，以提早做好闪躲的准备，并向该移动体发出声光音效的警示，以通知该移动体减缓速度并拉大安全间距。

当移动体以高速向本发明后方接近时，若移动体超出所设定的安全距离和／或速度对应值时，本发明可向车辆本身发出警示，以提早做好闪躲的准备。并向该移动体发出声光音效的警示，以通知该移动体减缓速度并拉大安全间距。

附图说明

图一为本发明实施例的结构图，

图二为本发明实施例微处理器的控制流程图，

图三为本发明实施例接收中断的控制流程图，

图四为本发明实施例回波检测信号接收中断的控制流程图，

图五为本发明实施例时间中断的控制流程图，

图六为本发明实施例发射时间中断的控制流程图。

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图中，10 为 12V 汽车蓄电池，11 为电源转换电路，12 为微波天线，13 为超高频振荡电路，14 为前置放大器一，15 为功率放大器，16 为电子开关一，17 为电子开关二，18 为前置放大器二，19 为放大器一，20 为带通放大器，21 为放大器二，22 为检波电路，23 为 A/D 类比数码转换器，24 为电子开关三，25 为反馈电路，26 为蜂鸣器的驱动电路，27 为蜂鸣器，28 为车速信号源，29 为引擎启动检测电路，30 为微处理器，31 为键盘。

图一所示，电源转换电路 11 将汽车蓄电池的 12V 输出电压转换为 5V，并输出至上述的电路和微处理器 30。

电子开关一 16、功率放大器 15、前置放大器一 14、超高频振荡电路 13 构成微波发射电路；电子开关二 17、前置放大器二 18、放大器一 19、带通放大器 20、放大器二 21、检波电路 22、A/D 转换器 23 和电子开关三 24 构成检波电路。

当与微处理器 30 相连接的引擎启动电路 29 输入给微处理器 30 引擎启动信号后，微处理器 30 就会检测与之连接的车速信号源 28，检测到车速信号源 28 的车速等于或高于最低启动本发明的车辆速度时，微处理器 30 会指令超高频振荡电路 13 产生 24.125GHz 的固定频率，经过前置放大器一 14，作信号载波后输出至功率放大器 15，功率放大器 15 将功率放大后输出至电子开关一 16，同时，微处理器命令电子开关一 16 打开，通过微波天线 12 将微波信号发射出去；电子开关一 16 打开的同时，电子开关二 17、电子开关三 24 在微处理器 30 的指令下关闭。

最低启动本发明的车辆速度可以在微处理器内预先设定，也可以通过与微处理器相连接的键盘 31 输入。

微波信号发射出去的同时，微处理器 30 内的计时器归零重新计时，并指令关闭电子开关一 16，同时停止超高频振荡电路 13 的运作及打开电子开关二 17 和电子开关三 24，准备接收发射波碰到障碍物而产生的回波检测信号。

当微波天线 12 接收到回波检测信号，经过电子开关二 17、前置放大器二 18、将小信号放大后输出至放大器一 19，放大器一 19 将信号再放大，同时放大器一 19 又受反馈电路 25 控制，作回授信号补偿后输出至带通放大器 20，带通放大器 20 设定只放大且通过频率为 24.125GHz±3db 的信号，并输出至放大器二 21，放大器二 21 为可调整灵敏度的放大器，它将信号放大后，输出至检波电路 22，检波电路 22 将 24.125GHz 的混波信号过滤，只剩下所需要的低频回波信号通过，再将这些信号输入到 A/D 转换器 23，然后通过电子开关三 24 输入到微处理器 30 作运算处理。

微处理器接收到回波信号后，立即停止计时器的时间，再以接收到回波检测信号的时间总和，计算并转换成车辆与障碍物之间的距离，并以车辆的车速信号源 28 的实际速度为计算基础，计算、比较车辆与对应移动物所应保持的距离，如果检测到的距离小于或者等于所应保持的距离，则微处理器 30 输出信号，指令蜂鸣器的驱动电路输出音频信号，使蜂鸣器发出声音警示。

图二所示，微处理器 30 设定本发明的中断周期，中断周期可以预先设定，然后检测车速，当车速达到预定的最低值时，微处理器 30 就会产生相应的旗标符号，检测到该符号，微处理器 30 才指令微波发射电路发射微波信号，发射后马上计时，并检测是否接收到回波信号，检测电路

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中有回波信号时，微处理器 30 就会产生回波的时间旗标，并停止计时，然后将车速资料换算成为车距距离，换算回波时间成为回波距离，并验证车距是否大于等于回波距离，大于等于就启动蜂鸣器，提供警示，警示后取消发射波旗标和接收回波旗标，重新开始检测发射波旗标；没有回波信号时间旗标，就检测是否有回波信号逾时旗标，有就取消旗标，重新开始检测发射波旗标。

图三所示，微处理器 30 先读取车速资料，读取完成后，换算车速资料成为移动速度，确定移动速度是否大于设定的最低速度，大于，则设定车速旗标，以使微处理器启动本发明，移动速度低于设定速度时，清除车速旗标，车速接收完成，如果读取资料没有完成，检查是否愉时，逾时也清除车速旗标，不逾时则重新读取车速资料。

图四所示，回波检测信号接收中断是微处理器先检测是否有传送发射波旗标，有则读取回波时间，读取完成后设定接收回波旗标，中断过程结束，没有则确认读取是否逾时，有逾时就清除接收回波时间旗标，没有逾时就重新读取回波时间。

图五所示，微处理器的时间中断控制过程为：先检测引擎是否启动，确认引擎启动再检测是否有车速旗标，有车速旗标，关闭车速及回波检测信号中断条件，引擎没有启动或没有车速旗标就直接取消传送发射波旗标，过程结束；关闭车速及回波检测信号中断条件后，关闭电子开关二、电子开关三，打开电子开关一，传送发射检测信号及清除回波时间，然后打开电子开关二、电子开关三，关闭电子开关一，启动车速及回波检测信号中断条件，再设定传送发射波旗标及发射时间中断周期，整个过程结束。

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图六所示，微处理器控制发射时间中断的流程为：先设定回波信号逾时旗标，然后取消传送发射波旗标，过程结束。

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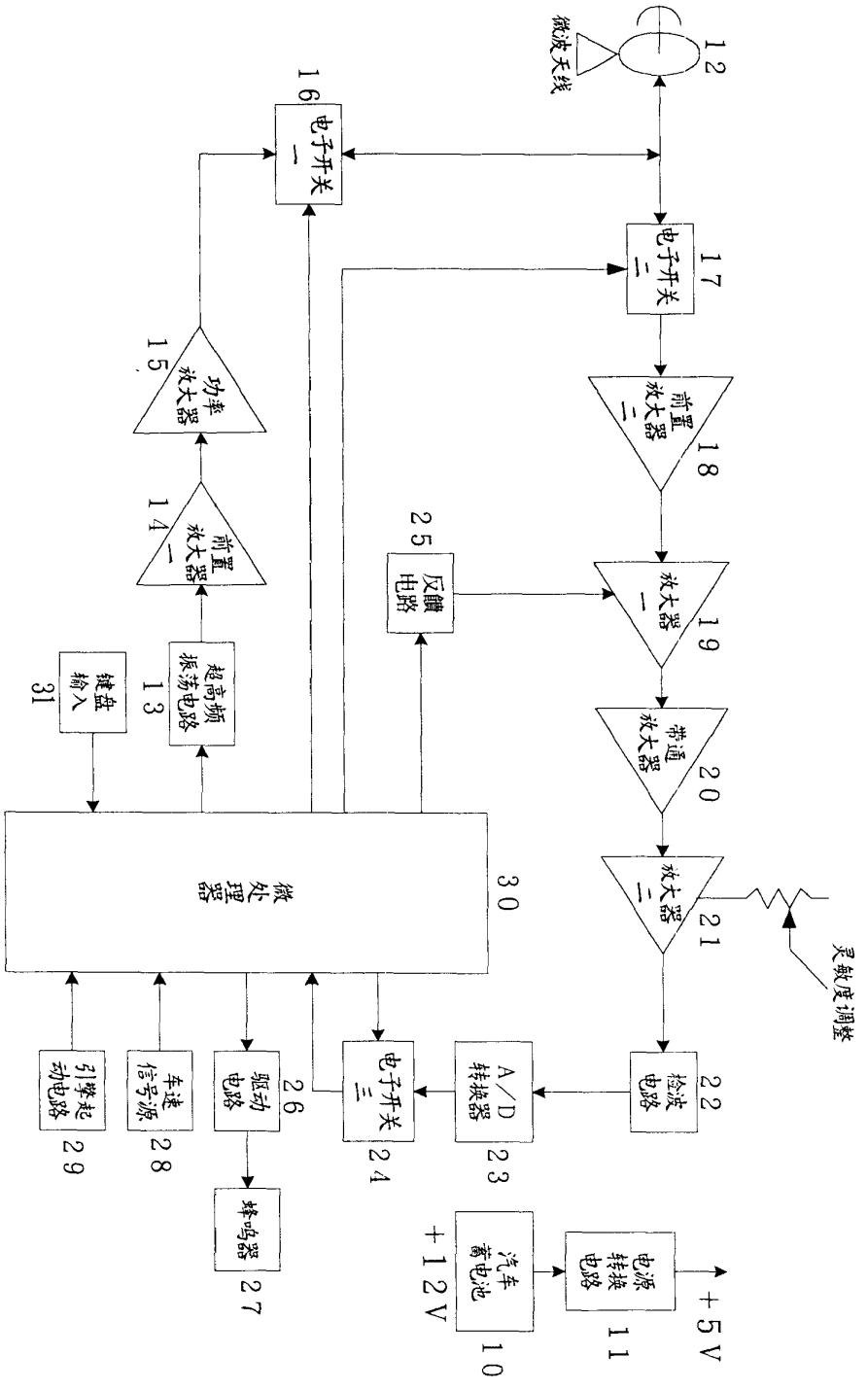

12
微波天线
16
电子开关一
17
电子开关二
18
前置放大器二
19
放大器一
20
带通放大器
21
放大器三
灵敏度调整
22
检波电路
23
A/D转换器
24
电子开关三
25
反馈电路
15
功率放大器
14
前置放大器一
13
超高频振荡电路
31
键盘输入
30
微处理器
26
驱动电路
27
蜂鸣器
28
车速信号源
29
引擎起动电路
10
汽车蓄电池 +12V
11
电源转换电路
+5V

图 1

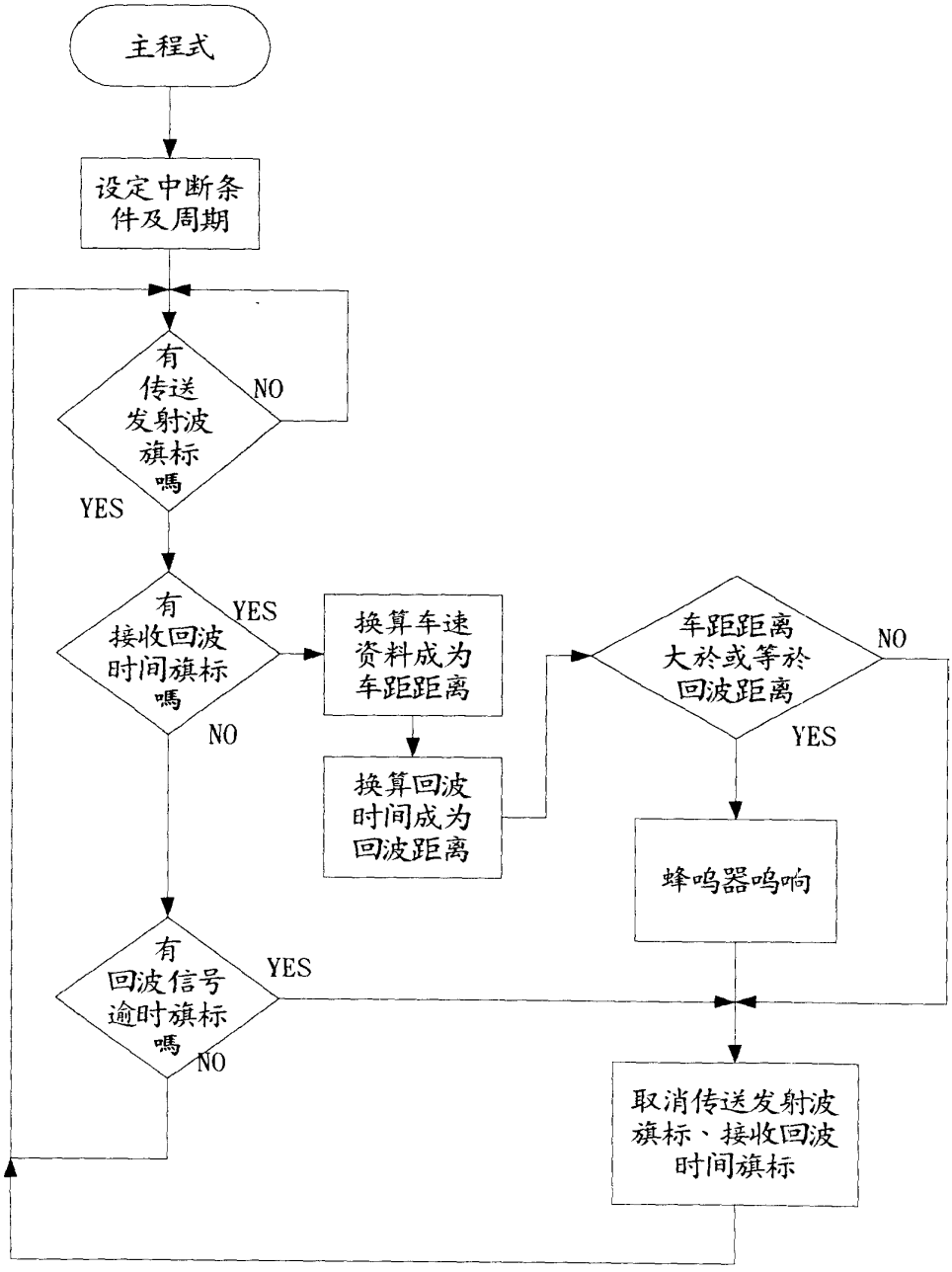

主程式
设定中断条件及周期
有传送发射波旗标嗎
NO
YES
有接收回波时间旗标嗎
YES
NO
換算车速资料成为车距距离
換算回波时间成为回波距离
车距距离大於或等於回波距离
NO
YES
蜂鸣器鸣响
有回波信号逾时旗标嗎
YES
NO
取消传送发射波旗标、接收回波时间旗标

图 2

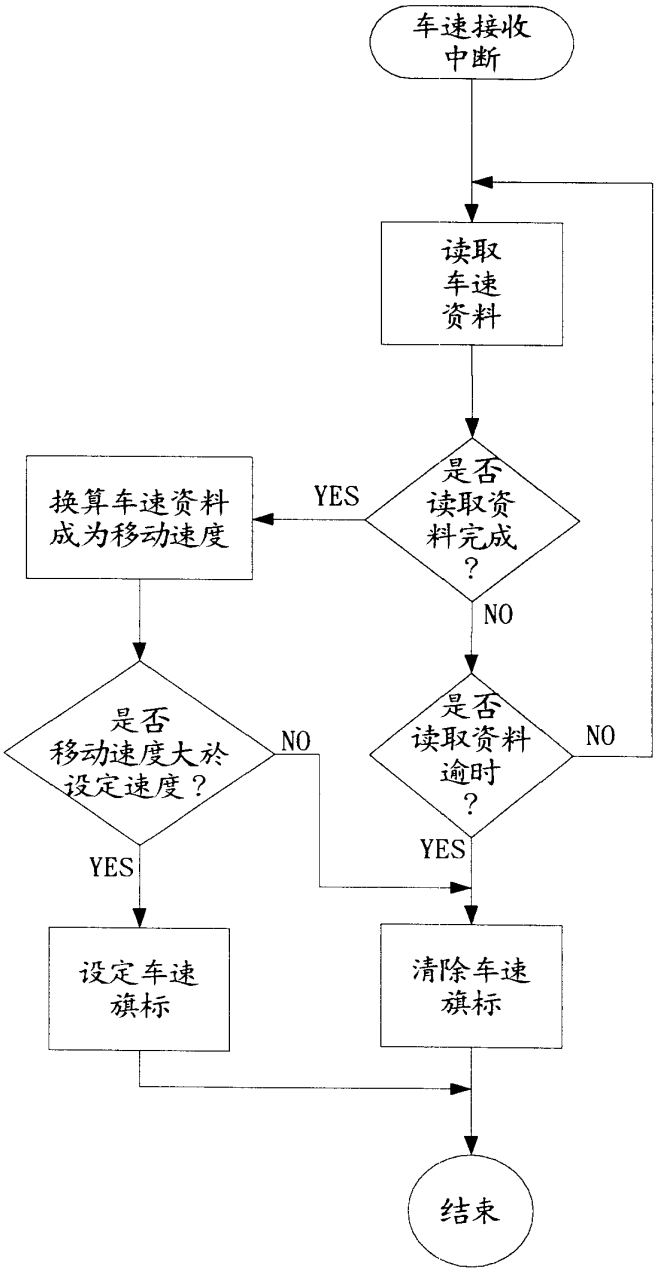

车速接收
中断
读取
车速
资料
是否
读取资
料完成
？
YES
换算车速资料
成为移动速度
NO
是否
读取资料
逾时
？
NO
是否
移动速度大於
设定速度？
NO
YES
YES
设定车速
旗标
清除车速
旗标
结束

图 3

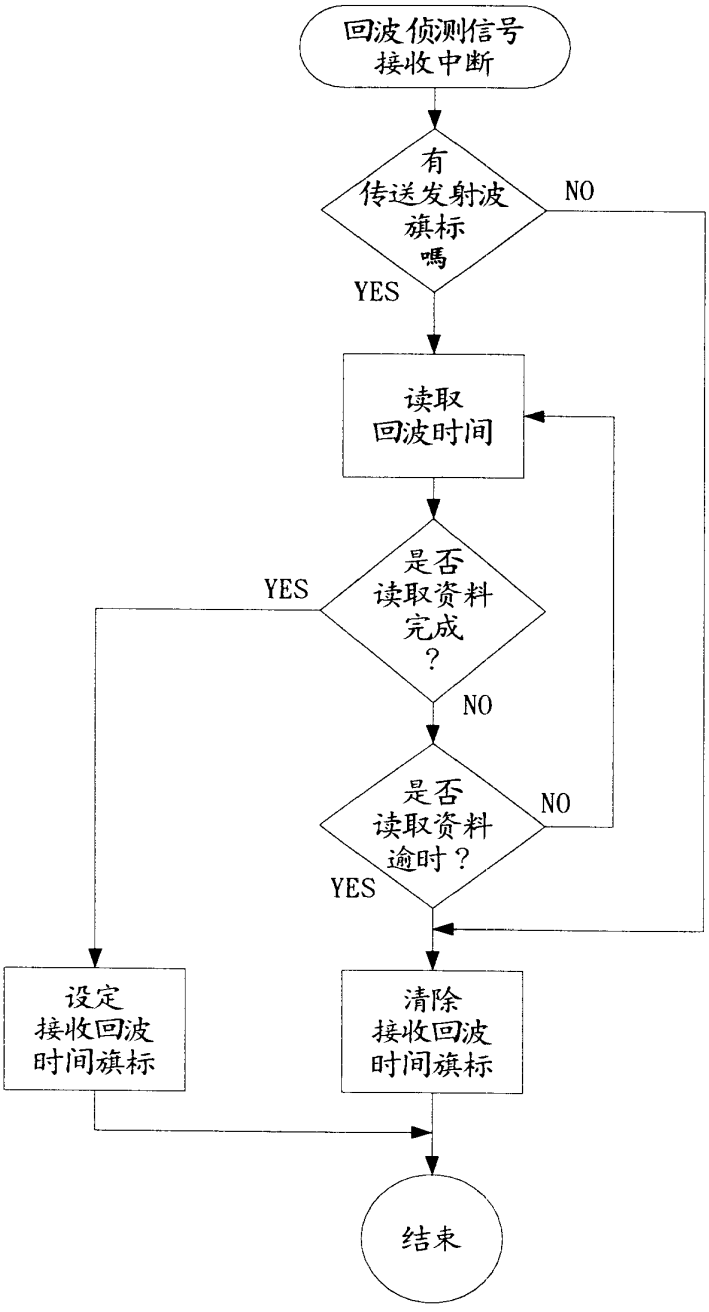


图 4

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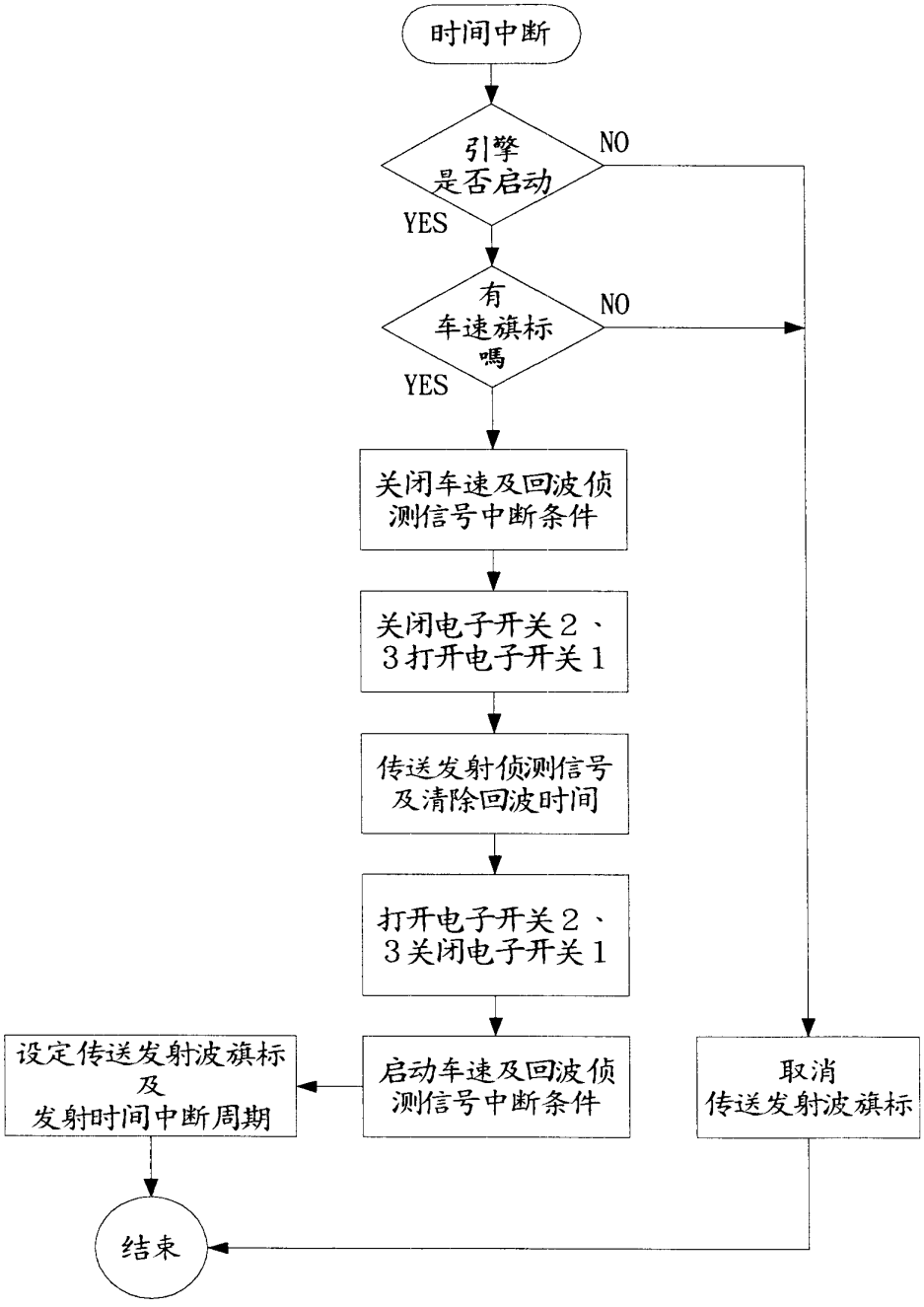


图 5

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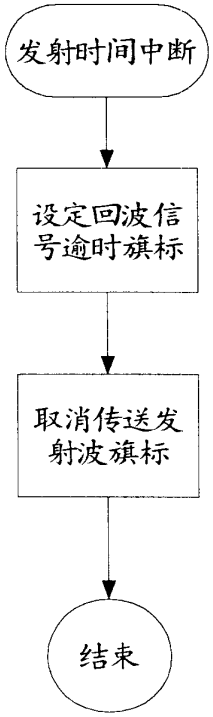


图 6

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Espacenet

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Automobile intelligent anticollision system

Inventor(s): WU FUPEI [CN]; LI SHENGPING [CN] ± (FUPEI WU, ; SHENGPING LI, ; FUPEI,LI WU)

Applicant(s): UNIV SHANTOU [CN] ± (SHANTOU UNIV)

Classification: **- international:** ***B60R21/00; B60T7/12;*** (IPC1-7): B60R21/00; B60T7/12

- cooperative:

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Abstract of CN1676375 (A)

The present invention discloses an intelligent collision resisting system. Said system is formed from distance-measuring device, chip microprocessor, alarm subsystem and automatic brake device. Said invention is an all-weather traffic intelligent collision avoidance system applicable to general road condition.

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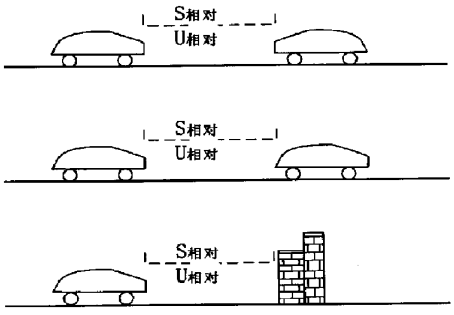
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权利要求书 1 页 说明书 6 页 附图 2 页

[54] 发明名称 一种汽车智能防撞系统

[57] 摘要

本发明公开的一种汽车智能防撞系统，由测距装置、单片机、报警子系统、自动刹车装置组成。该系统可依据实时测得的距离和相对速度自行推断行车是否安全，并在危险突发的情况下需急速刹车以保安全时可自动进行刹车，是一种全天候、适用于普遍路况的交通智能防撞系统，所用到的技术设施简单，可靠性高，且造价低，易推广。



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1、一种汽车智能防撞系统，由测距装置、单片机、报警子系统、自动刹车装置组成，其特征在于：测距装置发射激光脉冲信号，单片机根据激光脉冲信号的发射与接收时间顺序实时地测出行车与前方机车或障碍物的相对距离和相对速度，并将所得的相对距离与安全行车所要求的安全距离相比较来判断行车是否处于安全行驶状态，当安全距离小于安全行车距离时，单片机发出指令给报警子系统提示司机，处于极度危险状态时，单片机直接将指令传给自动刹车装置，由自动刹车装置进行自动刹车。

2、根据权利要求 1 所述的汽车智能防撞系统，其特征在于：该系统由信号发生器 IC1 产生的信号，经编码器 IC2，功率放大器 IC3，红外发射二极管 D1 发射探测信号，由红外接收二极管 D2、IC4、电阻、电容组成的信号接收放大器 M 接收反射回的探测信号，经解码器 IC5 解码，由检测器 IC6 检测，并将实时检测到的信号传输到单片机 89C51 中，单片机 89C51 按设定好的程序推算出本车与前方机车或障碍物的相对距离 $s_{i相对}$ 和相对速度 $u_{i相对}$，将 $s_{i相对}$ 与事先内置于单片机 89C51 的安全行车函数 $s=f(u)$ 算出的 $s_{安全}=f(u_{i相对})$ 相比较，依据程序设定的逻辑，单片机 89C51 推断行车的安全情况，单片机 89C51 的输出一路信号与光电报警电路 IC10 连接，驱动光报警器 F、声报警器 G 报警；单片机 89C51 输出另一路信号与刹车电路 IC11 连接，控制刹车装置 D 刹车。

一种汽车智能防撞系统

所属技术领域

本发明涉及一种汽车智能防撞系统，属于汽车安全行驶领域、特别是涉及汽车行驶过程中自动避免与前方机车或障碍物相撞的一种智能防撞系统。

背景技术

汽车的安全行驶是大众日益关心的问题，一旦发生事故，其后果所造成的损失是难以估量的。然而在我国乃至全球因司机疏忽、疲劳、酒后开车或司机在紧急时刻反应不及，未能采取紧急刹车措施等情况所造成的车与车相撞、车与障碍物相撞的事件却时有发生。据官方统计，自二战后至今，因交通事故造成的人员伤亡不少于20世纪两次世界大战伤亡人员的总和。鉴于此，目前已有不少关于保证汽车安全行驶的技术，但能推广应用的不多，主要是这些技术还存在诸多待解的问题。如申请号为00101549.4的中国专利，介绍一种“高速公路上的汽车防撞报警装置”，该装置面对的是于高速公路行驶的车辆，且只能显示前方车辆的距离并为司机提供可能的报警，却无法应对突发情况下，司机来不及操作的车车相撞。申请号为02100762.4的中国专利，介绍一种 “智能化数字标尺高速公路汽车防撞系统”，该系统主要解决的是高速公路或类似场合避免汽车尾追的一种防撞，它要求在行驶路上每隔一定距离设无线收发数字标尺装

置，每一数字标尺设唯一的地址码，用以确定汽车的位置；而在垂直路面的方向上每间隔一段距离装红外或微波测距传感器，判断相应车道、进行数字通信和信号处理，它的应用要求对现有的公路进行大规模的改造，这决定了该系统难以推广应用。还有申请号为 02276471.2 的中国专利，介绍一种“红外激光全自动汽车防撞装置”，该装置的适用范围稍广，但在判断是否与前方机车或障碍物相撞的可能性时，它考虑的是以自身车辆的车速来评定行车的安全距离，没有考虑到两车相向行驶时其相对速度要大于自身的车速，此时相应的安全行车、刹车距离比只考虑自身车速而确定的安全行车、刹车距离要大得多。当然，亦有采用气囊保护、防护操作管装置等来保证行车安全的，但这些装置都是有碰撞发生之后才起作用，属于事后控制，只可以减缓碰撞所造成的损伤，而无法事先避免可能发生的碰撞。所以，现有的汽车自动防撞装置距离实际应用效果还不理想，还需要进行改进。

发明内容

本发明正是针对现有技术存在的问题而提出的一种汽车智能防撞系统。该系统可依据实时测得的距离和相对速度自行推断行车是否安全，并在危险突发情况下需急速刹车以保安全时可自动进行刹车。

一种汽车智能防撞系统，由测距装置、单片机、报警子系统、自动刹车装置组成，测距装置发射激光脉冲信号，单片机根据激光脉冲信号的发射与接收时间顺序实时地测出行车与前方机车或障碍物的相对距离和相对速度，并将所得的相对距离与安全行车所要求的安全距离相比较来判断行车是否处于安全行驶状态，当安全距离小于安全行车距离时，单片机发

出指令给报警子系统提示司机、或处于极度危险状态时，单片机直接将指令传给自动刹车装置，由自动刹车装置进行自动刹车。

本发明技术方案包括：由信号发生器 IC1 门生的信号，经编码器 IC2，功率放大器 IC3，红外发射二极管 D1 发射探测信号，由红外接收二极管 D2、IC4、电阻、电容组成的信号接收放大器 M 接收反射回的探测信号，经解码器 IC5 解码，由检测器 IC6 检测，并将实时检测到的信号传输到单片机 89C51 中，单片机 89C51 按设定好的程序推算出本车与前方机车或障碍物的相对距离 $s_{i相对}$ 和相对速度 $u_{i相对}$，将 $s_{i相对}$ 与事先内置于单片机 89C51 的安全行车函数 $s=f(u)$ 算出的 $s_{安全}=f(u_{i相对})$ 相比较，依据程序设定的逻辑，单片机 89C51 推断行车的安全情况，单片机 89C51 的输出一路信号与光电报警电路 IC10 连接，驱动光报警器 F、声报警器 G 报警；单片机 89C51 输出另一路信号与刹车电路 IC11 连接，控制刹车装置 D 刹车。

附图说明

下面结合附图和实施例对本实用新型进一步说明。

图 1 为本发明汽车行驶测距示意图；

图 2 为本发明电路输出控制图；

图 3 为本发明电路原理图。

图中：1、测距装置，2、4 红外激光发射器，3、红外激光接收器，5、单片机，6、自动刹车装置，7、报警器，8、10 灯光闪动，9、报警音。

具体实施方式

汽车在任一速度 u（u 为汽车相对于地面的速度）下行驶时都有一对应的安全刹车距离 s，即有 $s=f(u)$。这一数据关系由汽车生产企业提供。

Ex. 1002 - Page 225

假设汽车与前方机车或障碍物的距离为$s_{相对}$，相对速度为$u_{相对}$。如图一所示。若两车同向行驶，一般有$u_{相对} \le u$，则$f(u_{相对}) \le f(u)$；若两车相向行驶，有$u_{相对} \ge u$，则有$f(u_{相对}) \ge f(u)$，因此选用相对速度$u_{相对}$来确定安全刹车距离比选用汽车本身的车速u来确定安全刹车距离要合理、也保险得多。若汽车以$u_{相对}$行驶时的安全刹车距离为$s_{安全}$，即$s_{安全}=f(u_{相对})$（此时相当于假定前言机车或障碍物静止），为保证汽车的安全，应满足：

如果 1： $s_{相对} \ge s_{安全}$ 正常行驶；

如果 2： $s_{相对} \le s_{安全}$ 紧急刹车否则危险。

但为了降低紧急刹车给车内人员带来的不适，建议在刹车阶段提供两种选择：人工制动和自动制动。

当$s_{安全} < s_{相对} \le \lambda \cdot s_{安全}$，$\lambda > 1$，报警提示司机进行人工刹车；当$s_{相对} \le s_{安全}$，人工刹车已来不及，此时由自动制动装置实行紧急刹车。

因此本汽车智能防撞系统处理以下三种情况：

对于： $u_{相对}$、$s_{相对}$，

如果 1： $s_{相对} \ge \lambda \cdot s_{安全}$ 正常行驶；

如果 2： $s_{安全} < s_{相对} \le \lambda \cdot s_{安全}$， $\lambda > 1$ 报警、人工制动；

如果 3： $s_{相对} \le s_{安全}$ 自动制动装置紧急刹车。

下面结合附图对本发明的实施作详细描述。

图 1 为行车遇到的三种情况：两车相向行驶、两车同向行驶、行车前方有障碍物。如图 2 所示，测距装置 1 由红外激光发射器 2、4，红外激光接收器 3 等组成。红外激光发射器 2、4 周期性地向汽车前方发射脉冲

信号，该信号遇到障碍立即反射回来，由红外激光接收器 3 接收。假设红外激光信号的发射周期为 T，传播速度为$u_{信}$。单片机 5 依据第 i 个周期信号从发射到回收所经历的时间为t_{is}算得本车与前方机车或障碍物的相对距离：$s_{i相对}=u_{信}\cdot t_{is}/2$，再依据测得的相邻两次距离：$s_{i-1相对}$、$s_{i相对}$算得本车与前方机车或障碍物的相对速度为：$u_{i相对}=(s_{i-1相对}-s_{i相对})/T$，其中 i 为自然数。将实时测得的$s_{i相对}$与事先内置于单片机 5 的安全行车函数$s=f(u)$算出的$s_{安全}=f(u_{i相对})$相比较，依据程序设定的逻辑，单片机 5 自行推断行车的安全情况。若$s_{相对}\geq\lambda\cdot s_{安全}$，说明汽车处于安全行驶状态；若$s_{安全}<s_{相对}\leq\lambda\cdot s_{安全}$，$\lambda>1$，说明汽车处于危险行驶状态，此时单片机 5 发出报警指令，报警器 7 便发出报警信号：灯光闪动 8、10 和报警音 9，提示司机避免安全事故；若$s_{相对}\leq s_{安全}$，此时提示司机进行人为刹车已来不及，单片机 5 会立即将指令传到自动刹车装置 6，进行自动刹车，避免发生撞车事故。其中自动刹车装置 6 是通过添加诱发性的自动制动装置共用本车原有的制动系统。

图 3 是本发明的电路实施例图。如图 3 所示，由信号发生器 IC1 门生的信号，经编码器 IC2，功率放大器 IC3，红外发射二极管 D1 发射探测信号。由红外接收二极管 D2、IC4、电阻、电容组成的信号接收放大器 M 接收反射回的探测信号，经解码器 IC5 解码，由检测器 IC6 检测，并将实时检测到的信号传输到单片机 89C51 中，单片机 89C51 按设定好的程序推算出本车与前方机车或障碍物的相对距离$s_{i相对}$和相对速度$u_{i相对}$，将$s_{i相对}$与事先内置于单片机 89C51 的安全行车函数$s=f(u)$算出的$s_{安全}=f(u_{i相对})$相比较，依据程序设定的逻辑，单片机 89C51 推断行车的安全情况。若

推断出汽车处于危险行驶状态，则单片机 89C51 将报警信号发给光电报警电路 IC10，光报警器 F、声报警器 G 报警；若推断出汽车处于极其危险的行驶状态，则单片机 89C51 将紧急刹车信号传给刹车电路 IC11，控制刹车装置 D 刹车。稳压电源 IC7、复位电路 IC8、时钟电路 IC9 与单片机 89C51 相接。

本发明可依据实时测得的距离和相对速度自行推断行车是否安全，并在危险突发情况下需急速刹车以保安全时可自动进行刹车，是一种全天候、适用于普遍路况的交通智能防撞系统，所用到的技术设施简单，可靠性高，且造价低，易推广。

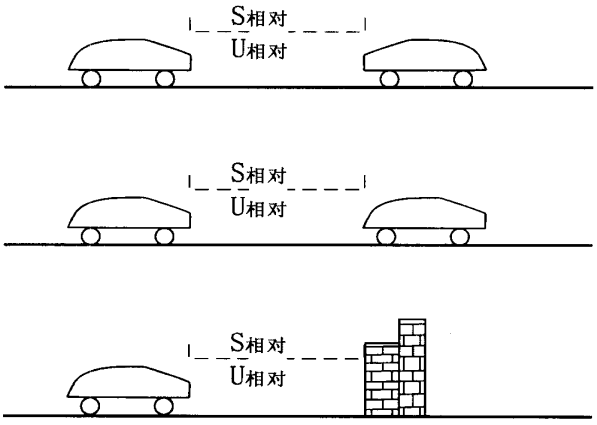


图1

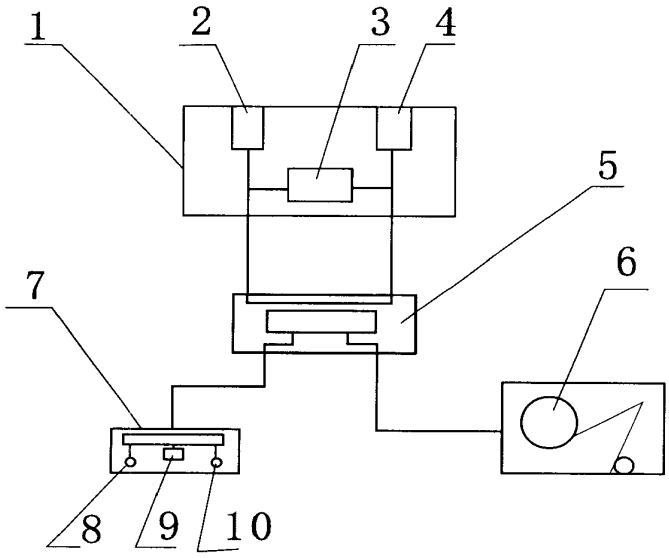


图2

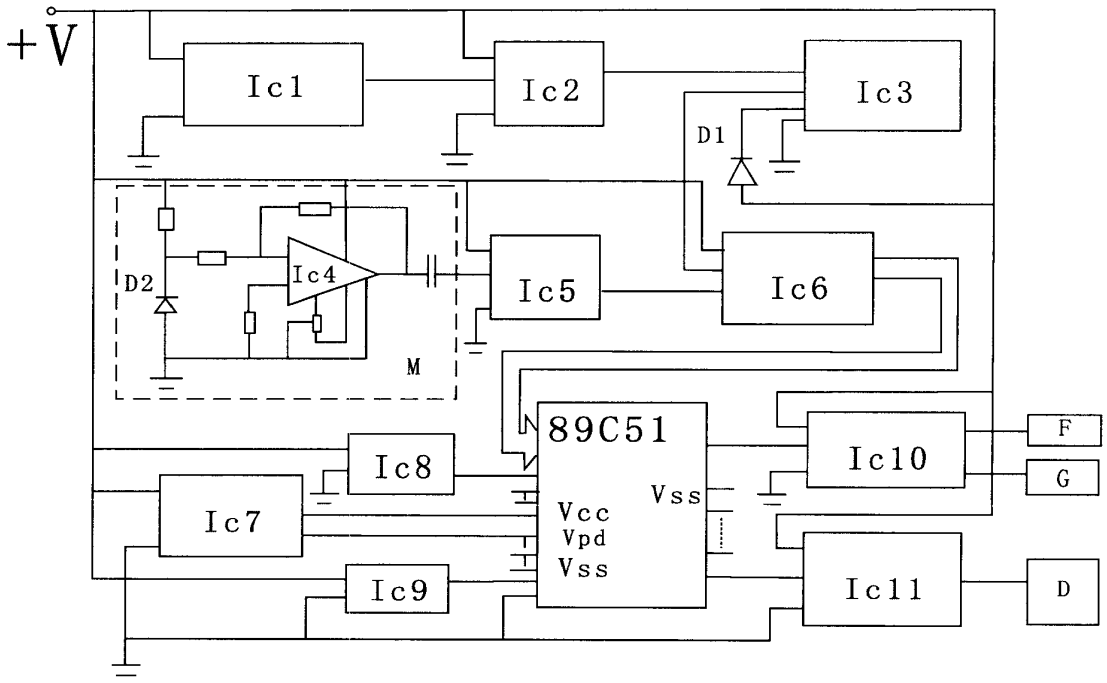

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Ic5
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M
89C51
Vcc
Vpd
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Vss
Ic8
Ic7
Ic9
Ic10
Ic11
F
G
D

图3

Espacenet

Bibliographic data: CN102923158 (A) — 2013-02-13

Rail train emergency braking safety system

Inventor(s): CHEN GENGTIAN ± (CHEN GENGTIAN)

Applicant(s): CHEN GENGTIAN ± (CHEN GENGTIAN)

Classification: **- international:** ***B60T17/22; B61D25/00; B61H7/04; E05F15/692***

- cooperative:

Application number: CN20111230439 20110812 Global Dossier

Priority number(s): CN20111230439 20110812

Abstract of CN102923158 (A)

A rail train emergency braking safety system can issue a safety warning in emergency braking, is slow to brake and free from derailing, can automatically open all windows in necessary and can open more passages for life-saving and rescuing; and the rail train emergency braking safety system is characterized by consisting a main control system and five subsystems such as a brake warning system, a window automatic opening system, a derailing prevention device, an auxiliary acceleration device and a stable brake control system; the main control system consists of voltage E, a brake switch S, a time circuit IC1, an alarming circuit controller K1, a brake distribution circuit HC2, a deceleration umbrella controller K2, a window controller K3 and corresponding devices; and the time circuit IC1 is respectively connected with the alarming controller K1, the brake distribution circuit IC2, the deceleration umbrella controller K3 and the window automatic controller.

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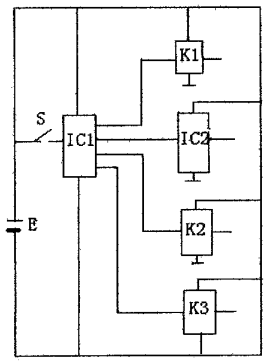
权利要求书 1 页 说明书 3 页 附图 1 页

(54)发明名称

轨道列车紧急制动安全系统

(57)摘要

一种轨道列车紧急制动安全系统，能够在紧急制动时发出避险预警，平缓制动，不会脱轨，能够在需要时自动打开全部车窗，给逃生和救援打开更多通道；特征在于：由一个总控系统和制动预警，车窗自动控制，防脱轨装置，附加减速装置，平稳制动控制系统五个分系统组成；其中总控系统由电压E，制动开关S，时间电路IC1，报警电路控制器K1，制动分配电路HC2，减速伞控制器K2，车窗控制器K3及相应的元器件组成；时间电路IC1的各路分别与报警控制器K1，制动分配电路IC2，减速伞控制器K3，车窗自动控制器K4连接。



CN 102923158 A

1. 轨道列车紧急制动安全系统的特征在于：由一个总控系统和制动预警，车窗自动控制，防脱轨装置，附加减速装置，平稳制动控制系统五个分系统组成。

2. 权利要求 1 所述的总控系统的特征在于：由电压 E，制动开关 S，时间电路 IC1，报警电路控制器 K1，制动分配电路 HC2，减速伞控制器 K2，车窗控制器 K3 及相应的元器件组成；电源 E 取自车载电源，其正负极分别与各电路器件的正负极对应连接，正极又通过开关 S 与 IC1 的触发端连接，时间电路 IC1 的 1 路输出与报警控制器 K1 的触发端连接，2 路输出与制动分配电路 IC2 的触发端连接，IC2 的输出与制动系统连接，3 路输出与减速伞控制器 K3 的控制端连接，4 路输出与车窗自动控制器 K4 连接；其中制动开关 S 接通后 1 路立即输出制动报警指令，二路适当延时输出制动指令，3 路再延时输出打开减速伞指令，列车停止后，4 路输出打开车窗指令。

3. 权利要求 1 所述的制动预警分系统的特征在于：是安装在各车厢的报警器，受控于 K1。

4. 权利要求 1 所述的附加减速装置的特征在于：是安装在车厢外的减速伞，受控于 K2，权利要求 1 所述的。

5. 权利要求 1 所述的所述的平稳制动控制系统的特征在于：是列车的制动系统，受控于 IC2，又 IC2 对制动力进行控制分配，避免突然制动。

6. 权利要求 1 所述的防脱轨分系统的特征在于：由防脱轨挂钩 (2) 紧固螺栓 (3) 组成；防脱轨挂钩 (2) 的上端扣在列车的底盘大梁 (1) 上，下端扣在轨道 (4) 上，并预留适量的间隙，以便行驶或转弯时不与轨道摩擦，然后用紧固螺栓 (3) 紧固，为增强抗拉力，挂钩 (2) 的两侧可以背加强筋，每节车厢安装数量根据需要确定。

7. 权利要求 1 所述的车窗自动控制分系统的特征在于：由车窗和控制装置两部分组成，车窗部分由玻璃 (5)，密封圈 (6)，扳手 (7)，合页 (9) 组成，密封圈 (6) 套在玻璃 (5) 外周，对车窗和窗口进行密封，用合页 (9) 对车窗和窗口进行连接，扳手 (7) 通过紧固件与车窗边沿连接，并可转动，将车窗关上，向内拉扳手，并转动使其卡在窗口上，使车窗压紧固定；控制部分由动力装置 M，电器开关 K3，拨叉 (1)，限位开关 (2)，牵引绳 (3)，滚轮 (4)，牵引件 (8) 组成；开关 K 的输出与动力装置 M 的线圈连接，M 通过拉线与拨叉 (1) 的主动臂连接，滚轮 (4) 固定在牵引绳 (3) 上，位置靠近卡紧车窗的拉手 (7) 旁边，牵引绳 (3) 的另一端与牵引件 (8) 的一端连接，牵引件 (8) 的另一端通过转轴固定在车后端的车窗旁；动力装置 M，开关 K3，固定在车前端的车窗旁，拨叉 (1) 通过转轴固定在合适位置，限位开关 (2) 固定在拨叉 (1) 旁，其输出与开关 K3 的控制端连接；遇到紧急情况，需要从车窗逃生，只要按一下开关 K，动力装置 M 便会通过拨叉 (1) 拉动牵引绳 (3)，并通过滚轮 (4) 带动扳手 (7) 转动，使车窗全部打开，也可手动转动扳手打开车窗。

轨道列车紧急制动安全系统

[0001] 技术领域：本发明涉及一种轨道列车制动系统，尤其是一种轨道列车紧急制动安全系统

[0002] 背景技术：现有的轨道列车制动系统存在着五方面不足，分别是：制动时，仅靠车轮与轨道几乎是点接触的滑动摩擦力克服巨大的惯力进行制动，导致制动距离很长，增大了碰撞风险；没有防脱轨装置，增加了脱轨而导致旅客二次伤害的危险；没有制动预警系统，使旅客来不及采取防范措施，巨大的惯力会将旅客向前进方向抛出，导致旅客被伤害；突然制动使车内的物品被巨大的惯力抛落，导致旅客被砸伤；车窗没有逃生自动控制装置，旅客无法从车窗逃生，救援人员也不能从车窗进入施救，导致伤害进一步扩大；总结 7.23 中国温州特大列车追尾事故更暴露了原制动系统的不足，如果具备了提前预警装置，旅客及时采取防范措施，就不会伤亡的那么惨；如果有防脱轨装置，后车就不会把前车压扁两节车厢后又摔到桥下，导致被压的车厢内的大量旅客伤亡，也不会使摔到桥下的旅客受到二次伤害。

[0003] 发明内容：为了解决上述问题，本发明提供了一种轨道列车紧急制动安全系统，能够在紧急制动时对旅客发出避险预警，科学分配制动力，将突然制动变为平缓制动，缩短制动距离或虽然制动距离没有缩短，但制动变得更为平缓，即使发生撞击，也不会脱轨，大幅度降低紧急制动造成的伤害和损失，能够在需要时自动打开全部车窗，给逃生和救援打开更多通道；从而大幅度降紧急制动所造成的损失；实现上述发明所采取的技术方案特征在于：由一个总控系统和制动预警，车窗自动控制，防脱轨装置，附加减速装置，平稳制动控制系统五个分系统组成；其中总控系统由电压 E，制动开关 S，时间电路 IC1，报警电路控制器 K1，制动分配电路 HC2，减速伞控制器 K2，车窗控制器 K3 及相应的元器件组成；电源 E 取自车载电源，其正负极分别与各电路器件的正负极对应连接，正极又通过开关 S 与 IC1 的触发端连接，时间电路 IC1 的 1 路输出与报警控制器 K1 的触发端连接，2 路输出与制动分配电路 IC2 的触发端连接，IC2 的输出与制动系统连接，3 路输出与减速伞控制器 K3 的控制端连接，4 路输出与车窗自动控制器 K4 连接；其中制动开关 S 接通后 1 路立即输出制动报警指令，二路适当延时输出制动指令，3 路再延时输出打开减速伞指令，列车停止后，4 路输出打开车窗指令；所述的制动预警分系统是安装在各车厢的报警器，受控于 K1；所述的附加减速装置是安装在车厢外的减速伞，受控于 K2，所述的平稳制动控制系统是列车的制动系统，受控于 IC2，又 IC2 对制动力进行控制分配，避免突然制动；所述的防脱轨分系统由防脱轨挂钩 (2) 紧固螺栓 (3) 组成；防脱轨挂钩 (2) 的上端扣在列车的底盘大梁 (1) 上，下端扣在轨道 (4) 上，并预留适量的间隙，以使行驶或转弯时不与轨道摩擦，然后用紧固螺栓 (3) 紧固，为增强抗拉力，挂钩 (2) 的两侧可以背加强筋，每节车厢安装数量根据需要确定；所述的车窗自动控制分系统由车窗和控制装置两部分组成，车窗部分由玻璃 (5)，密封圈 (6)，扳手 (7)，合页 (9) 组成，密封圈 (6) 套在玻璃 (5) 外周，对车窗和窗口进行密封，用合页 (9) 对车窗和窗口进行连接，扳手 (7) 通过紧固件与车窗边沿连接，并可转动，将车窗关上，向内拉扳手，并转动使其卡在窗口上，使车窗压紧固定；控制部分由动力装置 M，电器开关 K3，拨叉 (1)，限位开关 (2)，牵引绳 (3)，滚轮 (4)，牵引件 (8) 组成；开关 K 的输出与动力装置

M 的线圈连接，M 通过拉线与拨叉 (1) 的主动臂连接，滚轮 (4) 固定在牵引绳 (3) 上，位置靠近卡紧车窗的拉手 (7) 旁边，牵引绳 (3) 的另一端与牵引件 (8) 的一端连接，牵引件 (8) 的另一端通过转轴固定在车后端的车窗旁；动力装置 M，开关 K3，固定在车前端的车窗旁，拨叉 (1) 通过转轴固定在合适位置，限位开关 (2) 固定在拨叉 (1) 旁，其输出与开关 K3 的控制端连接；遇到紧急情况，需要从车窗逃生，只要按一下开关 K，动力装置 M 便会通过拨叉 (1) 拉动牵引绳 (3)，并通过滚轮 (4) 带动扳手 (7) 转动，使车窗全部打开，也可手动转动扳手打开车窗，本发明的有益效果在于：可把紧急制动对乘客造成的伤害降到最低限度，下面结合附图和实施例进一步说明。

[0004] 附图 1 是总控系统原理框图

[0005] 附图 2 是防脱轨系统结构框图

[0006] 附图 3 是车窗自动控制电原理和结构图

[0007] 实施例 1. 附图 1 所示的特征在于：由电压 E，制动开关 S，时间电路 IC1，报警电路控制器 K1，制动分配电路 HC2，减速伞控制器 K2，车窗控制器 K3 及相应的元器件组成；电源 E 取自车载电源，其正负极分别与各电路器件的正负极对应连接，正极又通过开关 S 与 IC1 的触发端连接，时间电路 IC1 的 1 路输出与报警控制器 K1 的触发端连接，2 路输出与制动分配电路 IC2 的触发端连接，IC2 的输出与制动系统连接，3 路输出与减速伞控制器 K3 的控制端连接，4 路输出与车窗自动控制器 K4 连接；其中制动开关 S 接通后 1 路立即输出制动报警指令，二路适当延时输出制动指令，3 路再延时输出打开减速伞指令，列车停止后，4 路输出打开车窗指令；

[0008] 实施例 2. 所述的平稳制动控制系统是列车的制动系统，受控于 IC2，又 IC2 对制动力进行控制分配，避免突然制动；

[0009] 实施例 3. 所述的制动预警分系统的特征在于：是安装在各车厢的报警器，受控于 K1；

[0010] 实施例 4. 所述的附加减速装置是安装在车厢外的减速伞，受控于 K2，所述的平稳制动控制系统是列车的制动系统，受控于 IC2，又 IC2 对制动力进行控制分配，避免突然制动；

[0011] 实施例 5. 附图 2 所示的特征在于：由防脱轨挂钩 (2) 紧固螺栓 (3) 组成；防脱轨挂钩 (2) 的上端扣在列车的底盘大梁 (1) 上，下端扣在轨道 (4) 上，并预留适量的间隙，以便行驶或转弯时不与轨道摩擦，然后用紧固螺栓 (3) 紧固，为增强抗拉力，挂钩 (2) 的两侧可以背加强筋，每节车厢安装数量根据需要确定；

[0012] 实施例 6. 所示的特征在于：车窗自动控制分系统由车窗和控制装置两部分组成，车窗部分由玻璃 (5)，密封圈 (6)，扳手 (7)，合页 (9) 组成，密封圈 (6) 套在玻璃 (5) 外周，对车窗和窗口进行密封，用合页 (9) 对车窗和窗口进行连接，扳手 (7) 通过紧固件与车窗边沿连接，并可转动，将车窗关上，向内拉扳手，并转动使其卡在窗口上，使车窗压紧固定；控制部分由动力装置 M，电器开关 K3，拨叉 (1)，限位开关 (2)，牵引绳 (3)，滚轮 (4)，牵引件 (8) 组成；开关 K 的输出与动力装置 M 的线圈连接，M 通过拉线与拨叉 (1) 的主动臂连接，滚轮 (4) 固定在牵引绳 (3) 上，位置靠近卡紧车窗的拉手 (7) 旁边，牵引绳 (3) 的另一端与牵引件 (8) 的一端连接，牵引件 (8) 的另一端通过转轴固定在车后端的车窗旁；动力装置 M，开关 K3，固定在车前端的车窗旁，拨叉 (1) 通过转轴固定在合适位置，限位开关 (2) 固定

Ex. 1002 - Page 235

在拨叉 (1) 旁，其输出与开关 K3 的控制端连接；遇到紧急情况，需要从车窗逃生，只要按一下开关 K，动力装置 M 便会通过拨叉 (1) 拉动牵引绳 (3)，并通过滚轮 (4) 带动扳手 (7) 转动，使车窗全部打开，也可手动转动扳手打开车窗；虽然制动前先预警，增加了制动时间，但减速伞又缩短了制动时间和距离。

Ex. 1002 - Page 236

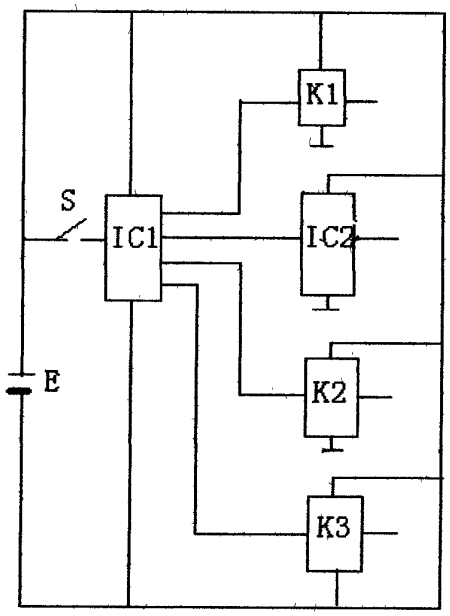


图 1

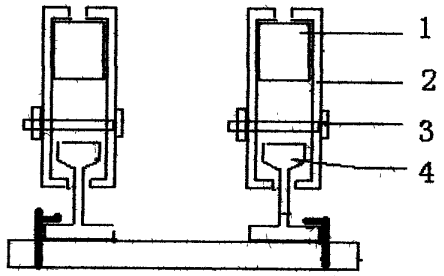


图 2

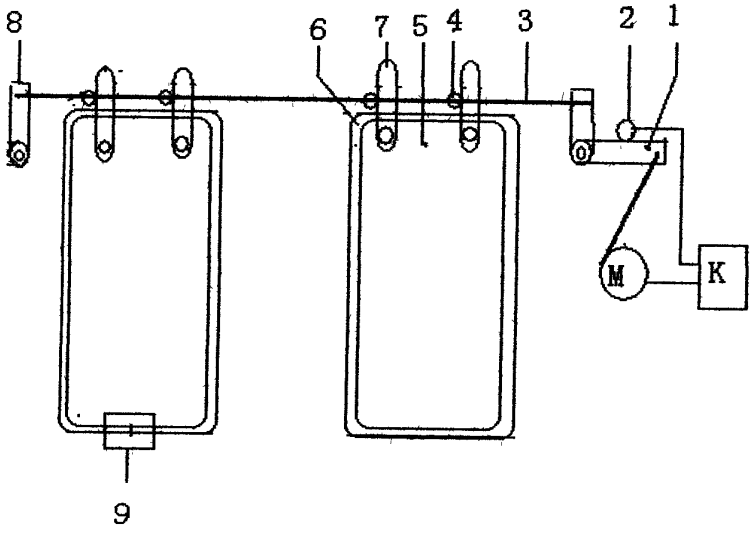


图 3

For Pros
Atty's
USPTOS

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY, LTD.
500 W. MADISON, 34TH FLOOR
CHICAGO, IL 60661

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 28 JUN 2019
Applicant's or agent's file reference 63154WO01	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US 19/20385	International filing date *(day/month/year)* 01 March 2019 (01.03.2019)
Applicant METROM RAIL, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **22 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Telephone No. PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2014)

RECEIVED
By Docket
JUL 02 2019
Action Due: Art 19 Amend / Resp to Search Report
Due Date: 8.28.19 / 1.2.20
McAndrews, Held & Malloy

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 63154WO01	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 19/20385	International filing date *(day/month/year)* 01 March 2019 (01.03.2019)	(Earliest) Priority Date *(day/month/year)* 02 March 2018 (02.03.2018)
Applicant METROM RAIL, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the drawings to be published with the abstract is Figure No. 1

   ☒ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☐ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 19/20385

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B61L 27/04 (2019.01)
CPC - B61L 27/04; B61L 15/009; B61L 15/0072

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History Document

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 2015/0329130 A1 (Metrom Rail LLC) 19 November 2015 (19.11.2015) ; entire document, especially, abstract, FIG.1,2, 4, 8,9, para [0038], [0042], [0050] - [0054], [0057], [0058], [0062], [0063], [0087], [0089], [0091], [0118], [0121], [0127], [0133], [0144], [0153],	1-11, 13-18, 20 ---------- 12, 19
Y	US 2013/0024054 A1 (Katsuta et al.) 24 January 2013 (24.01.2013); entire document, especially, abstract, para [0039]	12
Y	US 6,435,459 B1 (Sanderson et al.) 20 August 2002 (20.08.2002); entire document, especially, abstract, FIG. 1, 3B, col. 2, ln 63 ? col. 3, ln 2-10	19
A	US 2016/0221592 A1 (Solfice Research, Inc.) 04 August 2016 (04.08.2016); entire document	1-20
A	US 2016/0200327 A1 (Xi?an Shiyun Transportation Equipment Co., Ltd) 14 July 2016 (14.07.2016); entire document	1-20
P, X	US 2019/0054942 A1 (Metrom Rail, LLC) 21 February 2019 (21.02.2019); entire document , especially, FIG. 2, 3, para [0041]-[0046], [0049]-[0053], [0061]-[0069]	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 June 2019	28 JUN 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY, LTD.
500 W. MADISON, 34TH FLOOR
CHICAGO, IL 60661

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	28 JUN 2019

Applicant's or agent's file reference	FOR FURTHER ACTION
63154WO01	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 19/20385	01 March 2019 (01.03.2019)	02 March 2018 (02.03.2018)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B61L 27/04 (2019.01)
CPC - B61L 27/04; B61L 15/009; B61L 15/0072

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	02 June 2019	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2, 4, 5, 7-12, 14, 17-19	YES
	Claims	1, 3, 6, 13, 15, 16, 20	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 3, 6, 13, 15, 16 and 20 lack novelty under PCT Article 33(2) as being anticipated by US 2015/0329130 A1 to Metrom Rail LLC (hereinafter Metrom).

Regarding claim 1, Metrom discloses: A train-mounted device configured for use within a train (10, FIG. 1, para [0050] "The rail control system 2 can include a vehicle mounted control system ("VMCS") 10, which can be, for example, mounted or installed on a rail vehicle such as a train or subway car") ,
to support a decentralized train control system (para [0087] "Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network"), the train-mounted device comprising:
one or more antennas (para [0091] "For example, the reporting stations 30 and/or the VMCS 10 can include one or more antennae, receivers, transmitter, and/or transceivers that allow the reporting stations to send and receive information via Bluetooth, WiFi, radio signals, cellular signals, microwaves, infrared signals, lasers, ultrasonic signals, electromagnetic induction signals, or other modes of wireless communication"),
configured for transmitting and/or receiving wireless signals (para [0038] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system"); and
one or more circuits (para [0153] "Aspects of the techniques described herein may be implemented in digital electronic circuitry, computer software, firmware, or hardware, including the structures disclosed herein and their structural equivalents, or in various combinations ")configured to:
process signals and data (para [0051] "The reporting stations 30 can include a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to exchange data and information, and otherwise communicate with the reporting stations 30"), and
perform one or more functions relating to operations of the train-mounted device within the decentralized train control system (para [0087] "These other speed determining components (speedometer and/or wheel speed sensor) may be used together with the RFID tag scanning system. Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network");
wherein the train-mounted device is configured to, during operation of the train within a railway network that supports use of the decentralized train control system (para [0087] "These other speed determining components (speedometer and/or wheel speed sensor) may be used together with the RFID tag scanning system. Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network"):
communicate with any wayside unit (30, FIG.1),
and/or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises transmission and/or reception of ultra-wideband (UWB) based signals (para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track" and para [0038] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system") ;
processing the ultra-wideband (UWB) based signals (para [0051] "The reporting stations 30 can include a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to exchange data and information, and otherwise communicate with the reporting stations 30. For example, the reporting stations 30 can include transceivers that allow the reporting stations to send and receive information via Bluetooth, WiFi, radio signals, cellular signals, UWB, peer-to-peer networks, microwaves, infrared signals, lasers, ultrasonic signals, electromagnetic induction signals, or other modes of wireless communication"); and
generate based on the processing of the ultra-wideband (UWB) based signals, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network (para [0053] "Information from the VMCS 10 mounted on the rail vehicles can communicate with the network 50 via the reporting stations 30 such that each vehicle can be aware of the location of other vehicles traveling along the railroad, their speeds, weather conditions, railroad conditions or situations (e.g., steep grades, approaching sharp curves, rail crossings, or stations), and other information that can be useful to ensure safe and efficient rail transportation").

---See Continuation on Supplemental Page---

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Regarding claim 3, Metrom discloses the train-mounted device of claim 1.
Furthermore, Metrom discloses: wherein the train-mounted device is configured to:
assess based on the processing of the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network (para [0052] "The reporting station 30 can also communicate and exchange information with a rail network 50. For example, the reporting station can be in wireless or wired communication with a rail network 50 that manages and maintains information relating to the speed and location of the rail vehicles connected to the network 50, as well as other information about the rail tracks and present weather conditions, for example. The rail network 50 can manage and control railroads and tracks in several locations or geographical areas" and para [0053] "Information from the VMCS 10 mounted on the rail vehicles can communicate with the network 50 via the reporting stations 30 such that each vehicle can be aware of the location of other vehicles traveling along the railroad, their speeds, weather conditions, railroad conditions or situations (e.g., steep grades, approaching sharp curves, rail crossings, or stations), and other information that can be useful to ensure safe and efficient rail transportation");
when at least one condition meets one or more particular criteria, determine one or more responsive actions (para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track. The reporting stations 30 can include a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to exchange data and information, and otherwise communicate with the reporting stations 30"); and
perform or cause performing each of the one or more responsive actions (manage and control, para [0052] "The reporting station 30 can also communicate and exchange information with a rail network 50. For example, the reporting station can be in wireless or wired communication with a rail network 50 that manages and maintains information relating to the speed and location of the rail vehicles connected to the network 50, as well as other information about the rail tracks and present weather conditions, for example. The rail network 50 can manage and control railroads and tracks in several locations or geographical areas").

Regarding claim 6, Metrom discloses the train-mounted device of claim 1.
Furthermore, Metrom discloses: wherein the train-mounted device is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network (para [0054] "The rail control system 2 can also include one or more RFID tags 20 mounted at locations along a railroad track. For example, the RFID tags 20 can be mounted on the railroad rails or the ties of the railroad").

Regarding claim 13, Metrom discloses: A wayside device, configured for use in a railway network para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track"),
that supports use of a decentralized train control system (para [0087] "These other speed determining components (speedometer and/or wheel speed sensor) may be used together with the RFID tag scanning system. Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network"), the wayside device comprising:
one or more antennas (para [0091] "For example, the reporting stations 30 and/or the VMCS 10 can include one or more antennae, receivers, transmitter, and/or transceivers that allow the reporting stations to send and receive information via Bluetooth, WiFi, radio signals, cellular signals, microwaves, infrared signals, lasers, ultrasonic signals, electromagnetic induction signals, or other modes of wireless communication"),
configured for transmitting and/or receiving wireless signals (para [0038] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system"); and
one or more circuits (para [0153] "Aspects of the techniques described herein may be implemented in digital electronic circuitry, computer software, firmware, or hardware, including the structures disclosed herein and their structural equivalents, or in various combinations "), configured to:
process signals and data (para [0051] "The reporting stations 30 can include a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to exchange data and information, and otherwise communicate with the reporting stations 30"), and
perform one or more functions relating to operations of the wayside device within a decentralized train control system (para [0087] "These other speed determining components (speedometer and/or wheel speed sensor) may be used together with the RFID tag scanning system. Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network"); wherein:
the wayside device is configured to communicate with any train-mounted unit, configured for use within a train to support the decentralized train control system during operation of the train within the railway network, when the trainmounted unit comes within communication range of the train-mounted unit (para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track" and para [0038] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system"); and
the communicating comprises transmission and/or reception of ultrawideband (UWB) based signals (para [0051] "The reporting stations 30 can include a communication mechanism that allows the rail vehicles and/or the VMCS 10 installed on the rail vehicles to exchange data and information, and otherwise communicate with the reporting stations 30. For example, the reporting stations 30 can include transceivers that allow the reporting stations to send and receive information via Bluetooth, WiFi, radio signals, cellular signals, UWB, peer-to-peer networks, microwaves, infrared signals, lasers, ultrasonic signals, electromagnetic induction signals, or other modes of wireless communication").

---See Continuation on Supplemental Page---

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Regarding claim 15, Metrom discloses the wayside device of claim 13.
Furthermore, Metrom discloses: wherein the wayside device is configured for communicating with other components or devices in the railway network, not mounted within trains (para [0053] "Information from the VMCS 10 mounted on the rail vehicles can communicate with the network 50 via the reporting stations 30 such that each vehicle can be aware of the location of other vehicles traveling along the railroad, their speeds, weather conditions, railroad conditions or situations (e.g., steep grades, approaching sharp curves, rail crossings, or stations), and other information that can be useful to ensure safe and efficient rail transportation" and para [0054] "The rail control system 2 can also include one or more RFID tags 20 mounted at locations along a railroad track. For example, the RFID tags 20 can be mounted on the railroad rails or the ties of the railroad").

Regarding claim 16, Metrom discloses the wayside device of claim 15.
Furthermore, Metrom discloses: wherein the wayside device is configured for communicating with at least one other component or device in the railway network via wired based connection (para [0052] "The reporting station 30 can also communicate and exchange information with a rail network 50. For example, the reporting station can be in wireless or wired communication with a rail network 50 that manages and maintains information relating to the speed and location of the rail vehicles connected to the network 50, as well as other information about the rail tracks and present weather conditions, for example").

Regarding claim 20, Metrom discloses: A system for providing decentralized control operations in a railway network (FIG. 1, para [0087] "Data from the speed determining components may be transmitted to other system components via an ad hoc, decentralized network"), the system comprises:
a plurality of wayside units, each configured for placement on or near tracks in the railway network (30, FIG. 1, para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track"); and
one or more train-mounted units, each configured for deployment on a train operating in the railway network (10, FIG. 1, para [0050] "The rail control system 2 can include a vehicle mounted control system ("VMCS") 10, which can be, for example, mounted or installed on a rail vehicle such as a train or subway car") ;
wherein each train-mounted unit is configured to:
communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals (para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track" and para [0036] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system"); and
generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network (para [0053] "information from the VMCS 10 mounted on the rail vehicles can communicate with the network 50 via the reporting stations 30 such that each vehicle can be aware of the location of other vehicles traveling along the railroad, their speeds, weather conditions, railroad conditions or situations (e.g., steep grades, approaching sharp curves, rail crossings, or stations), and other information that can be useful to ensure safe and efficient rail transportation").

Claims 2, 4, 5, 7-11, 14, 17 and 18 lack an inventive step under PCT Article 33(3) as being obvious over Metrom.

Regarding claim 2, Metrom discloses the train-mounted device of claim 1.
Metrom does not explicitly disclose in the embodiment used for claim 1: wherein the train-mounted device is configured to generate at least part of the control information based on sources other than the processing of the ultra-wideband (UWB) based signals.
However, Metrom in a different embodiment discloses: wherein the train-mounted device is configured to generate at least part of the control information based on sources other than the processing of the ultra-wideband (UWB) based signals (passing rail vehicle, FIG. 2, para [0057] "In some embodiments, the reporting station 30 can transmit and/or receive information from a passing rail vehicle 5 via a VMCS 10, for example. The reporting station 30 can then transmit rail vehicle information and/or other information (e.g., information regarding weather conditions) to the rail network. For example, the reporting station 30 can include a transponder sensor module adapted to communicate with the transponder sensor module installed on the rail vehicle 5").
It would have been obvious to a person of ordinary skill in the art to have included the method of using sources other than UWB signals for the control information of the train-mounted device as per the other embodiment of Metrom since it allows for the efficient control of the train using multiple sources for the signals (See para [0057]-[0058]).

---See Continuation on Supplemental Page---

WRITTEN OPINION OF THE
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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Regarding claim 4, Metrom discloses the train-mounted device of claim 3.
Metrom does not disclose in the embodiment used for claim 3:
wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:
monitor actions of the train operator;
assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and
when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.
However, Metrom in a different embodiment discloses:
wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator(para [0058] "The reporting station 30 can also be, for example, a signal control point that generates signals viewable by an operator of the rail vehicle 5. For example, the reporting station 30 can provide signals in the form of various colored lights that provide information and/or instructions to an operator of a passing rail vehicle 10"), the train-mounted unit is configured to:
It would have been obvious to a person of ordinary skill in the art to have included the method of providing indication to a train operator as per the other embodiment of Metrom since it allows for providing efficient and safe operation of the vehicle.
Metrom does not disclose in the above embodiments:
monitor actions of the train operator;
assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action
when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.
However, Metrom in a different embodiment discloses:
monitor actions of the train operator (para [0118] "once the vehicle has been brought to a stop or otherwise has been brought into compliance with the control signal, any warning signals currently generated (e.g., by step 840) may cease or be altered to notify the vehicle operator of the current state of events");
assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action (FIG. 8, para [0118] "If it is determined at step 850 that the rail vehicle is not observing the control signal, speed limit, or approaching vehicle, then the flow diagram 800, at step 860, automatically brakes the vehicle, for example, using an auto-braking system. In some embodiments, the auto-braking feature can be applied until the rail vehicle comes to a complete stop, or until the vehicle speed is below a determined threshold (e.g., below 2 miles per hour or below the speed limit for that portion of the track), depending on the conditions and the situation. In some embodiments, once the vehicle has been brought to a stop or otherwise has been brought into compliance with the control signal, any warning signals currently generated (e.g., by step 840) may cease or be altered to notify the vehicle operator of the current state of events"); and
when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action (para [0121] "The systems and methods disclosed herein can provide additional layer(s) of protection for transit operations by warning the vehicle operator when operating rules are violated. If necessary to restore safe operating margins, the VMCS can cause the vehicle slow or stop using the vehicle's full service brake. The protection provided by these systems and methods can include signal compliance, speed limit compliance, vehicle-to-vehicle collision avoidance, operations and incident recording, work-zone temporary speed limits, vehicle location tracking, and precision station stopping").
It would have been obvious to a person of ordinary skill in the art to have included the method of monitoring the compliance and performing any required responsive action as per the other embodiment of Metrom since it allows for efficient and safe operation of the vehicle (See para [0121].

Regarding claim 5, Metrom discloses the train-mounted device of claim 1.
Metrom does not explicitly disclose in the embodiment used for claim 1: wherein the train-mounted device is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or the other train-mounted unit.
However, Metrom in a different embodiment discloses: wherein the train-mounted device is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or the other train-mounted unit (passing rail vehicle, FIG. 2, para [0057] "In some embodiments, the reporting station 30 can transmit and/or receive information from a passing rail vehicle 5 via a VMCS 10, for example. The reporting station 30 can then transmit rail vehicle information and/or other information (e.g., information regarding weather conditions) to the rail network. For example, the reporting station 30 can include a transponder sensor module adapted to communicate with the transponder sensor module installed on the rail vehicle 5").
It would have been obvious to a person of ordinary skill in the art to have included the method of using non-UWB signals for communicating data as per the other embodiment of Metrom since it allows for the efficient control of the train using multiple sources for the signals (See para [0057]-[0058]).

---See Continuation on Supplemental Page---

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Regarding claim 7, Metrom discloses the train-mounted device of claim 1.
Metrom does not disclose in the embodiments used for claim 1: wherein the train-mounted device is configured for handling satellite based signals.
However, Metrom in a different embodiment discloses: wherein the train-mounted device is configured for handling satellite based signals (para [0133] "The GPS radio 1005 may be capable of receiving GPS information from satellites. This information may be translatable into a position by the control electronics module 1010").
It would have been obvious to a person of ordinary skill in the art to have included the method of configuring the device for handling satellite based signals as per the other embodiment of Metrom since it allows for efficiently control the speed and location of the vehicle for collision avoidance (See para [0133]).

Regarding claim 8, Metrom discloses the train-mounted device of claim 7.
Furthermore, Metrom discloses: wherein the train-mounted device is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information (para [0133] "The GPS radio 1005 may be capable of receiving GPS information from satellites. This information may be translatable into a position by the control electronics module 1010. The GPS operating frequency may be 1.575 GHz (civilian frequency). The GPS information may include absolute location and time/date information. The location information may be used to derive speed of the vehicle. The location and speed information may be used for collision avoidance techniques ").

Regarding claim 9, Metrom discloses the train-mounted device of claim 1.
Metrom does not disclose in the embodiment used for claim 1: wherein the train-mounted device is configured for connecting to and/or interfacing with other systems of the train.
However, Metrom in a different embodiment discloses: wherein the train-mounted device is configured for connecting to and/or interfacing with other systems of the train (FIG. 4, para [0062] "FIG. 4 is a block diagram of a VMCS 10 that can be used in connection with the rail line vehicle separation control system of the present technology. The VMCS 10 can comprise one or more components that can be mounted, connected, or otherwise installed on a rail vehicle. For example, the VMCS 10 can be a single module comprising one or more components that and installable at a location on a rail vehicle. Additionally and/or alternatively, the VMCS 10 can comprise one or more modules, each module comprising one or more components and being installable at one or more locations on a rail vehicle").
It would have been obvious to a person of ordinary skill in the art to have included the method of configuring the train-mounted device to connect/interface with any required train systems as per the other embodiment of Metrom since it allows for efficient collision avoidance (See para [0063]).

Regarding claim 10, Metrom discloses the train-mounted device of claim 1.
Metrom does not disclose in the embodiments used for claim 1: comprising one or more input/output (I/O) components , for receiving input from an operator of the train and/or for providing output to the operator of the train.
However, Metrom in a different embodiment discloses: comprising one or more input/output (I/O) components (100-300, 500, FIG. 4, para [0063] "FIG. 4 is a block diagram of a VMCS 10 that can be used in connection with the rail line vehicle separation control system of the present technology. The VMCS 10 can comprise one or more components that can be mounted, connected, or otherwise installed on a rail vehicle. For example, the VMCS 10 can be a single module comprising one or more components that and installable at a location on a rail vehicle. Additionally and/or alternatively, the VMCS 10 can comprise one or more modules, each module comprising one or more components and being installable at one or more locations on a rail vehicle" and para [0063] "In certain embodiments, the VMCS 10 comprises a collision avoidance system 100, an RFID reader 200, a data collection system 300 and a supervisory component 500").
for receiving input from an operator of the train and/or for providing output to the operator of the train (FIG. 8, para [0118] "If it is determined at step 850 that the rail vehicle is not observing the control signal, speed limit, or approaching vehicle, then the flow diagram 800, at step 860, automatically brakes the vehicle, for example, using an auto-braking system. In some embodiments, the auto-braking feature can be applied until the rail vehicle comes to a complete stop, or until the vehicle speed is below a determined threshold (e.g., below 2 miles per hour or below the speed limit for that portion of the track), depending on the conditions and the situation. In some embodiments, once the vehicle has been brought to a stop or otherwise has been brought into compliance with the control signal, any warning signals currently generated (e.g., by step 840) may cease or be altered to notify the vehicle operator of the current state of events").
It would have been obvious to a person of ordinary skill in the art to have included the I/O components for receiving/providing input/output to the operator as as per the other embodiment of Metrom since it allows for efficient and safe operation of the vehicle (See para [0121).
---See Continuation on Supplemental Page---

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 19/20385

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Regarding claim 11, Metrom discloses the train-mounted device of claim 1.
Metrom does not explicitly disclose in the embodiment used for claim 1: comprising a power component for supplying and/or obtaining power for components of the train-mounted device.
However, Metrom in a different embodiment discloses: comprising a power component for supplying and/or obtaining power for components of the train-mounted device (1002, FIG. 9, para [0127] "FIG. 9 illustrates a vehicle management control system 1000 (or vehicle-mounted subsystem), and may be similar to VMCS 10. For example, either the VMCS 1000or VMCS 10 may be adapted to perform the techniques disclosed herein. The VMCS 1000 may include a backup power module 1001, a power supply/charger 1002").
It would have been obvious to a person of ordinary skill in the art to have included the power supply as per the other embodiment of Metrom since it allows for providing efficient management control to the vehicle-mounted subsystem device (See para [0127]).

Regarding claim 14, Metrom discloses the wayside device of claim 13.
Metrom does not explicitly disclose in the embodiment used for claim 13: wherein the wayside device is configured for utilizing non-UWB based signals for communicating at least some data with the trainmounted unit.
However, Metrom in a different embodiment discloses: wherein the wayside device is configured for utilizing non-UWB based signals for communicating at least some data with the trainmounted unit (passing rail vehicle, FIG. 2, para [0057] "In some embodiments, the reporting station 30 can transmit and/or receive information from a passing rail vehicle 5 via a VMCS 10, for example. The reporting station 30 can then transmit rail vehicle information and/or other information (e.g., information regarding weather conditions) to the rail network. For example, the reporting station 30 can include a transponder sensor module adapted to communicate with the transponder sensor module installed on the rail vehicle 5").
It would have been obvious to a person of ordinary skill in the art to have included the method of using non-UWB signals for communicating data as per the other embodiment of Metrom since it allows for the efficient control of the train using multiple sources for the signals (See para [0057]-[0058]).

Regarding claim 17, Metrom discloses the wayside device of claim 13.
Metrom does not disclose in the embodiment used for claim 13: comprising a support structure for holding and/or supporting the wayside device when placed on or near the tracks.
However, Metrom in a different embodiment discloses: comprising a support structure for holding and/or supporting the wayside device when placed on or near the tracks (para [0042] " The RFID system can also include RFID tags (e.g., active and/or passive RFID tags), which can be mounted at locations on, along, or around the railroad track. For example, the RFID tags can be mounted on the rails or ties of the railroad track, or alternatively, on structures adjacent to the track").
It would have been obvious to a person of ordinary skill in the art to have included the support structure for holding the wayside devices as per the other embodiment of Metrom since it allows for providing required information such as speed limit, track number etc., to the train mounted device (See para [0042]).

Regarding claim 18, Metrom discloses the wayside device of claim 13.
Metrom does not explicitly disclose in the embodiment used for claim13: comprising a power component for supplying and/or obtaining power for components of the wayside device.
However, Metrom in a different embodiment discloses: comprising a power component for supplying and/or obtaining power for components of the wayside device (1002, FIG. 9, para [0127] "FIG. 9 illustrates a vehicle management control system 1000 (or vehicle-mounted subsystem), and may be similar to VMCS 10. For example, either the VMCS 1000or VMCS 10 may be adapted to perform the techniques disclosed herein. The VMCS 1000 may include a backup power module 1001, a power supply/charger 1002").
It would have been obvious to a person of ordinary skill in the art to have included the power supply as per the other embodiment of Metrom since it allows for providing efficient management control to the vehicle-mounted subsystem device (See para [0127]).

---See Continuation on Supplemental Page---

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 19/20365

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box No. V.2. Citations and Explanations:
Claim 12 lacks an inventive step under PCT Article 33(3) as being obvious over Metrom in view of US 2013/0024054 A1 to Katsuta et al. (hereinafter Katsuta).

Regarding claim 12, Metrom discloses the train-mounted device of claim 1.
Furthermore, Metrom discloses: wherein the train-mounted device is configured for communicating, directly or via at least one of the wayside unit and the other train-mounted device, with one or more other components or devices in the railway network (para [0051] "The system 2 can also comprise one or more reporting stations 30 located along a railroad. The reporting stations 30 can be located at or integrated with, for example, signal control points or other objects positioned at fixed positions along a railroad track" and para [0038] "The present technology utilizes a variety of functionalities and technologies to monitor, control, and enforce separation between rail vehicles on a rail track. For example, in some embodiments, the present technology combines ranging technology such as ultra-wideband ("UWB") ranging, RFID tags and detectors, an ad hoc wireless network between vehicles and control signal control portions, and a wireless or wired data collection system"),
Metrom does not explicitly disclose : the one or more other components or devices in the railway network not being part of decentralized train control system.
However, Katsuta discloses: In a railway signalling system which transmits a control order to an on-board signalling system by a trackside signalling system, the on-board signalling system being mounted on a train running on a line and the control order being compliant with a signalling system of the line, the present invention allows the train to run through into lines with different signalling systems using a single on-board signalling system (abstract) and further discloses:
the one or more other components or devices in the railway network not being part of decentralized train control system (para [0039] "Also, the communication network used may be the same as or different from the one used for the communication with the on-board signalling systems. The wayside equipment is involved in operation of the trains on the line. The wayside equipment includes, for example, a train control system, CTC (centralized train control system), interlocking system, track circuit, switch machine, loop coil, and transponder").
It would have been obvious to a person of ordinary skill in the art to have included the components/devices not being part of decentralized train control system as per Katsuta for the train-mounted device of Metrom since it allows for controlling the train safely according to required signaling system (See Katsuta, para [0039] and Metrom, para [0144]).

Claim 19 lacks an inventive step under PCT Article 33(3) as being obvious over US 6,435,459 B1 to Sanderson et al. (hereinafter Sanderson).

Regarding claim 19, Metrom discloses the wayside device of claim 13.
Metrom does not explicitly disclose: comprising a housing for enclosing components of the wayside device;
However, Sanderson discloses: A wayside signal for a railway includes a plurality of light emitting diodes housed in a housing (abstract) and further discloses:
comprising a housing for enclosing components of the wayside device (FIG.1, 3B, col.3, ln 2-10 " As shown most clearly in FIG. 3B, the housing of the wayside signal 100 of the present invention includes two housing halves or portions 31, 32which form an overall housing. FIG. 1 shows the wayside signal 100 with the housing portion 31 removed to provide a view of the internal elements in the wayside signal 100. The LED's 21, 23 are mounted on the circuit board 17. The circuit board 17 may be a metal clad printed circuit board which is thermally bonded to the housing portions 31, 32").
It would have been obvious to a person of ordinary skill in the art to have included the housing of Sanderson for the wayside device of Metrom since it allows for providing sealing against moisture, dirt etc., for the wayside device (See Sanderson, col. 2, ln 63 . col. 3, ln 2).

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

SEARCH HISTORY

Application Number	PCT/US 19/20385
Search Conducted By	SCS
Search Approved By	RII

Best Fit IPC/CPC Classifications Searched	IPC(8) – B61L 27/04 (2019.01) CPC - B61L 27/04; B61L 15/009; B61L 15/0072

Other Classifications Searched	IPC(8) - B61L 27/04 (2019.01) CPC - H04L 67/12; H04W 4/00; B61L 2205/00; B61L 27/0061
Search Terms Used	**Train-mounted device, decentralized, antennas, wireless signals, wayside unit, UWB /ultra-wideband, railway network,**
Date Conducted	02 June 2019 (02.06.2019)

Electronic Database Searched	**Orbit**
Files Searched	world patents (full text & biblio) grouped by invention-based families (FamPat)
Date Conducted	02 June 2019 (02.06.2019)

Search Logic:

1	47640	((B61L-027/04)/IPC OR (H04L-067/12 OR H04W-004/00 OR B61L-2205/0 OR B61L-027/0061 OR B61L-027/04 OR B61L-015/009 OR B61L-015/0072)/CPC)
2	586	1 AND (TRAIN 5D MOUNT+) /BI/TX
3	19	2 AND (DECENTRALI+) /BI/TX
4	184	2 AND (ANTENNA?) /BI/TX
5	9	4 AND (UWB OR ULTRA WIDEBAND OR ULTRA WIDE BAND) /BI/TX
6	39	4 AND (RFID OR RADIO FREQUENCY ID+) /BI/TX
7	39	4 AND (WAYSIDE) /BI/TX
8	68	(5 OR 6 OR 7)
9	51	4 AND SATELLITE /BI/TX
10	39	9 AND ((LOCATION? OR POSITION?) 5D TRAIN?) /BI/TX
11	5	5 AND (CENTRALI+) /BI/TX
12	53336	(TRAIN 5D MOUNT+) /BI/TX
13	205	12 AND (DECENTRALI+) /BI/TX

		13 AND (UWB OR ULTRA WIDEBAND OR ULTRA WIDE
14	6	BAND) /BI/TX
15	3	14 AND (RFID OR RADIO FREQUENCY ID+) /BI/TX
16	39	13 AND SATELLITE /BI/TX
17	15	16 AND ((LOCATION? OR POSITION?) 5D TRAIN?) /BI/TX
18	27	13 AND (WAYSIDE) /BI/TX

Electronic Database Searched	Google
Files Searched	Scholar (Articles excluding patents)
Date Conducted	02 June 2019 (02.06.2019)

Search Logic:

(("train-mounted") OR ("train mounted")) (centralized) (wayside) ((UWB) OR ("ultra-wideband")) – no results
(("train-mounted") OR ("train mounted")) ((centralized) OR (decentralized)) (wireless) (wayside) - 4 results
(("train-mounted") OR ("train mounted")) (centralized) (wayside) – 7 results
(("train-mounted") OR ("train mounted")) (centralized) (wireless) – 27 results

Electronic Database Searched	Google
Files Searched	Patents (US Patents/Published Applications, EPO publications, International, China, Germany, Canada)
Date Conducted	02 June 2019 (02.06.2019)

Search Logic:

(("train-mounted") OR ("train mounted")) (centralized) (wayside) ((UWB) OR ("ultra-wideband")) – 3 results
(("train-mounted") OR ("train mounted")) ((centralized) OR (decentralized)) (wireless) (wayside) - 37 results
(("train-mounted") OR ("train mounted")) (centralized) (wayside) – 49 results
(("train-mounted") OR ("train mounted")) (centralized) (wireless) – 199 results

RII:: Supplemental Search

Electronic Database Searched	PatBase
Files Searched	Full-text: AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO Bibliographic: (Europe) AT BA BE BG CH CS CY CZ DD DK EE ES FI GE GR HR HU IE IS IT LT LU LV MC MD MT NL NO PL PT RO RS SE SI SK SM TR UA YU (Asia) EA GC HK ID IL IN KZ MN MY PH RU SG SU TH TJ TW UZ VN (North America) CA CR CU DO GT HN MX NI PA SV TT (South America) AR BR CL CO EC PE UY (Australasia) AU NZ (Africa) AP DZ EG KE MA MW OA ZA ZM ZW
Date Conducted	02 June 2019 (02.06.2019)
Search Logic:	

Search 1: IC=(B61L27/04 or B61L027/04) (Results 1685)
Search 2: CPC=(B61L27/04 or B61L15/009 or B61L15/0072 or H04L67/12 or H04W4/00 or B61L2205/00 or B61L27/0061) (Results 31055)
Search 3: (1 or 2) (Results 32149)
Search 4: 3 and (trail* or railroad* or railway*) (Results 2636)
Search 5: 4 and antenn* (Results 818)
Search 6: 5 and (ultrawideband* or ultra-wideband* or (ultra wideband*)) (Results 69)
Search 7: 6 and decentraliz* (Results 5)
Search 8: 5 and decentraliz* (Results 30)
Search 9: 8 and (decentraliz* w3 control*) (Results 4)
Search 10: (trail* or railroad* or railway*) (Results 927710)
Search 11: 10 and antenn* (Results 32361)
Search 12: 11 and (ultrawideband* or ultra-wideband* or (ultra wideband*)) (Results 798)
Search 13: 12 and decentraliz* (Results 50)
Search 14: 13 and (decentraliz* w3 control*) (Results 6)
Search 15: 13 and network* (Results 49)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY LTD.
500 WEST MADISON STREET
CHICAGO, IL 60661

RECEIVED
By Docket
OCT 23 2018
Art 19 - 12-17-18
Action Due ISR - 2-4-19
McAndrews, Held & Malloy

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 61861WO01	Date of mailing *(day/month/year)* 18 OCT 2018
International application No. PCT/US2018/045388	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant METROM RAIL, LLC	International filing date *(day/month/year)* 06 August 2018

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **22 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2017)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
61861WO01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2018/045388	06 August 2018	04 August 2017
Applicant METROM RAIL, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 8 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 2

   ☒ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☐ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/045388

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B61L 3/08; B61L 1/20; B61L 3/16; B61L 19/06; B61L 23/30 (2018.01)

CPC - B61L 3/08; B61L 1/20; B61L 3/16; B61L 15/0018; B61L 15/0072; B61L 15/0081; B61L 27/0038; B61L 27/0088 (2018.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

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

USPC - 246/1C; 246/167R; 246/28R; 246/3; 324/76.11; 701/19 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016/0339934 A1 (PANASEC CORPORATION) 24 November 2016 (24.11.2016) entire document	1-20
A	US 2011/0172856 A1 (KULL) 14 July 2011 (14.07.2011) entire document	1-20
A	US 2014/0214248 A1 (THE NIPPON SIGNAL CO., LTD.) 31 July 2014 (31.07.2014) entire document	1-20
A	US 2014/0263856 A1 (QUEST RAIL LLC) 18 September 2014 (18.09.2014) entire document	1-20
A	US 2014/0191089 A1 (REICHLIN et al) 10 July 2014 (10.07.2014) entire document	1-20
A	US 2012/0126065 A1 (SMITH et al) 24 May 2012 (24.05.2012) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 October 2018	18 OCT 2018

Name and mailing address of the ISA/US	Authorized officer
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY LTD.
500 WEST MADISON STREET
CHICAGO, IL 60661

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	18 OCT 2018

Applicant's or agent's file reference	FOR FURTHER ACTION
61861WO01	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/045388	06 August 2018	04 August 2017

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B61L 3/08; B61L 1/20; B61L 3/16; B61L 19/06; B61L 23/30 (2018.01)
CPC - B61L 3/08; B61L 1/20; B61L 3/16; B61L 15/0018; B61L 15/0072; B61L 15/0081; B61L 27/0038; B61L 27/0088 (2018.08)

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	05 October 2018	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/045388

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/045388

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	6, 7, 10, 11, 17, 18	YES
	Claims	1-5, 8, 9, 12-16, 19, 20	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-5, 8, 9, 12-16, 19, and 20 lack novelty under PCT Article 33(2) as being anticipated by Panasec Corporation (hereinafter Panasec).

Regarding claim 1, Panasec discloses a system for providing decentralized control operations in a railway network (system for providing control operations in a railway network, abstract, through localized control units [decentralized], [0013], [0052]), the system comprises: a plurality of wayside control units, configured for placement on or near tracks in the railway network (located along track 60 may be one or more monitoring units 310-330 that are located so as to monitor and detect abnormal conditions and/or deviations from a nominal condition. For example, a wayside monitor 310 may be provided e.g., where the track configuration is deemed to need monitoring because of its nature, [0045]. FIGS. 6A and 6B which are a schematic diagram of an example embodiment of positive train control wayside monitors 310 located along a track way 60 and a schematic plan view thereof, respectively; and FIG. 7 is a schematic block diagram of an example embodiment of a positive train control wayside monitor unit 310 suitable for mounting, e.g., along a track way 60, [0095]); and one or more train-mounted units, wherein each train-mounted unit is incorporated into a particular train (FIG. 3 is a schematic block diagram of an example embodiment of a positive train control unit 100 suitable for mounting to a train, [0055]); wherein: each wayside control unit is configured to: obtain information corresponding to each train that passes within communication range of the wayside control unit (processor 120 processes the data received from sensors 110, locating system 130 and data input 300, 140 to determine the geographic location of the train (positive train control unit 100) on the track map and its speed and direction, to compare that location, speed and position to the applicable train order, speed limits and known track conditions, e.g., as reported by one or more monitors 310-330, [0071]. Data sensed by sensors 110, 312 is communicated to processor 3120 (which corresponds to processor 120 of positive train control unit 100) over cables, e.g., electrical cables and/or optical fiber cables, which processes the sensor data to determine the track conditions within its fields of view, and to then determine whether any dangerous or hazardous condition exists, and based thereon to transmit data that may be combined with positive train control unit 100 sensor 110 data on a train 50 by processor 120 thereof to, e.g., initiate appropriate actions to signal the train crew and/or exercise control over train 50, [0102]. All data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105]. Therefore, a positive train control wayside monitor unit 310 receives train-related information from sensors 110 and 312, associated with the positive train control unit 100 located on the train as it passes within a communication range of the wayside monitors 310, [0152], [0156]); and provide obtained train-related information to each train-mounted unit that passes within communication range of the wayside control unit (all data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105]. All data received and processed by positive train control wayside monitor unit 310 can be transmitted to the train mounted control unit 100 on train 50, [0106], [0107], [0113], [0119]. Therefore, train-related information, including route or speed, is communicated to train control unit 100 on train 50 that is within communication range, [0156]); and each train-mounted unit is configured to: receive train-related information from each wayside control unit that comes within communication range of the train-mounted unit (train control unit 100 on trains 50 receive train related and track related information from the wayside monitors that are within communication range, 0106], [0107], [0113], [0119]); process the received train-related information (train control unit 100 processes received train-related data to integrate collected data for analyzation, [0106], [0107], [0113], [0119]); assess based on the processing of the train-related information one or more conditions relating to operation of train within the railway network; and when at least one condition meets one or more particular criteria, perform or cause performing one or more responsive actions (the combined, integrated correlated data and any identified hazards 440-460 are then utilized in positive train control unit 100 on train 50. To that end the integrated correlated data 440-460 is tested 470, 480, e.g., compared 470, 480, to predetermined limits established to determine whether the integrated correlated data is within or is outside of those limits. In a first instance, the integrated correlated data is compared 470 with a first predetermined limit, typically a limit indicative of a relatively lower risk, to determine if a warning action 464 should be taken, and if yes 470-Y, then alerts and warnings are provided 472 to the train operator, e.g., train crew. Such warnings may be by one or more visual and/or audible signals at the train crew work stations, e.g., in the train control cab for the train engineer and assistant. If the data is within the predetermined first limit, the path 470-N returns operation 400 to repeat 415 the process 400, [0092], [0102]. Therefore, when a condition is detected, the control unit alerts an operator or takes action, [0093], [0156]).

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding claim 2, Panasec discloses the system, wherein the wayside control unit receives at least a portion of train related information from at least one train-mounted unit (the wayside monitor 310 can receive train information from the train control unit 100, [0095], [0105], [0107], [0156]).

Regarding claim 3, Panasec discloses the system, wherein the wayside control unit autonomously determine at least a portion of train related information corresponding to at least one train (preferably, a unique identifier is stored in a memory, e.g., the memory of processor 120, of each positive train control unit 100 so as to uniquely identify that positive train control unit and by association the train on which it is mounted on any track or railway, [0055]. RFID devices and readers may also be used, [0067], [0068]. FIGS. 6A and 6B which are a schematic diagram of an example embodiment of positive train control wayside monitors 310 located along a track way 60 and a schematic plan view thereof, respectively; and FIG. 7 is a schematic block diagram of an example embodiment of a positive train control wayside monitor unit 310 suitable for mounting, e.g., along a track way 60, [0095]. All data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105], [therefore, the positive train control wayside monitor unit 310 along with train identifiers and location information can determine train related information corresponding to a train]).

Regarding claim 4, Panasec discloses the system, wherein each train-mounted unit maintains unique identification information associated with a corresponding train and a route assigned to the train within the railway network (preferably, a unique identifier is stored in a memory, e.g., the memory of processor 120, of each positive train control unit 100 so as to uniquely identify that positive train control unit and by association the train on which it is mounted on any track or railway, [0055]. RFID devices and readers may also be used, [0067], [0068]. Alternatively, and optionally, processor 120 may adjust the rate at which plural sensors 110 operate to sense and analyze 420 data as a function of the speed of train 50, e.g., as a function of the planned speed profile as defined by a train routing order, [0083]).

Regarding claim 5, Panasec discloses the system, wherein each train-mounted unit communicates the unique identification information to each wayside control unit that comes within communication range of the train-mounted unit (preferably, a unique identifier is stored in a memory, e.g., the memory of processor 120, of each positive train control unit 100 so as to uniquely identify that positive train control unit and by association the train on which it is mounted on any track or railway, [0055]. RFID devices and readers may also be used, [0067], [0068]).

Regarding claim 8, Panasec discloses the system, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to: monitor actions of the train operator; assess based on the monitoring, the train operator's handling of at least one expected subsequent responsive action; and directly perform the at least one expected subsequent responsive action when the train operator fails to do so (positive train control unit 100 is preferably mounted at the front of train 50 so as to have a clear field of view forward of train 50 in the direction it is traveling. Positive train control unit 100 includes various sensors (described below) of different types, e.g., visible, infrared, radar, acoustic and the like, that monitor the way ahead to detect and identify objects and/or conditions that might affect the safety of train 50 and a processor to process the data from those sensors and from other sources, so as to provide indications of conditions ahead to the train crew, e.g., including the train operator, and if the indication is a warning or alert, take appropriate action to control the train 50 if the train crew does not appropriately respond to the warning or alert in a timely manner, [0045]. Data and indications from processor 120 may be communicated to an operator alert device 210 which may include one or more display monitors, an audible warning device, a visual warning device, a tactile warning device, or a combination thereof, [0073]. If the train crew or operator does not respond either properly or timely to the advice, alert and/or warning, processor 120 communicates the necessary action to be taken to the train control system 220 of the train which automatically takes the necessary action, e.g., to reduce speed, apply the brakes and/or apply the brakes for an emergency stop, [0074]. The combined, integrated correlated data and any identified hazards 440-460 are then utilized in positive train control unit 100 on train 50. To that end the integrated correlated data 440-460 is tested 470, 480, e.g., compared 470, 480, to predetermined limits established to determine whether the integrated correlated data is within or is outside of those limits. In a first instance, the integrated correlated data is compared 470 with a first predetermined limit, typically a limit indicative of a relatively lower risk, to determine if a warning action 464 should be taken, and if yes 470-Y, then alerts and warnings are provided 472 to the train operator, e.g., train crew. Such warnings may be by one or more visual and/or audible signals at the train crew work stations, e.g., in the train control cab for the train engineer and assistant. If the data is within the predetermined first limit, the path 470-N returns operation 400 to repeat 415 the process 400, [0092], [0102]).

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Supplemental Box

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Regarding claim 9, Panasec discloses a wayside control device, configured for use in a decentralized train control system (system for providing control operations in a railway network using wayside control and monitoring devices, abstract, through localized control units [decentralized], [0013], [0052]), the wayside control device comprising: a housing for enclosing components of the wayside control device (as seen in Fig.1, wayside monitor 310 [or positive train control wayside units 310, [similar to 100] [0095]], are enclosed, within a device [housing] to enclose components to be mounted, [0097]); a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals (as seen in Fig.7, positive train control wayside units 310 comprise an antenna 162 and wireless communication devices 3140 to transmit and receive wireless signals, [0065], [0070], [0157]); and one or more circuits operable to: process signals and data (positive train control wayside unit 310 comprises processor 3120 P to process signals, [0102]), and perform one or more functions relating to operations of the wayside control device within the decentralized train control system (data sensed by sensors 110, 312 is communicated to processor 3120 (which corresponds to processor 120 of positive train control unit 100) over cables, e.g., electrical cables and/or optical fiber cables, which processes the sensor data to determine the track conditions within its fields of view, and to then determine whether any dangerous or hazardous condition exists, and based thereon to transmit data that may be combined with positive train control unit 100 sensor 110 data on a train 50 by processor 120 thereof to, e.g., initiate appropriate actions to signal the train crew and/or exercise control over train 50, [0102]); wherein: the wayside control device is configured for placement on or near tracks (FIGS. 6A and 6B which are a schematic diagram of an example embodiment of positive train control wayside monitors 310 located along a track way 60 and a schematic plan view thereof, respectively; and FIG. 7 is a schematic block diagram of an example embodiment of a positive train control wayside monitor unit 310 suitable for mounting, e.g., along a track way 60, [0095]); and the wayside control device is configured to: obtain information corresponding to each train operating with a railway network managed using the decentralized train control system, when the train passes within communication range of the wayside control device (processor 120 processes the data received from sensors 110, locating system 130 and data input 300, 140 to determine the geographic location of the train (positive train control unit 100) on the track map and its speed and direction, to compare that location, speed and position to the applicable train order, speed limits and known track conditions, e.g., as reported by one or more monitors 310-330, [0071]. Data sensed by sensors 110, 312 is communicated to processor 3120 (which corresponds to processor 120 of positive train control unit 100) over cables, e.g., electrical cables and/or optical fiber cables, which processes the sensor data to determine the track conditions within its fields of view, and to then determine whether any dangerous or hazardous condition exists, and based thereon to transmit data that may be combined with positive train control unit 100 sensor 110 data on a train 50 by processor 120 thereof to, e.g., initiate appropriate actions to signal the train crew and/or exercise control over train 50, [0102]. All data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105]. Therefore, a positive train control wayside monitor unit 310 receives train-related information from sensors 110 and 312, associated with the positive train control unit 100 located on the train as it passes within a communication range of the wayside monitors 310, [0152], [0156]); and provide train-related information associated with one train to at least one other train, when the at least one other train passes within communication range of the wayside control device (all data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105]. All data received and processed by positive train control wayside monitor unit 310 can be transmitted to the train mounted control unit 100 on train 50, [0106], [0107], [0113], [0119]. Therefore, train-related information, including route or speed, is communicated to train control unit 100 on train 50 that is within communication range, [0156]).

Regarding claim 12, Panasec discloses the wayside control device, comprising a support structure for holding and/or supporting the wayside control device when placed on or near the tracks (the monitoring units 310-330 can be mounted to the track 60, and to a support structure as seen in Fig.1, [0049], [0095], [0116]).

Regarding claim 13, Panasec discloses the wayside control device, comprising a power component for supplying and/or obtaining power for components of the wayside control device (power is supplied to the monitoring units 310-330 through power line connection, [0116], [0141], [0142]. Positive train control unit 100 [and similarly a power train control wayside unit 310], may be configured as an assembled unit that may be mounted or attached, either temporarily or permanently, to a movable vehicle, e.g., a train, or may be in one or more modules or units of equipment that are mounted to the train, and in either case interconnected therewith. Preferably the positive train control unit 100 is mounted to the train at the forward most end thereof where it will have a suitably clear field of view forward of the train and so be able to observe and/or sense what, if anything, lies ahead, and is connected to one or more train systems and/or equipment, typically via a predefined interface, e.g., using one or more electrical connectors, for receiving electrical power from the train and providing interconnections for communicating data therebetween, [0056])

Regarding claim 14, Panasec discloses the wayside control device, comprising one or more sensory components, for detecting, monitoring, and/or tracking trains (in such instance, sensors 112, 114, 116, 118 and/or 122 provide output data that includes data representing any detected objects and or conditions relating to the track way. That output data are then further processed by PTC processor 120, which serves as a central or common resource, to provide combined and/or integrated data representative of track way and other conditions for effecting any necessary operator alerts 210 and/or train control 220 actions. Overall control of positive train control unit 100, including on, off and other control of sensors 112, 114, 116, 118 and/or 122, is preferably under the control of PTC processor 120, [0076]. Example wayside monitor 310 sensors 110, 312 may include one or more of visible band imagers 3112 producing either sequential still images or video images, one or more infrared (IR) band imagers 3114 producing either sequential still IR images or video IR images, one or more radar imagers 3116 including Doppler radars and other types of radars 116, 3116, one or more laser ranging devices 3118 and/or one or more acoustic ranging and/or sonar ranging devices 3122. Sensors 3112, 3114, 3116, 3118 and/or 3122 preferably, but need not, correspond to like sensors 112, 114, 116, 118 and 122 of positive train control unit 100, [0101]).

Supplemental Box

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Regarding claim 15, Panasec discloses a train-mounted device, configured for use within a train to support a decentralized train control system (system for providing control operations in a railway network, abstract, through localized control units [decentralized], [0013], [0052]. FIG. 3 is a schematic block diagram of an example embodiment of a positive train control unit 100 suitable for mounting to a train, [0055]), the train-mounted device comprising: a housing for enclosing components of the train-mounted device (train control 100 is mounted to the front of train 50 [and therefore as seen in Fig.1 comprises a housing with components housed inside in order to be attached, Fig.3], [0045]); a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals (accordingly, data input device 140 typically includes one or more wireless communication devices 140 operating via one or more antennas 142, e.g., mounted to train 50, typically and preferably to locomotive 52 thereof, [0068]. Plural communication devices 160 may be employed for improved reliability and redundancy, and each may operate via one or more antennas 142, 162, e.g., located on train 50, and preferably on locomotive 52 thereof, [0070]); one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train (external data inputs 300 for positive train control unit 100 may be provided via data input device 140 which may include any number of data input devices, e.g., a keyboard, a touch screen, a USB drive reader, a memory card reader, a CD or DVD reader, a magnetic stripe reader, an RFID reader, and the like, and sources, [0067]. Data and indications from processor 120 may be communicated to an operator alert device 210 which may include one or more display monitors, an audible warning device, a visual warning device, a tactile warning device, or a combination thereof, [0073]); and one or more circuits operable to: process signals and data, and perform one or more functions relating to operations of the train-mounted device within the decentralized train control system (data sensed by sensors 110 is communicated to positive train control unit processor 120 over cables, e.g., electrical cables and/or optical fiber cables, which processes the sensor data to determine the track conditions ahead, and to then determine whether any dangerous or hazardous condition exists, and based thereon to initiate appropriate actions to signal the train crew, [0060]); wherein the train-mounted device is configured to, during operation of the train within a railway network managed using the decentralized train control system: receive train-related information from one or more wayside control units in the decentralized train control system, when coming within communication range of the train-mounted device (as seen in Fig.7, positive train control wayside units 310 comprise an antenna 162 and wireless communication devices 3140 to transmit and receive wireless signals, [0065], [0070], [0157]. All data produced by sensors 110, 312 is associated with the location of wayside monitor 310 provided by location determination 130, 3132 at the time the data was acquired, and is also time tagged, e.g., by processor 3120 so that all sensor data is both geo-tagged and time tagged for facilitating its being cross referenced to other data, both similar data and dissimilar data, for storing and processing such data within wayside monitor 310, and by any positive train control unit 100 to which it may be transmitted, and at a central location to which such data may be transmitted 160, 162, [0105]. All data received and processed by positive train control wayside monitor unit 310 can be transmitted to the train mounted control unit 100 on train 50, [0106], [0107], [0113], [0119]. Therefore, train-related information, including route or speed, is communicated to train control unit 100 on train 50 that is within communication range, [0156]); process the received train-related information (train control unit 50 processes received train-related data to integrate collected data for analyzation[0106], [0107], [0113], [0119]); assess based on the processing of the train-related information one or more conditions relating to operation of the train within the railway network; and when at least one condition meets one or more particular criteria, perform or cause performing one or more responsive actions (the combined, integrated correlated data and any identified hazards 440-460 are then utilized in positive train control unit 100 on train 50. To that end the integrated correlated data 440-460 is tested 470, 480, e.g., compared 470, 480, to predetermined limits established to determine whether the integrated correlated data is within or is outside of those limits. In a first instance, the integrated correlated data is compared 470 with a first predetermined limit, typically a limit indicative of a relatively lower risk, to determine if a warning action 464 should be taken, and if yes 470-Y, then alerts and warnings are provided 472 to the train operator, e.g., train crew. Such warnings may be by one or more visual and/or audible signals at the train crew work stations, e.g., in the train control cab for the train engineer and assistant. If the data is within the predetermined first limit, the path 470-N returns operation 400 to repeat 415 the process 400, [0092], [0102]. Therefore, when a condition is detected, the control unit alerts an operator or takes action, [0093], [0156]).

Regarding claim 16, Panasec discloses the train-mounted device, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to: monitor actions of the train operator; assess based on the monitoring, the train operator's handling of at least one expected subsequent responsive action; and directly perform the at least one expected subsequent responsive action when the train operator fails to do so (positive train control unit 100 is preferably mounted at the front of train 50 so as to have a clear field of view forward of train 50 in the direction it is traveling. Positive train control unit 100 includes various sensors (described below) of different types, e.g., visible, infrared, radar, acoustic and the like, that monitor the way ahead to detect and identify objects and/or conditions that might affect the safety of train 50 and a processor to process the data from those sensors and from other sources, so as to provide indications of conditions ahead to the train crew, e.g., including the train operator, and if the indication is a warning or alert, take appropriate action to control the train 50 if the train crew does not appropriately respond to the warning or alert in a timely manner, [0045]. Data and indications from processor 120 may be communicated to an operator alert device 210 which may include one or more display monitors, an audible warning device, a visual warning device, a tactile warning device, or a combination thereof, [0073]. If the train crew or operator does not respond either properly or timely to the advice, alert and/or warning, processor 120 communicates the necessary action to be taken to the train control system 220 of the train which automatically takes the necessary action, e.g., to reduce speed, apply the brakes and/or apply the brakes for an emergency stop, [0074]. The combined, integrated correlated data and any identified hazards 440-460 are then utilized in positive train control unit 100 on train 50. To that end the integrated correlated data 440-460 is tested 470, 480, e.g., compared 470, 480, to predetermined limits established to determine whether the integrated correlated data is within or is outside of those limits. In a first instance, the integrated correlated data is compared 470 with a first predetermined limit, typically a limit indicative of a relatively lower risk, to determine if a warning action 464 should be taken, and if yes 470-Y, then alerts and warnings are provided 472 to the train operator, e.g., train crew. Such warnings may be by one or more visual and/or audible signals at the train crew work stations, e.g., in the train control cab for the train engineer and assistant. If the data is within the predetermined first limit, the path 470-N returns operation 400 to repeat 415 the process 400, [0092], [0102]).

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
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Regarding claim 19, Panasec discloses the train-mounted device, comprising a power component for supplying and/or obtaining power for components of the train-mounted device (positive train control unit 100 may be configured as an assembled unit that may be mounted or attached, either temporarily or permanently, to a movable vehicle, e.g., a train, or may be in one or more modules or units of equipment that are mounted to the train, and in either case interconnected therewith. Preferably the positive train control unit 100 is mounted to the train at the forward most end thereof where it will have a suitably clear field of view forward of the train and so be able to observe and/or sense what, if anything, lies ahead, and is connected to one or more train systems and/or equipment, typically via a predefined interface, e.g., using one or more electrical connectors, for receiving electrical power from the train and providing interconnections for communicating data therebetween, [0056]).

Regarding claim 20, Panasec discloses the train-mounted device, comprising an interface component for connecting to and/or interfacing with other systems of the train (if the train crew or operator does not respond either properly or timely to the advice, alert and/or warning, processor 120 communicates the necessary action to be taken to the train control system 220 of the train which automatically takes the necessary action, e.g., to reduce speed, apply the brakes and/or apply the brakes for an emergency stop, [0074]. Because processor 120 and the train systems 200, e.g., including train control 220, are in direct communication, processor 120 receives train operating data from train control 220 that is processed to determine, e.g., train speed and direction (forward or reverse), brake and braking status, engine status, train integrity, train deadman device status, and the like, thereby to produce data from the train control that can be compared to data determined from sensors 110, locating system 130, and data inputs and monitors 300 for consistency and accuracy, the lack of which would provide an indication of a device or other malfunction or failure for which an alert or warning may need to be given and/or action may need to be taken, [0075]).

Claims 6, 7, 10, 11, 17, and 18 lack an inventive step under PCT Article 33(3) as being obvious over Panasec Corporation (hereinafter Panasec).

Regarding claim 6, Panasec lacks in the teaching of the system, wherein the plurality of wayside control units is configured for supporting and/or utilizing ultra-wideband (UWB) based communications. However, Panasec does teach wherein the plurality of wayside control units is configured for supporting and/or utilizing different communication bands (such communication devices typically employ jamming and interference resistance transmission protocols and/or may operate on different bands, and may have additional transponders and/or relays associated therewith, which may be closely ane/or remotely located, all so as to increase the reliability and accuracy of communication, e.g., given the geographic and topographic conditions associated with their geographic locations, [0052]. The communication device 3140, 3160 may communicate the positive indication: by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof; or to a positive train control unit 100 on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320,330, to a central train facility or to any combination thereof; or by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof, to a positive train control unit on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320, 330, to a central train facility or to any combination thereof, [0157]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use ultra-wideband (UWB) based communications, since the use of ultra-wideband (UWB) based communications for short range communication was well known in the art during the time the invention was made. The motivation would have been to provide a range of communication to ensure communication between the devices (Panasec, [0052], [0157]).

Regarding claim 7, Panasec lacks in the teaching of the system, wherein the one or more train-mounted units are configured for supporting and/or utilizing ultra-wideband (UWB) based communications. However, Panasec does teach wherein the one or more train-mounted units is configured for supporting and/or utilizing different communication bands (such communication devices typically employ jamming and interference resistance transmission protocols and/or may operate on different bands, and may have additional transponders and/or relays associated therewith, which may be closely ane/or remotely located, all so as to increase the reliability and accuracy of communication, e.g., given the geographic and topographic conditions associated with their geographic locations, [0052]. The communication device 3140, 3160 may communicate the positive indication: by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof; or to a positive train control unit 100 on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320,330, to a central train facility or to any combination thereof; or by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof, to a positive train control unit on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320, 330, to a central train facility or to any combination thereof, [0157]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use ultra-wideband (UWB) based communications, since the use of ultra-wideband (UWB) based communications for short range communication was well known in the art during the time the invention was made. The motivation would have been to provide a range of communication to ensure communication between the devices (Panasec, [0052], [0157]).

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/045388

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding claim 10, Panasec lacks in the teaching of the wayside control device, wherein the communication component is configured for supporting and/or utilizing ultra-wideband (UWB) based communications. However, Panasec does teach wherein the plurality of wayside control units is configured for supporting and/or utilizing different communication bands (such communication devices typically employ jamming and interference resistance transmission protocols and/or may operate on different bands, and may have additional transponders and/or relays associated therewith, which may be closely ane/or remotely located, all so as to increase the reliability and accuracy of communication, e.g., given the geographic and topographic conditions associated with their geographic locations, [0052]. The communication device 3140, 3160 may communicate the positive indication: by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof; or to a positive train control unit 100 on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320,330, to a central train facility or to any combination thereof; or by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof, to a positive train control unit on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320, 330, to a central train facility or to any combination thereof, [0157]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use ultra-wideband (UWB) based communications, since the use of ultra-wideband (UWB) based communications for short range communication was well known in the art during the time the invention was made. The motivation would have been to provide a range of communication to ensure communication between the devices (Panasec, [0052], [0157]).

Regarding claim 11, Panasec lacks in the teaching of the wayside control device, comprising one or more radio-frequency identification (RFID) tags configured for uniquely identifying the wayside control device within the railway network. However, Panasec does teach RFID readers and devices for identification (the monitoring devices, including the wayside monitor 310, can include RFID readers or devices for identification, [0151], [0157]) and a unique identifier for the train mounted device (preferably, a unique identifier is stored in a memory, e.g., the memory of processor 120, of each positive train control unit 100 so as to uniquely identify that positive train control unit and by association the train on which it is mounted on any track or railway, [0055]. RFID devices and readers may also be used, [0067], [0068]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use RFID tags configured for uniquely identifying the wayside control device within the railway network, since the use of RFID tags for identification was well known in the art during the time the invention was made. The motivation would have been to provide and identifier for each wayside device for communication (Panasec, [0067], [0151], [0157]).

Regarding claim 17, Panasec lacks in the teaching of the train-mounted device, wherein the communication component is configured for supporting and/or utilizing ultra-wideband (UWB) based communications. However, Panasec does teach wherein the one or more train-mounted units is configured for supporting and/or utilizing different communication bands (such communication devices typically employ jamming and interference resistance transmission protocols and/or may operate on different bands, and may have additional transponders and/or relays associated therewith, which may be closely and/or remotely located, all so as to increase the reliability and accuracy of communication, e.g., given the geographic and topographic conditions associated with their geographic locations, [0052]. The communication device 3140, 3160 may communicate the positive indication: by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof; or to a positive train control unit 100 on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320,330, to a central train facility or to any combination thereof; or by a wireless communication device 3140, 3160 including a 220 MHz communication device 3140, 3160, a WiFi network, an ad hoc network, cellular communication, a bluetooth device, an RFID device, or by any combination thereof, to a positive train control unit on a train, to a wayside monitor 310, to a switch monitor 320, 330, to a track monitor 320, 330, to a central train facility or to any combination thereof, [0157]). Therefore, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use ultra-wideband (UWB) based communications, since the use of ultra-wideband (UWB) based communications for short range communication was well known in the art during the time the invention was made. The motivation would have been to provide a range of communication to ensure communication between the devices (Panasec, [0052], [0157]).

Regarding claim 18, Panasec discloses the train-mounted device, wherein the communication component comprises an radio-frequency identification (RFID) reader (the monitoring devices, including the wayside monitor 310, can include RFID readers or devices for identification, [0151], [0157]) and a unique identifier for the train mounted device (preferably, a unique identifier is stored in a memory, e.g., the memory of processor 120, of each positive train control unit 100 so as to uniquely identify that positive train control unit and by association the train on which it is mounted on any track or railway, [0055]. RFID devices and readers may also be used, [0067], [0068]), but lacks in the teaching wherein the radio-frequency identification (RFID) reader is configured for interacting with RFID tags in wayside control units of the decentralized train control system. However, it would have been obvious to one of ordinary skill in the art during the time the invention was made to use the radio-frequency identification (RFID) reader for interacting with RFID tags in wayside control units of the decentralized train control system, since the use of RFID tags for identification was well known in the art during the time the invention was made. The motivation would have been to provide and identifier for each wayside device for communication (Panasec, [0067], [0151], [0157]).

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Search History:

Limited Classification Search

The Patent Analyst performed a limited classification search within the following US, IPC, CPC, ECLA, or F-Term classification areas:

CPC Class/Subclass(es): B61L 3/08; B61L 1/20; B61L 3/16; B61L 15/0018; B61L 15/0072; B61L 15/0081; B61L 27/0038; B61L 27/0088 (2018.08)

IPC (8) Class/Subclass(es): B61L 3/08; B61L 1/20; B61L 3/16; B61L 19/06; B61L 23/30 (2018.01)

U.S. Class/Subclass(es): 246/3; 324/76.11; 701/19

See Global Search Results.

Global Patent Literature Text Search

The Patent Analyst performed the following global text search, which was not limited by classification but may or may not have been limited by other criteria:

Questel Orbit: https://www.orbit.com

#	Search query	Results
1	((METROM D RAIL)/PA/OPA/PAH/OWR/REAS)	7
2	((RAIL+ OR TRAIN+) AND (CONTROL+ OR MONITOR+ OR REGULAT+ OR +CONTROLLER OR +COMPUTER) AND (WAYSID+ OR EDG+ OR TRACK+) AND (DECENTRAL+ OR TRANSFER+ OR WIRELESS+ OR AUTO+) AND (UNIT+ OR DEVIC+ OR APPARATUS+) AND (COMMUNICAT+ OR TRANS+ OR SEND+) AND (PROCESS+ OR ANALY+ OR COMPUT? OR DETERMIN+) AND (CONDITION+ OR STATUS+ OR DANGER+ OR THRESHOLD+ OR EMERGENC+ OR FAULT+ OR ERROR+ OR EVENT+ OR SAF+))/TI/AB/IW	762
3	2 AND (INFO+ OR DATA+ OR SENS+ OR DETECT+) AND (RESPON+ OR ACTION+ OR PREVENT+ OR WARN+ OR ADJUST+ OR MODIF+ OR CHANG+)	461
4	3 AND TRACK+	371
5	4 AND (HOUS+ OR ENCLOS+)	55
6	(WO2014166070 OR CN104859683 OR US20120217350 OR US8214092 OR US9156484 OR WO201392113 OR US8473127 OR WO2014108861)/PN	7
7	(US9321469 OR EP2762379 OR US20110238242 OR US9278702 OR US8924050 OR US7092801 OR US20140209760 OR US6865454 OR EP650429 OR EP-650429 OR EP0650429 OR US8977414 OR US20140209758 OR US20100258682 OR WO201184251 OR WO2012176416 OR EP2754582 OR US20060195236 OR EP1147966 OR WO2013117398 OR US20070233335)/PN	16
8	(US20040182970 OR US9434397 OR US8532842 OR US7302319 OR US20160257319 OR US20120123617 OR	14

	US9352761 OR EP2754582 OR US9321469 OR US7140577 OR CA2102822 OR US20170148323 OR WO200942283 OR US8998149 OR US8214091)/PN	
9	(US9434397 OR CA2281683 OR US20110238242 OR US20120123617 OR US20030236598 OR WO201774912 OR WO9842096 OR US20170148323 OR US20040182970)/PN	9
10	(246003000)/PCL	831
11	(701019000)/PCL	848
12	(246028000R)/PCL	226
13	(246167000R)/PCL	350
14	(246001000C)/PCL	192
15	(324076110)/PCL	1079
16	(10 OR 11 OR 12 OR 13 OR 14 OR 15) AND (RAIL+ OR TRAIN+) AND (CONTROL+ OR MONITOR+ OR REGULAT+ OR +CONTROLLER OR +COMPUTER) AND (WAYSID+ OR EDG+ OR TRACK+) AND (DECENTRAL+ OR TRANSFER+ OR WIRELESS+ OR AUTO+) AND (UNIT+ OR DEVIC+ OR APPARATUS+) AND (COMMUNICAT+ OR TRANS+ OR SEND+) AND (PROCESS+ OR ANALY+ OR COMPUT? OR DETERMIN+) AND (CONDITION+ OR STATUS+ OR DANGER+ OR THRESHOLD+ OR EMERGENC+ OR FAULT+ OR ERROR+ OR EVENT+ OR SAF+)	187
17	16 AND (DECENTRAL+ OR LOCAL+ OR REMOT+)	82
18	17 AND (WIRELESS+ OR RADIO+)	49
19	18 AND WAYSID+	13
20	(B61L-027/02)/IPC	75
21	(B61L-003/02)/IPC	546
22	(B61L-003/16)/IPC	533
23	(B61L-019/06)/IPC	1478
24	(B61L-027/04)/IPC	1450
25	(B61L-011/08)/IPC	312
26	(B61L-001/20)/IPC	774
27	(B61L-023/30)/IPC	125
28	(B61L-003/08)/IPC	927
29	(20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28) AND (RAIL+ OR TRAIN+) AND (CONTROL+ OR MONITOR+ OR REGULAT+ OR +CONTROLLER OR +COMPUTER) AND (WAYSID+ OR EDG+ OR TRACK+) AND (DECENTRAL+ OR LOCAL+ OR REMOT+) AND (UNIT+ OR DEVIC+ OR APPARATUS+) AND (COMMUNICAT+ OR TRANS+ OR SEND+) AND (PROCESS+ OR ANALY+ OR COMPUT? OR DETERMIN+) AND (CONDITION+ OR	46

4	train control AND railway network AND wayside control device AND communication AND track AND (autonomous OR automatic) AND train mounted	3,250
5	train control AND railway network AND wayside control device with housing AND communication AND track AND (autonomous OR automatic) AND train mounted	649
6	train control AND railway network AND plurality of wayside control device AND communication AND track AND (autonomous OR automatic) AND train mounted	2,320
7	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted	2,190
8	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote)	1,840
9	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety	2,090
10	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety AND (RFID OR identification OR ID)	2,090
11	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety AND (RFID OR identification OR ID) AND (condition OR status)	1,600

Computer Accessed Text Databases Searched

The Patent Analyst searched the following computer accessed text databases:

Proquest: http://www.proquest.com/

#	Search query	Results
1	decentralized train control AND railway network AND wayside device AND communication	61
2	train control AND railway network AND wayside control device AND communication	337
3	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted	2
4	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety	2
5	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety AND (RFID OR identification OR ID)	2

	STATUS+ OR DANGER+ OR THRESHOLD+ OR EMERGENC+ OR FAULT+ OR ERROR+ OR EVENT+ OR SAF+) AND (WIRELESS+ OR RADIO+)	
30	(B61L-027/02)/CPC	23
31	(B61L-003/02)/CPC	274
32	(B61L-003/16)/CPC	53
33	(B61L-019/06)/CPC	1099
34	(B61L-027/04)/CPC	610
35	(B61L-011/08)/CPC	186
36	(B61L-001/20)/CPC	738
37	(B61L-023/30)/CPC	28
38	(B61L-003/08)/CPC	553
39	(B61L-027/0005)/CPC	605
40	(B61L-027/0038)/CPC	729
41	(B61L-003/006)/CPC	270
42	(B61L-015/0018)/CPC	204
43	(B61L-015/0072)/CPC	507
44	(B61L-015/0081)/CPC	592
45	(B61L-027/0088)/CPC	337
46	(B61L-027/0027)/CPC	265
47	(30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40 OR 41 OR 42 OR 43 OR 44 OR 45 OR 46) AND (RAIL+ OR TRAIN+) AND (CONTROL+ OR MONITOR+ OR REGULAT+ OR +CONTROLLER OR +COMPUTER) AND (WAYSID+ OR EDG+ OR TRACK+) AND (DECENTRAL+ OR LOCAL+ OR REMOT+) AND (UNIT+ OR DEVIC+ OR APPARATUS+) AND (COMMUNICAT+ OR TRANS+ OR SEND+) AND (PROCESS+ OR ANALY+ OR COMPUT? OR DETERMIN+) AND (CONDITION+ OR STATUS+ OR DANGER+ OR THRESHOLD+ OR EMERGENC+ OR FAULT+ OR ERROR+ OR EVENT+ OR SAF+) AND (WIRELESS+ OR RADIO+)	74

Google Patents: https://patents.google.com

#	Search query	Results
1	decentralized train control AND railway network AND wayside device AND communication	144
2	train control AND railway network AND wayside control device AND communication	3,080
3	train control AND railway network AND wayside control device AND communication AND track	3,940

Google Scholar: https://scholar.google.com/

#	Search query	Results
1	decentralized train control AND railway network AND wayside device AND communication	1,050
2	train control AND railway network AND wayside control device AND communication	8,580
3	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted	1,300
4	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety	1,100
5	train control AND railway network AND plurality of wayside control device AND wireless communication AND track AND (autonomous OR automatic) AND train mounted AND (decentralized OR local OR remote) AND safety AND (RFID OR identification OR ID)	1,050

Date search was completed: 05 October 2018

PZ/CC

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY LTD.
500 WEST MADISON STREET
34TH FLOOR
CHICAGO, IL 60661

RECEIVED
By Docket
OCT 12 2018
McAndrews, Held & Malloy

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)*
Applicant's or agent's file reference 61997WO01	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2018/049062	International filing date *(day/month/year)* 31 August 2018
Applicant METROM RAIL, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **22 months from the priority date, the applicant may request that a supplementary international search be carried** out by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2017)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
61997WO01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2018/049062	31 August 2018	01 September 2017
Applicant METROM RAIL, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the drawings to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/049062

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B61L 27/00; B61L 25/02; B61L 15/00; B61L 23/16 (2018.01)
CPC - B61L 27/0005; B61L 15/0027; B61L 27/0038; B61L 27/0077; B61L 15/0018 (2018.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 246/124; 701/19; 701/20 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2016/0280240 A1 (METROM RAIL, LLC) 29 September 2016 (29.09.2016) entire document	1-18
Y	US 2011/0075641 A1 (SIRIWONGPAIRAT et al) 31 March 2011 (31.03.2011) entire document	1-18
Y	US 2015/0060608 A1 (METROM RAIL, LLC) 05 March 2015 (05.03.2015) entire document	3, 8, 10, 11
Y	US 2009/0326746 A1 (MIAN) 31 December 2009 (31.12.2009) entire document	12, 13
A	US 2017/0101116 A1 (ELECTRO-MOTIVE DIESEL, INC.) 13 April 2017 (13.04.2017) entire document	1-18
A	US 2017/0113707 A1 (GHALY) 27 April 2017 (27.04.2017) entire document	1-18
A	US 2016/0046308 A1 (PANASEC CORPORATION) 18 February 2016 (18.02.2016) entire document	1-18
A	US 2015/0344048 A1 (WESTINGHOUSE AIR BRAKE TECHNOLOGIES CORPORATION) 03 December 2015 (03.12.2015) entire document	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 October 2018	09 NOV 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

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Applicant's or agent's file reference	FOR FURTHER ACTION
61997WO01	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/049062	31 August 2018	01 September 2017

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B61L 27/00; B61L 25/02; B61L 15/00; B61L 23/16 (2018.01)
CPC - B61L 27/0005; B61L 15/0027; B61L 27/0038; B61L 27/0077; B61L 15/0018 (2018.08)

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	26 October 2018	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-18	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-18	NO
Industrial applicability (IA)	Claims	1-18	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 2, 4-7, 9, and 14-18 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Siriwongpairat).

Regarding claim 1, Metrom'240 discloses a system for wireless train communications (railway systems, para.0002; the train 101 may be equipped with the VAD 120, which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. train communications], para.0037; VAD include circuitry for wireless communications, para.0084; WDU include circuitry for wireless communications, para.0076 [thus interpreted as wireless train communications]), the system comprises:
a plurality of wayside communication units, configured for placement on or near path of trains, wherein each wayside communication unit (wayside detection units (WDU), configured for placement on or near paths of the vehicles [i.e. trains], Abstract; The WDU 130 is configured to operate as stand-alone device, placed on or near the path of the object being detected. For example, the WDU is temporarily placed near the track 103. The WDU 130 broadcasts a signal when a train or vehicle passes, para.0019) comprises:
a power component configured for generating and/or obtaining power for powering components of the wayside communication unit (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27);
a communication component configured for transmitting and/or receiving wireless signals (WDU 400 includes a communication subsystem 454 that may comprise suitable circuitry operable to communicate signals from and/or to the electronic device, via wireless connections, para.0076; wayside detection unit comprising a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals, claim 27); and
one or more circuits operable to: process signals and data, and perform one or more applications or functions relating to operations of the wayside communication unit (the WDU 400 may comprise suitable circuitry for performing various operations in support of its functions. For example, the WDU 400 may comprise one or more main processors 450. Each main processor 450 may comprise suitable circuitry operable to process data, and/or control and/or manage operations of the WDU 400, and/or tasks and/or applications performed therein, para.0073, 0074; wayside detection unit comprises one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the wayside detection unit, claim 27);
wherein the wayside communication unit is configured to communicate signals and/or messages with each train-based device that moves within communication range of the wayside communication unit (the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 [i.e. wayside communication unit] as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. VAD or train based device approaching or moving within specified distance i.e. communication range of the WDU], para.0037; the WDU is temporarily placed near the track 103. The WDU 130 broadcasts a signal when a train or vehicle passes, para.0019).
Metrom'240 lacks the teaching of wireless train communications configured for operation in conjunction with legacy train control systems, and wherein a wayside communication unit is configured to communicate signals and/or messages with one or more local control devices within a legacy train control system.
Metrom'240 further teaches using wireless train communication in existing systems (system 100 [i.e. wireless train communication system] may be configured to provide backward compatibility with existing protection solutions and/or protocols. Further, it may be particularly designed and implemented such that it may be integrated into future communications based train control systems [i.e. CBTC based systems], para.0030).
Siriwongpairat discloses railroad communication system (Abstract) and teaches wireless train communications configured for operation in conjunction with legacy train control systems (central office 101 receive the status messages through at least one of the base stations 103. Wired communication links between the base stations 103 and central office 101 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to wayside units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0339; system 100 supports wireless communications between a central office 101 and locomotives 102 and other railroad vehicles located at various points around a rail system [i.e. wireless train communications in conjunction with legacy train control system formed by central office 101 and base stations 103a and 103b], para.0048, Fig.1), and a wayside communication unit is configured to communicate signals and/or messages with one or more local control devices within a legacy train control system (wayside status updates are forwarded to central office 101 from wayside units 104, para.0054, Fig.1; locomotives 102 and base stations 103 can receive status messages from multiple wayside monitoring subsystems 104 [i.e. wayside communication units] simultaneously, para.0057; central office 101 must receive the wayside interface unit (WIU) status messages through at least one of the base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 that receive messages via wayside units 120 i.e. local control devices, see PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus base stations 103a and 103b in wired connection with central office 101 are interpreted as local control devices within

Supplemental Box

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Continuation of:

the legacy train control system that receive status messages from wayside communication units 104a and 104b], para.0339, Fig.1).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for operating wireless train communications in conjunction with legacy train control systems in the invention of Metrom'240.
The motivation would have been for solving the constraints of dispersing devices over large geographical areas by providing wireless communication links and thereby maintaining a reliable and efficient communication handling different types of data (para.0003, 0004, Siriwongpairat).

Regarding claim 2, Metrom lacks the teaching that legacy train control systems comprise communication-based train control (CBTC) based systems.
Metrom furthermore teaches communication based train control based systems (system 100 may be configured to provide backward compatibility with existing protection solutions and/or protocols. Further, it may be particularly designed and implemented such that it may be integrated into future communications based train control systems [i.e. CBTC based systems], para.0030).
Siriwongpairat teaches legacy train control system comprising communication based train control based system (central office 101 receive the status messages through at least one of the base stations 103. Wired communication links between the base stations 103 and central office 101 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to wayside units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0339; communications in positive train control systems, para.0005; supporting railroad communications including interoperability positive train control systems [i.e. train control systems supporting communications i.e. communication based train control systems], para.0007).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for incorporating legacy train control systems comprising communication based train control systems in the invention of Metrom.
The motivation would have been for providing centralized control of locomotives or trains based on communications through central office i.e. communication based train control (para.0054, Siriwongpairat).

Regarding claim 4, modified Metrom'240 teaches the wayside communication unit obtaining information relating to trains associated with train-based devices that move within communication range of the wayside communication unit and providing the obtained information to other devices (the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 [i.e. wayside communication unit] as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. VAD or train based device approaching or moving within specified distance i.e. communication range of the WDU]. The WDU 130 may send proximity warnings (trigger alarms) to all local PADs 110 [i.e. WDU sending alarms to other devices based on information received from VAD i.e. train based devices], para.0037) but lacks the teaching of providing the obtained information to the legacy train control system, via the one or more local control devices.
Siriwongpairat teaches wayside communication unit providing information to the legacy train control system, via the one or more local control devices (wayside monitoring systems communicating monitored information to central office through base stations, para.0049; central office 101 must receive the wayside interface unit (WIU) status messages through at least one of the base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 that receive messages via wayside units 120 i.e. local control devices, see PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus base stations 103a and 103b in wired connection with central office 101 are interpreted as local control devices within the legacy train control system that receive status messages from wayside communication units 104a and 104b], para.0339).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for providing information to legacy train control system in the invention of Metrom'240.
The motivation would have been for providing central office with status updates thereby supporting signal system health and centralized control of control points (para.0054, Siriwongpairat).

Regarding claim 5, modified Metrom'240 teaches that each of plurality of wayside communication units is configured for detecting, monitoring, and/or tracking trains (wayside detection unit comprising one or more sensory components, for detecting, monitoring, and/or tracking vehicles, claim 27; the wayside devices monitor for and detect approaching vehicles (e.g., the train 101), broadcast alarms (or signals triggering alarms) when a vehicle is in proximity (e.g., determined when at particular distance from the wayside device and/or moving at particular speed), para.0036).

Regarding claim 6, modified Metrom'240 teaches that each of plurality of wayside communication units is configured for detecting, monitoring, and/or tracking trains, based on interactions with train-based devices associated with the trains (the wayside devices monitor for and detect approaching vehicles and broadcast alarms when a vehicle is in proximity, para.0036; the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit interacting with train-based devices], such as when the train 101 is at a specified distance. In response, the WDU 130 may send proximity warnings (trigger alarms) to all local PADs 110, para.0037).

Regarding claim 7, modified Metrom'240 teaches that at least one of plurality of wayside communication units is configured for obtaining ranging related information for trains, based on interactions with train-based devices associated with the trains (the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit interacting with train-based devices], such as when the train 101 is at a specified distance [distance relating to ranging information], para.0037; the WDU 400 may have sensory elements, such as a train detector 430. The train detector 430 may be operable to monitor, detect, and track approaching vehicle, using one or more suitable technologies (e.g., visual, infrared, laser ranging, etc.), and/or to enable generating corresponding data (distance, relative speed, etc.) [i.e. obtaining ranging related information such as distance], para.0072).

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Regarding claim 9, modified Metrom'240 teaches that at least one of plurality of wayside communication units is configured for directly interacting with trains based on communications with train-based devices associated with the trains (the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit (WDU) directly interacting with trains through train-based devices], such as when the train 101 is at a specified distance, para.0037).

Regarding claim 14, Metrom'240 lacks the teaching that at least one of plurality of wayside communication units is configured for interacting with one or more other wayside devices.
Siriwongpairat teaches wayside communication units configured for interacting with one or more other wayside devices (wayside monitoring subsystem 104a [i.e. wayside communication unit] is shown monitoring a switch 105 and a signal 106 [switch is interpreted as the wayside device, see PCT Application claim 15], and wayside monitoring subsystem 104b [i.e. wayside communication unit] is shown monitoring a hand-throw switch 107 [switch is interpreted as the wayside device], para.0050).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for interacting with wayside devices in the invention of Metrom'240.
The motivation would have been for controlling railroad systems by providing status updates of monitored devices such as switches (para.0054, 0050, Siriwongpairat).

Regarding claim 15, Metrom'240 lacks the teaching wherein one or more other wayside devices comprise track switches and/or signals.
Siriwongpairat teaches wayside devices comprising track switching and/or signals (wayside monitoring subsystem 104a is shown monitoring a switch 105 and a signal 106 [i.e. wayside devices], and wayside monitoring subsystem 104b is shown monitoring a hand-throw switch 107 [i.e. wayside device], para.0050).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for implementing wayside device comprising track switching and signals in the invention of Metrom'240.
The motivation would have been for controlling railroad systems by providing status updates of monitored devices such as switches (para.0054, 0050, Siriwongpairat).

Regarding claim 16, Metrom'240 lacks the teaching wherein the at least one of plurality of wayside communication units forwards control data from the legacy train control system to the one or more wayside devices.
Siriwongpairat teaches wayside communication units forwarding control data from legacy train control system to wayside devices (system 100 supports wireless communications between a central office (Communications system 100 includes a series of wayside monitoring subsystems [i.e. wayside communication units], which monitor wayside systems such as signals, switches, and track circuits [i.e. wayside devices] and communicate the monitored information directly to central office 101, though base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to waysice units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0050, Fig.1; central office 101 provides centralized control [i.e. control data] of control points through communication path between waysides 104 and central office [Fig.1 shows that wayside units 104 communicating control data from central office to wayside devices 105, 106 and 107], para.0054, Fig.1).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for forwarding control data from legacy system to wayside device through wayside communication units in the invention of Metrom'240.
The motivation would have been for controlling switch positons of the devices through control data for preventing train-to-train collisions, and over-speed derailments (para.0316, 0005, Siriwongpairat).

Regarding claim 17, modified Metrom'240 teaches that each wayside communication unit comprises a housing for enclosing components of the wayside communication unit (the wayside detection unit comprising: a housing for enclosing components of the wayside detection unit, claim 27; the WDU 400 may comprise a housing 410 for enclosing various components of the WDU 400 and/or allowing attachment to certain external elements or structures, para.0072).

Regarding claim 18, modified Metrom'240 teaches that each wayside communication unit comprises a support structure for holding and supporting the wayside communication unit when placed on or near train tracks (the wayside detection unit comprising a support structure for holding and supporting the wayside detection unit when placed on or near the path, claim 27; The WDU 400 typically would also comprise a support structure 420, such as a rigid tripod, to enable placement of the WDU 400, such as near train tracks, para.0072).

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 3, 8, 10, and 11 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Siriwongpairat) and Metrom Rail, Llc (hereinafter Metrom'608).

Regarding claim 3, modified Metrom'240 teaches communication component in communications with train-based devices (WDU 400 includes a communication subsystem 454 that may comprise suitable circuitry operable to communicate signals from and/or to the electronic device, via wireless connections, para.0076; the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. communication with train based device], para.0037) but lacks the teaching wherein the communication component is configured for utilizing ultra-wideband (UWB) based communications with one or both of the one or more local device and train-based devices.
Metrom'608 discloses vehicle management system (Abstract) and teaches communication component configured for utilizing UWB based communications with train based devices (A system for vehicle management includes a control signal interface subsystem and a vehicle-mounted subsystem [i.e. vehicle mounted subsystem is interpreted as train based device]. Each of these subsystems includes an ultra-wideband (UWB) communications component. The subsystems communicate with each other through the UWB components, Abstract; communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem, para.0013).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for implementing UWB based communications with train based devices in the invention of Metrom'240.
The motivation would have been for combining ranging technology such as UWB for measuring distance and assist in controlling and enforcing separation between rail vehicles on a rail track (para.0038, 0132, Metrom'608).

Regarding claim 8, modified Metrom'240 teaches that the at least one of plurality of wayside communication units is configured for obtaining ranging (the WDU 400 [i.e. wayside communication unit] may have sensory elements, such as a train detector 430. The train detector 430 may be operable to monitor, detect, and track approaching vehicle, using one or more suitable technologies (e.g., visual, infrared, laser ranging, etc.), and/or to enable generating corresponding data (distance, relative speed, etc.) [i.e. obtaining ranging related information such as distance], para.0072) but lacks the teaching of obtaining ranging based on ultra-wideband (UWB) signaling.
Metrom'608 teaches obtaining ranging based on UWB signaling (determining speed by distance ranging over time for example, using the UWB time-of-flight data over time, para.0090; UWB may provide a wide bandwidth distance measurement signal that can be used to measure distance, para.0132).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for obtaining ranging data based on UWB signaling in the invention of Metrom'240.
The motivation would have been for combining ranging technology such as UWB for measuring distance and assist in controlling and enforcing separation between rail vehicles on a rail track (para.0038, 0132, Metrom'608).

Regarding claim 10, modified Metrom'240 teaches at least one of plurality of wayside communication units directly interaction with systems on the train (the train 101 may be equipped with the VAD 120 [i.e. system on the train], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit (WDU) directly interacting with VAD i.e. train system], such as when the train 101 is at a specified distance, para.0037) but lacks the teaching of controlling one or more systems within the trains.
Metrom'608 teaches directly interacting and controlling one or more systems with the train (When the collision avoidance system 100 determines that the signals provided by the signal control point 40 are not being followed by the rail vehicle operator, the processor 150 can operate one or more other functions of the collision avoidance system 100. For example, the processor may use the auto-braking system 130 to initiate an auto-braking feature to automatically brake or otherwise reduce the speed of the rail vehicle [i.e. controlling auto-braking system within the train] or otherwise reduce the speed of the rail vehicle, para.0076; the auto-braking system 130 can be adapted to automatically brake a rail vehicle based on the distance between the vehicle and a signal control point 40, depending on the signal indicated by the signal control point 40. For example, the collision avoidance system 100 can automatically brake the rail vehicle when the collision avoidance system 100 detects that the rail vehicle is not observing a stop signal communicated by the signal control point, para.0077).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for controlling systems within the train in the invention of Metrom'240.
The motivation would have been for controlling and enforcing sufficient vehicle separation thereby avoiding disastrous collisions and accidents (para.0008, 0005, Metrom'608).

Regarding claim 11, Metrom'240 lacks the teaching wherein the one or more systems within the trains comprise automated braking, speed sensors, or operator displays.
Metrom'608 teaches that systems within the trains comprise automated braking or speed sensors (the auto-braking system 130 can be adapted to automatically brake a rail vehicle based on the distance between the vehicle and a signal control point 40, depending on the signal indicated by the signal control point 40. For example, the collision avoidance system 100 can automatically brake the rail vehicle when the collision avoidance system 100 detects that the rail vehicle is not observing a stop signal communicated by the signal control point, para.0077).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for controlling systems such as automated braking within the train in the invention of Metrom'240.
The motivation would have been for controlling and enforcing sufficient vehicle separation thereby avoiding disastrous collisions and accidents (para.0008, 0005, Metrom'608).

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Claims 12 and 13 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Siriwongpairat) and Milan.

Regarding claim 12, modified Metrom'240 teaches the power component configured to obtain power (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27) but lacks the teaching of obtaining power using one or more power harvesting techniques.
Milan discloses wireless railroad monitoring system (Abstract) and teaches obtaining power using power harvesting techniques (a power harvesting component configured to generate power from motion of a rail vehicle and provide sufficient power to operate the sensor node without access to any additional power sources, para.0008, 0019).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Milan for implementing power harvesting techniques for obtaining power in the invention of Metrom'240.
The motivation would have been for providing power for rail operation without requiring access to any additional power sources such as connection to an external electrical grid (para.0019, Milan).

Regarding claim 13, modified Metrom'240 teaches the power component is configured to obtain power (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27) but lacks the teaching of obtaining power by harvesting solar energy.
Milan teaches obtaining power by harvesting solar energy (The set of power harvesting components 12 can include one or more power harvesting components 12 configured to generate power from an ambient condition of the operating environment, e.g., solar power generators, para.0020; sensor node 10 can include a power harvesting component 12 comprising a solar cell, which can be configured to generate power from sunlight, para.0029).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Milan for obtaining power by harvesting solar energy in the invention of Metrom'240.
The motivation would have been for providing power for rail operation without requiring access to any additional power sources such as connection to an external electrical grid (para.0019, Milan).

Claims 1-18 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Search History:

Limited Classification Search

The Patent Analyst performed a limited classification search within the following US, IPC, CPC, ECLA, or F-Term classification areas:

CPC Class/Subclass(es): B61L 27/0005; B61L 15/0027; B61L 27/0038; B61L 27/0077; B61L 15/0018 (2018.08)

IPC (8) Class/Subclass(es): B61L 27/00; B61L 25/02; B61L 15/00; B61L 23/16 (2018.01)

U.S. Class/Subclass(es): 246/124; 701/19; 701/20

See Global Search Results.

Global Patent Literature Text Search

The Patent Analyst performed the following global text search, which was not limited by classification but may or may not have been limited by other criteria:

Minesoft PatBase: https//www.patbase.com

#	Search query	Results
1	FT=((wireless w2 train) AND (legacy w2 train))	2
2	PA=(METROM RAIL, LLC)	6
3	PA=((METROM w2 RAIL))	6
4	FT=(wireless* AND (train* w2 communicat*) AND wayside*)	239
5	FT=(wireless* AND (train* w2 communicat*) AND wayside* AND power*)	191
6	FT=(wireless* AND (train* w2 communicat*) AND wayside* AND power* AND CBTC)	22
7	FT=(wireless* AND (train* w2 communicat*) AND wayside* AND power* AND UWB)	0
8	PN=(US2016280240 OR US2016046308 OR US2015344048 OR US2011075641 OR US2015060608)	5
9	CPC=(B61L27/0005)	603
10	4 AND 9	26
11	CPC=(B61L15/0027)	909
12	4 AND 11	63
13	CPC=(B61L27/0038)	710
14	4 AND 13	26
15	CPC=(B61L27/0077)	421
16	4 AND 15	29
17	CPC=(B61L15/0018)	189

18	4 AND 17	8
19	IC=(B61L27/00)	5927
20	4 AND 19	106
21	IC=(B61L25/02)	5267
22	4 AND 21	82
23	IC=(B61L15/00)	2483
24	4 AND 23	68
25	IC=(B61L23/16)	2615
26	4 AND 25	3
27	UC=(246/124)	199
28	4 AND 27	5
29	UC=(701/19)	992
30	4 AND 29	84
31	UC=(701/20)	444
32	4 AND 31	36

Google Patents: https://patents.google.com

#	Search query	Results
1	(METHODS AND SYSTEMS FOR WIRELESS TRAIN COMMUNICATIONS)	100+
2	assignee:(Metrom Rail LLC)	8
3	(wireless train communications) (wayside communication units)	100+
4	"wireless" "train" "communications" "wayside" "power"	100+
5	"wireless" "train" "communications" "wayside" "power" "legacy"	36
6	"wireless" "train" "communications" "wayside" "power" "legacy" "train control system"	30
7	(wireless train communications) (power component) (harvesting power) (harvesting solar energy)	100+
8	"wireless" "train" "wayside communication" "track" "switches" "power"	17
9	"wireless train communications" "wayside"	0
10	"wireless" "train" "wayside communication" "track" "switches" "power" "UWB"	0

Computer Accessed Text Databases Searched

The Patent Analyst searched the following computer accessed text databases:

Google Scholar: https://scholar.google.com/

#	Search query	Results
1	(METHODS AND SYSTEMS FOR WIRELESS TRAIN COMMUNICATIONS)	100+
2	(wireless train communications) (wayside communication units)	100+
3	"wireless" "train" "communications" "wayside" "power"	100+
4	"wireless" "train" "communications" "wayside" "power" "legacy"	100+
5	"wireless" "train" "communications" "wayside" "power" "legacy" "train control system"	40
6	(wireless train communications) (power component) (harvesting power) (harvesting solar energy)	100+
7	"wireless" "train" "wayside communication" "track" "switches" "power"	32
8	"wireless train communications" "wayside"	2
9	"wireless" "train" "wayside communication" "track" "switches" "power" "UWB"	4

Date search was completed: 26 October 2018

AK/MP

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 29153WO01	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2016/023754	International filing date *(day/month/year)* 23 March 2016	(Earliest) Priority Date *(day/month/year)* 23 March 2015
Applicant METROM RAIL, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☒ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 1A

   ☐ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☒ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/023754

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See supplemental page

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-20

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/023754

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 21/02; G08B 21/18 (2016.01)
CPC - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 13/2488; G08B 21/02 (2016.05)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 21/02; G08B 21/18; G08G 1/123; G08G 1/16; G08G 7/02
CPC - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 13/2488; G08B 21/02; G08B 21/18; G08G 1/123; G08G 1/16; G08G 1/163; G08G 1/166; G08G 7/02; G08G 9/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 246/15; 246/122R; 246/124; 340/540; 340/901; 340/903; 340/933; 340/944; 701/301 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar
Search terms used: alarm, alert, protect, safety, worker, personnel, train, rail, wearable, circuitry, antenna, diverse, polarize, motion sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/0006912 A1 (SHEARDOWN et al) 13 January 2011 (13.01.2011) entire document	1, 7, 8, 11, 12, 15, 20
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Y		2-6, 9, 10, 13, 14, 16-19
Y	US 2014/0045547 A1 (SILVERPLUS, INC.) 13 February 2014 (13.02.2014) entire document	2-5
Y	US 2011/0152971 A1 (NGHIEM et al) 23 June 2011 (23.06.2011) entire document	6, 13, 14, 18
Y	US 2012/0296562 A1 (CARLSON et al) 22 November 2012 (22.11.2012) entire document	9, 10, 16, 17, 19
A	US 5,727,758 A (PENZA et al) 17 March 1998 (17.03.1998) entire document	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 July 2016	08 AUG 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/023754

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-20, drawn to a system for worker protection, the system comprises: a compact wearable personal alert device.
Group II, claims 21-26, drawn to a system for worker protection, the system comprises: a vehicle-mounted alert device.
Group III, claims 27-30, drawn to a system for worker protection, the system comprises: a wayside detection unit.

The inventions listed as Groups I, II and III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a compact wearable personal alert device, configured for use by a worker, the personal alert device comprising an attachment structure for attaching the personal alert device to the worker or an item used by the worker; generate, in response to signals received from a companion alert device, a safety alert; and output, via the one or more indicator components, one or more alert indications to the worker based on the safety alert as claimed therein is not present in the invention of Groups II and III. The special technical feature of the Group II invention: broadcast alert triggering signals; and generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle; and output based on the data, via the one or more I/O components, feedback information to the operator as claimed therein is not present in the invention of Groups I or III. The special technical feature of the Group III invention: a wayside detection unit, configured for placement on or near path of a vehicle; determine, based on sensory data obtained from the one or more sensors, when the vehicle is approaching the wayside detection unit as claimed therein is not present in the invention of Groups I or II.

Groups I, II and III lack unity of invention because even though the inventions of these groups require the technical feature of a system for worker protection; a housing; one or more antennas, configured for transmitting and/or receiving wireless signals; one or more circuits operable to process signals and data, and to perform one or more applications or functions, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2012/0296562 A1 (CARLSON et al) 22 November 2012 (22.11.2012) teaches a system for worker protection (Para. 25); a housing (Para. 40); one or more antennas, configured for transmitting and/or receiving wireless signals (Para. 28); one or more circuits operable to process signals and data, and to perform one or more applications or functions (Para. 49).

Since none of the special technical features of the Group I, II or III inventions are found in more than one of the inventions, unity of invention is lacking.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY LTD.
500 WEST MADISON STREET
34TH FLOOR
CHICAGO, IL 60661

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	08 AUG 2016

Applicant's or agent's file reference	FOR FURTHER ACTION
29153WO01	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2016/023754	23 March 2016	23 March 2015

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 21/02; G08B 21/18 (2016.01)
CPC - B61L 23/06; B61L 23/34; B61L 25/02; G08B 1/08; G08B 13/2488; G08B 21/02 (2016.05)

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	06 July 2016	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2016/023754

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2016/023754

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:

   ☐ paid additional fees.

   ☐ paid additional fees under protest and, where applicable, the protest fee.

   ☐ paid additional fees under protest but the applicable protest fee was not paid.

   ☒ not paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-20, drawn to a system for worker protection, the system comprises: a compact wearable personal alert device.
Group II, claims 21-26, drawn to a system for worker protection, the system comprises: a vehicle-mounted alert device.
Group III, claims 27-30, drawn to a system for worker protection, the system comprises: a wayside detection unit.

The inventions listed as Groups I, II and III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a compact wearable personal alert device, configured for use by a worker, the personal alert device comprising an attachment structure for attaching the personal alert device to the worker or an item used by the worker; generate, in response to signals received from a companion alert device, a safety alert; and output, via the one or more indicator components, one or more alert indications to the worker based on the safety alert as claimed therein is not present in the invention of Groups II and III. The special technical feature of the Group II invention: broadcast alert triggering signals; and generate, in response to triggering of alerts, data relating to alerts and/or to other devices or objects in path of the vehicle; and output based on the data, via the one or more 1/O components, feedback information to the operator as claimed therein is not present in the invention of Groups I or III. The special technical feature of the Group III invention: a wayside detection unit, configured for placement on or near path of a vehicle; determine, based on sensory data obtained from the one or more sensors, when the vehicle is approaching the wayside detection unit as claimed therein is not present in the invention of Groups I or II.

Groups I, II and III lack unity of invention because even though the inventions of these groups require the technical feature of a system for worker protection; a housing; one or more antennas, configured for transmitting and/or receiving wireless signals; one or more circuits operable to process signals and data, and to perform one or more applications or functions, this technical feature is not a special technical feature as it does not make a contribution over the prior art.

Specifically, US 2012/0296562 A1 (CARLSON et al) 22 November 2012 (22.11.2012) teaches a system for worker protection (Para. 25); a housing (Para. 40); one or more antennas, configured for transmitting and/or receiving wireless signals (Para. 28); one or more circuits operable to process signals and data, and to perform one or more applications or functions (Para. 49).

Since none of the special technical features of the Group I, II or III inventions are found in more than one of the inventions, unity of invention is lacking.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1-20

Form PCT/ISA/237 (Box No. IV) (January 2015)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2016/023754

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	2-6, 9, 10, 13, 14, 16-19	YES
	Claims	1, 7, 8, 11, 12, 15, 20	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 7, 8, 11, 12, 15, and 20 lack novelty under PCT Article 33(2) as being anticipated by Sheardown et al. (hereinafter Sheardown).

Regarding Claim 1, Sheardown discloses a system for worker protection (abstract), the system comprises: a compact wearable personal alert device (paragraph 28, 70, track worker 40 wears on his/her person a device 70 that is capable of transmitting signals that may constitute part or entirely of track worker information; paragraph 29, the device 70 may also be configured to receive notifications from the CIPC 50, such as when a safety warning notification is sent by the safety system 10 through the CIPC 50 that will alert the track worker 40 to move to a point of safety; claim 12, as a watch, therefore compact); configured for use by a worker (track worker 40, paragraph 28), the personal alert device comprising: a housing for enclosing components of the personal alert device (claim 12, a watch inherently comprises a housing); an attachment structure for attaching the personal alert device to the worker or an item used by the worker (claim 12, a watch inherently has an attachment structure for the worker); a power supply for powering components of the personal alert device (paragraph 28, has its own power source, such as a battery); a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals (paragraph 28, an RFID tag inherently comprises an antenna for transmitting and/or receiving wireless signals); one or more indicator components, for outputting alert indications (paragraph 66, beeps); and one or more circuits operable to process signals and data (paragraphs 28, 66, circuitry inherent for the RFID tag to process the data and signals to provide the output), and to perform one or more applications or functions relating to operations of the personal alert device (paragraph 67, inherent circuitry for GPS monitoring); wherein the personal alert device is operable to: process signals received from a companion alert device (CIPC, 50, paragraphs 26-28); and generate, in response to signals received from a companion alert device, a safety alert (paragraph 66, see figure 15); and output, via the one or more indicator components, one or more alert indications to the worker based on the safety alert (beeps, paragraph 66).

Regarding Claims 7-8, Sheardown discloses the system of claim 1, wherein triggering of alerts and/or broadcast of signals triggering of the alerts is based on one or more types of alert thresholds, the one or more types of alert thresholds comprise time-to-arrival (TTA), distance-from-train (DFT), and low-speed close proximity distance alert (CPD) (see figure 11, calculating if a collision is possible and sending alerts to the work if yes, therefore the threshold alert is distance from train for the collision).

Regarding Claim 11, Sheardown discloses the system of claim 1, wherein the companion alert device comprises a vehicle-mounted alert device, a wayside detection unit, or another personal alert device (see figure 15, CIPC is a wayside detection unit, paragraph 26).

Regarding Claim 12, Sheardown discloses the system of claim 1, wherein the one or more indicator components comprise at least one of visual indicator, audio indicator, and a tactile indicator (paragraph 66, beeps, audio).

Regarding Claim 15, Sheardown discloses the system of claim 1, wherein the attachment structure comprises a clip structure or a strap structure (claim 12, a watch inherently has a strap structure).

Regarding Claim 20, Sheardown discloses the system of claim 1, wherein the personal alert device is operable to: receive Global Navigation Satellite System (GNSS) signals; determine location information based on the received GNSS signals; and utilize the location information in conjunction with at least one of the operations of the personal alert device (using GPS data, which is a GNSS, to configure alarm data, paragraph 67).

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 2-5 lack an inventive step under PCT Article 33(3) as being obvious over Sheardown et al. (hereinafter Sheardown) in view of Silverplus, Inc. (hereinafter Silverplus).

Regarding Claims 2-5, Sheardown fails to explicitly disclose the personal alert device is operable to implement a power management scheme for optimizing power consumption in the personal alert device (claim 2); the power management scheme comprises transitioning the personal alert device from a full operation mode to a powersaving mode, the power-saving mode comprising at least one of shut-down mode and low-function mode (claim 3); the personal alert device comprises at least one control component for generating control data applicable to the power management scheme (claim 4); the at least one control component comprises a movement sensor for sensing movement of the worker, configured to generate indications when the personal alert device is moving or not (claim 5).
In the same field of endeavor, Silverplus teaches a wearable communications alert device (abstract, paragraph 7) comprising the device is operable to implement a power management scheme for optimizing power consumption in the personal alert device (paragraph 77, optimizing the power in the device); the power management scheme comprises transitioning the personal alert device from a full operation mode to a powersaving mode, the power-saving mode comprising at least one of shut-down mode and low-function mode (paragraph 70, the parameters to reduce power consumption; claim 80, detecting user interface for low power consumption); the personal alert device comprises at least one control component for generating control data applicable to the power management scheme (paragraph 70, claim 80, detecting user interface for low power consumption); the at least one control component comprises a movement sensor for sensing movement of the worker, configured to generate indications when the personal alert device is moving or not (paragraph 17, motion sensors for personal input).
It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Sheardown with the teaching of Silverplus for the purpose of using a hands-free communication device with optimal power saving configurations (Sliverplus, paragraphs 5, 11).

Claims 6, 13, 14, and 18 lack an inventive step under PCT Article 33(3) as being obvious over Sheardown et al. (hereinafter Sheardown) in view of Nghiem et al. (hereinafter Nghiem).

Regarding Claims 6, 13-14, 18, Sheardown fails to explicitly disclose wherein the one or more antennas comprise diversity antennas of identical or differing polarity, and the personal alert device is operable to support use of diversity during the transmitting and/or receiving of wireless signals (claim 6); the power supply comprises a rechargeable power supply (claim 13); the rechargeable power supply is operable to recharge without direct connection (claim 14); the housing completely seals internal space enclosing components of the personal alert device, and wherein charging the power supply and/or communication of data to and/or from the portable alert device is done without direct connection (claim 18).
In the same field of endeavor, Nghiem teaches a wearable alert device (abstract, implantable therefore a type of wearable; paragraph 67, for transmitting patient data; paragraph 63, how the patient reacted to the therapy, therefore a bad reaction acts as an alarm), comprising one or more antennas comprise diversity antennas of identical or differing polarity (paragraph 68, providing diversified antennae within the implantable device, paragraph 130, polarization diversity therefore different), and the personal alert device is operable to support use of diversity during the transmitting and/or receiving of wireless signals (paragraph 130, for the signals therefore during transmitting and/or receiving, see figure 2); the power supply comprises a rechargeable power supply (paragraph 126, a rechargeable power source); the rechargeable power supply is operable to recharge without direct connection (paragraph 97, via the RF antenna, therefore no direct connection); the housing completely seals internal space enclosing components of the personal alert device (paragraph 49), and wherein charging the power supply and/or communication of data to and/or from the portable alert device is done without direct connection (paragraph 97, via the RF antenna, therefore no direct connection).
It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Sheardown with the teaching of Nghiem for the purpose of tailoring the device to the specific need of the user (Nghiem, paragraphs 68, 62).

Claims 9, 10, 16, 17, and 19 lack an inventive step under PCT Article 33(3) as being obvious over Sheardown et al. (hereinafter Sheardown) in view of Carlson et al. (hereinafter Carlson).

Regarding Claims 9-10, 16-17, 19, Sheardown fails to explicitly disclose the personal alert device is operable to communicate with one or more nearby alert devices, to forward received signals and/or alerts generated in response to the received signals among the personal alert device and the one or more nearby alert devices (claim 9); the personal alert device is operable to log data relating to alerts triggered and/or handled by the personal alert device (claim 10); he personal alert device comprises one or more acknowledgment components, configured for receiving input from the worker, to indicate acknowledgment of the safety alert (claim 16); the personal alert device is operable to communicate a signal to the companion alert device to indicate the acknowledgment of the safety alert by the worker (claim 17); the personal alert device is operable to implement configurable alarm management for allowing setting and/or adjusting of rules controlling triggering and/or handling of alerts (claim 19).
In the same field of endeavor, Carlson teaches a device to alert a person (abstract, generating a warning for a user, figure 6) comprising the personal alert device is operable to communicate with one or more nearby alert devices (see figure 5, communicating with multiple devices; paragraph 42), to forward received signals and/or alerts generated in response to the received signals among the personal alert device and the one or more nearby alert devices (paragraph 96, each vehicle comprising a VMM, paragraph 37, paragraphs 78-79, passing along warnings to other VMMs); the personal alert device is operable to log data relating to alerts triggered and/or handled by the personal alert device (paragraph 120, saving the logs formed by the VMMs); the personal alert device comprises one or more acknowledgment components, configured for receiving input from the worker, to indicate acknowledgment of the safety alert (paragraph 108); the personal alert device is operable to communicate a signal to the companion alert device to indicate the acknowledgment of the safety alert by the worker (paragraph 111, an acknowledgment button); the personal alert device is operable to implement configurable alarm management for allowing setting and/or adjusting of rules controlling triggering and/or handling of alerts (paragraph 60, adjusting settings for each VMM, paragraph 119, the settings trigger the alarms).
It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Sheardown with the teaching of Carlson to better monitor the location of and separation distance between rail line vehicles (Carlson, paragraph 2).

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2016/023754

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 1-20 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: Andrew B. Karp
McAndrews, Held & Malloy, Ltd.
500 W. Madison, 34th Floor
Chicago, Illinois 60661
United States of America

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 18 FEB 2015
Applicant's or agent's file reference 27735WO01	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US14/53900	International filing date *(day/month/year)* 03 September 2014 (03.09.2014)
Applicant METROM RAIL, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **19 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2014)

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: Andrew B. Karp
McAndrews, Held & Malloy, Ltd.
500 W. Madison, 34th Floor
Chicago, Illinois 60661
United States of America

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)*
Applicant's or agent's file reference 27735WO01	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US14/53900	International filing date *(day/month/year)* 03 September 2014 (03.09.2014)
Applicant METROM RAIL, LLC	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.
   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within **19 months from the priority date, the applicant may request that a supplementary international search be carried out** by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 Telephone No. PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2014)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 27735WO01	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US14/53900	International filing date *(day/month/year)* 03 September 2014 (03.09.2014)	(Earliest) Priority Date *(day/month/year)* 03 September 2013 (03.09.2013)
Applicant METROM RAIL, LLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☒ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   ☒ the text is approved as submitted by the applicant.

   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

   a. the figure of the **drawings** to be published with the abstract is Figure No. 1

   ☒ as suggested by the applicant.

   ☐ as selected by this Authority, because the applicant failed to suggest a figure.

   ☐ as selected by this Authority, because this figure better characterizes the invention.

   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/53900

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Group I: Claims 1-12; Group II: Claims 13-15; Group III: Claims 16-20

-***-Please see Supplemental Page-***-

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/53900

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60T 7/12; G08G 1/16 (2015.01)
CPC - B60T 7/12; G08G 1/161
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) Classification(s): G08G 1/16; B61L 27/00, B61L 25/02, B61L 23/00; B60T 7/12 (2015.01)
CPC Classification(s): G08G 1/161; B61L 27/00, 27/0022, 2205/04, 25/025, 15/0027, 23/34; USPC Classification(s): 701/301, 19, 117

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC); ProQuest; IEEE/IEEEXplore; Google/Google Scholar: rail, train, vehicle, signal, length, distance, crash, collision, disaster, accident, alert, warning, stop, brake, ultra wideband, UWB, mount, install, radio frequency, RFID

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2012/0296562 A1 (CARLSON, R et al.) 22 November 2012: abstract; figures 4, 6, 7; paragraphs [0028], [0030], [0041], [0045], [0047], [0064], [0072], [0110], [0121].	1-12 --- 18-20
X --- Y	US 2011/0046845 A1 (KOZLAY, D.) February 24, 2011; figures 1, 5; paragraphs [0017], [0034]-[0036], [0089], [0093], [0094].	16, 17 --- 18-20
Y	US 5675190 A (MORITA, H.) October 07, 1997; abstract; figures 1, 6, 7, column 1, lines 7-14; column 4, lines 1-14; column 6, line 55 through column 7, line 28.	13-15
Y	US 2008/0114519 A1 (DUFAUX, D., et al.) May 15, 2008; paragraphs [0015], [0132], [0144].	13-15
A	US 2006/0151672 A1 (HEDDEBAUT, M et al.) 13 July 2006: entire document.	1-12
A	US 2010/0225527 A1 (TALTY, T et al.) 09 September 2010: entire document.	1-12
A	US 2004/0155760 A1 (GRISHAM, W et al.) 12 August 2004: entire document.	1-12

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 January 2015 (07.01.2015)	18 FEB 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

-***-Continued from Box No. III - Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-12 are directed toward a system for vehicle management.
Group II: Claims 13-15 are directed toward a vehicle-mounted system for interfacing with a brake loop of a vehicle.
Group III: Claims 16-20 are directed toward a system for vehicle speed management.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I include an ultra-wideband communication component; and determining a distance between a vehicle-mounted subsystem and a control signal interface subsystem based on time-of-flight of at least one communication, which are not present in Groups II-III.

The special technical features of Group II include a switch including a first contact configured to connect to a first side of a brake loop and a second contact configured to connect to a second side of the brake loop; automatically determining a braking event without receiving information about a status of an operator-controlled actuator; opening and closing the switch to electrically disconnect and connect the first contact from the second contact, which are not present in Groups I and III.

The special technical features of Group III include determining a rule for behavior of the vehicle according to information corresponding to a status of a control signal; and observe operation of the vehicle to evaluate compliance with the rule, which are not present in Groups I-II.

The common technical feature shared by Groups I-III is a vehicle-mounted system, comprising: a control signal interface subsystem; a vehicle-mounted subsystem configured to: communicate with the control signal interface subsystem to receive information corresponding to a status of the control signal.

However, these common features are previously disclosed by US 2003/0132666 A1 to BOND, III et al. (hereinafter "Bond"). Bond discloses a vehicle-mounted system (vehicle 12 comprises a brake control system 10; Abstract. Figure1, paragraph [0020]), comprising: a control signal interface subsystem (collision controller 17; Figure 1 and paragraph [0020]); a vehicle-mounted subsystem (object detection system 14; Figure 1, paragraph [0038]) configured to: communicate with the control signal interface subsystem to receive information corresponding to a status of the control signal (object detection system 14 monitors the current situation and communicates with the collision controller 17 to obtain an object status signal; Figure 1, paragraphs [0038]-[0039]).

Since the common technical features are previously disclosed by the Bond reference, these common features are not special and so Groups I-III lack unity.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: Andrew B. Karp
McAndrews, Held & Malloy, Ltd.
500 W. Madison, 34th Floor
Chicago, Illinois 60661
United States of America

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	18 FEB 2015
Applicant's or agent's file reference 27735WO01	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US14/53900	03 September 2014 (03.09.2014)	03 September 2013 (03.09.2013)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B60T 7/12; G08G 1/16 (2015.01)
CPC - B60T 7/12; G08G 1/161

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1 *bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to th IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Fom PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No 571-273-3201	07 January 2015 (07.01.2015)	Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US14/53900

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US14/53900

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:

   ☒ paid additional fees.

   ☐ paid additional fees under protest and, where applicable, the protest fee.

   ☐ paid additional fees under protest but the applicable protest fee was not paid.

   ☐ not paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

Group I: Claims 1-12; Group II: Claims 13-15; Group III: Claims 16-20

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-12 are directed toward a system for vehicle management.
Group II: Claims 13-15 are directed toward a vehicle-mounted system for interfacing with a brake loop of a vehicle.
Group III: Claims 16-20 are directed toward a system for vehicle speed management.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I include an ultra-wideband communication component; and determining a distance between a vehicle-mounted subsystem and a control signal interface subsystem based on time-of-flight of at least one communication, which are not present in Groups II-III.

The special technical features of Group II include a switch including a first contact configured to connect to a first side of a brake loop and a second contact configured to connect to a second side of the brake loop; automatically determining a braking event without receiving information about a status of an operator-controlled actuator; opening and closing the switch to electrically disconnect and connect the first contact from the second contact, which are not present in Groups I and III.

The special technical features of Group III include determining a rule for behavior of the vehicle according to information corresponding to a status of a control signal; and observe operation of the vehicle to evaluate compliance with the rule, which are not present in Groups I-II.

The common technical feature shared by Groups I-III is a vehicle-mounted system, comprising: a control signal interface subsystem; a vehicle-mounted subsystem configured to: communicate with the control signal interface subsystem to receive information corresponding to a status of the control signal.

However, these common features are previously disclosed by US 2003/0132666 A1 to BOND, III et al. (hereinafter "Bond"). Bond discloses a vehicle-mounted system (vehicle 12 comprises a brake control system 10; Abstract, Figure1, paragraph [0020]), comprising: a control signal interface subsystem (collision controller 17; Figure 1 and paragraph [0020]); a vehicle-mounted subsystem (object detection system 14; Figure 1, paragraph [0038]) configured to: communicate with the control signal interface subsystem to receive information corresponding to a status of the control signal (object detection system 14 monitors the current situation and communicates with the collision controller 17 to obtain an object status signal; Figure 1, paragraphs [0038]-[0039]).

Since the common technical features are previously disclosed by the Bond reference, these common features are not special and so Groups I-III lack unity.

4. Consequently, this opinion has been established in respect of the following parts of the international application:

   ☒ all parts.

   ☐ the parts relating to claims Nos. _____

Form PCT/ISA/237 (Box No. IV) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US14/53900

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	13-15, 18-20	YES
	Claims	1-12, 16, 17	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations:

Claims 1-12 lack novelty under PCT Article 33(2) as being anticipated by US 2012/0296562 A1 to CARLSON et al. (hereinafter 'Carlson').

As per claim 1, Carlson discloses a system for vehicle management, wherein the system comprises: a control signal interface subsystem including an ultra-wideband (UWB) communications component (collision avoidance system transmits and receive signals (control signal interface subsystem), using an Ultra Wideband (UWB) sensing unit to reliably track vehicles (vehicle management); abstract; paragraph [0030]); and a vehicle-mounted subsystem including a UWB communications component (a vehicle mounted module (vehicle-mounted subsystem) includes an ultra wideband (UWB) communications unit; paragraph [0028]), wherein the vehicle-mounted subsystem is configured to: interface with a braking system of the vehicle (the vehicle mounted module (vehicle-mounted subsystem) includes a vehicular interface for a braking system; figure 7; paragraphs [0028], [0047]); communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the vehicle-mounted subsystem (a collision avoidance system transmits and receive signals (control signal interface subsystem) and communicates with a vehicle mounted module (vehicle-mounted subsystem), using an Ultra Wideband (UWB) sensing unit; abstract; figure 6; paragraphs [0028], [0030], [0045]); and determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem (a collision avoidance system transmits and receive signals (control signal interface subsystem) and communicates with a vehicle mounted module (vehicle-mounted subsystem), using an Ultra Wideband (UWB) sensing unit to determine Time of Flight, TOF, distance, by measuring the distance between the UWB units; abstract; figure 6; paragraphs [0028], [0030], [0045], [0064]).

As per claim 2, Carlson discloses the system of claim 1, additionally, Carlson discloses wherein the vehicle-mounted subsystem is further configured to generate an alert if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a threshold (a warning system (alert) if certain distance/speed measurements violate certain thresholds (less than a threshold); abstract; figures 6, 15; paragraphs [0028], [0030], [0045], [0110]).

As per claim 3, Carlson discloses the system of claim 1, additionally, Carlson discloses wherein the vehicle-mounted subsystem is further configured to cause the braking system of the vehicle to activate if the distance between the vehicle-mounted subsystem and the control signal interface subsystem is less than a threshold (if certain distance/speed measurements violate certain thresholds (less than a threshold), the brakes are activated; abstract; figure 4; paragraphs [0030], [0041], [0110], [0121]).

As per claim 4, Carlson discloses the system of claim 1, additionally, Carlson discloses wherein the vehicle-mounted subsystem further comprises: a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the at least one RFID tag (a vehicle mounted module (vehicle-mounted subsystem) includes an RFID communication device uses a sensor to scan a field and may be attached to a worker's badge, while worker is standing on the tracks (RFID tag external to the vehicle) to monitor the workers (retrieve information); paragraphs [0024], [0028], [0121]); and wherein the vehicle-mounted subsystem is further configured to determine a distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag (an RF radio is used, and the separation distance between vehicles is monitored by utilizing RFID sensors stored information; paragraphs [0039], [0044], [0047], [0121]).

As per claim 5, Carlson discloses the system of claim 4, additionally, Carlson discloses wherein: the vehicle-mounted subsystem is further configured to substantially continuously receive information relating to speed of the vehicle (a vehicle mounted module (vehicle-mounted subsystem) continuously calculates distances and vehicle speed information; abstract; paragraphs [0024], [0028], [0099], [0100]); and the vehicle-mounted subsystem determines a changing distance between the vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag and the information relating to speed of the vehicle (monitor the separation distance between vehicles by utilizing mounted sensors on each vehicle, an RFID communication device (RFID tag), and the location information that is stored related to vehicle speed; abstract; paragraphs [0039], [0044], [0100], [0121]).

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US14/53900

Supplemental Box

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-***-Continued from Box V: Citations and Explanations-***-

As per claim 6, Carlson discloses the system of claim 1, further comprising: an access point external to the vehicle (a data link (access point) transmits data, and saved logs may be downloadable by an authorized person via a laptop computer (external to the vehicle); paragraphs [0067], [0120]); and wherein the vehicle-mounted subsystem is further configured to: store data relating to prior behavior of the vehicle (a vehicle mounted module (vehicle-mounted subsystem) logs and stores data related to the vehicle positioning over time (prior behavior of the vehicle), abstract; paragraphs [0028], [0120], [0128]); and communicate the data relating to prior behavior of the vehicle with the access point (a data link (access point) transmits data, and log information includes data related to the vehicle positioning over time (prior behavior of the vehicle), paragraphs [0067], [0120]).

As per claim 7, Carlson discloses a system for vehicle management, wherein the system comprises: a control signal interface subsystem including an ultra-wideband (UWB) communications component (collision avoidance system transmits and receive signals (control signal interface subsystem), using an Ultra Wideband (UWB) sensing unit to reliably track vehicles (vehicle management); abstract; paragraph [0030]); a first vehicle-mounted subsystem including a UWB communications component (a vehicle mounted module 402 (first vehicle-mounted subsystem) includes an ultra wideband (UWB) communications unit; figure 4; paragraphs [0028], [0041]), wherein the first vehicle-mounted subsystem is configured to interface with a braking system of the vehicle (the vehicle mounted module 402 (first vehicle-mounted subsystem) includes a vehicular interface for a braking system; figures 4, 7; paragraphs [0028], [0041], [0047]); a second vehicle-mounted subsystem including a UWB communications component, wherein the second vehicle-mounted subsystem is configured to be mounted on another vehicle (a plurality of vehicle mounted modules 404 (second vehicle-mounted subsystem) use multiple Ultra Wideband (UWB) sensing units, which track the location of the rail line vehicle and at least one other vehicle (another vehicle); abstract; figure 4; paragraphs [0025], [0028], [0041], [0064]), and wherein the first vehicle-mounted subsystem is configured to: communicate with the UWB communications component of the control signal interface subsystem via the UWB communications component of the first vehicle-mounted subsystem (a vehicle mounted module 402 (first vehicle-mounted subsystem) communicates using a Ultra Wideband (UWB) sensing unit of the collision avoidance system, which transmits and receive signals (control signal interface subsystem); abstract; figure 4; paragraphs [0028], [0030], [0041], [0045], [0064]); communicate with the UWB communications component of the second vehicle-mounted subsystem via the UWB communications component of the first vehicle-mounted subsystem (a vehicle mounted module 402 (first vehicle-mounted subsystem) communicates with a plurality of vehicle mounted modules 404 (second vehicle-mounted subsystem), where multiple Ultra Wideband (UWB) sensing units are used; abstract; figures 4, 6; paragraphs [0025], [0028], [0041], [0064]); determine a distance between the first vehicle-mounted subsystem and the control signal interface subsystem based on a time-of-flight of at least one communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the first vehicle-mounted subsystem (a collision avoidance system transmits and receive signals (control signal interface subsystem) and communicates with a vehicle mounted module 402 (first vehicle-mounted subsystem), where an Ultra Wideband (UWB) sensing unit determines Time of Flight, TOF, distance, by measuring the distance between the UWB units; abstract; figures 4, 6; paragraphs [0028], [0030], [0041], [0045], [0064]); and determine a distance between the first vehicle-mounted subsystem and the second vehicle-mounted subsystem based on a time-of-flight of at least one communication between the UWB communications component of the second vehicle-mounted subsystem and the UWB communications component of the first vehicle-mounted subsystem (a vehicle mounted module 402 (first vehicle-mounted subsystem) communicates with a plurality of vehicle mounted modules 404 (second vehicle-mounted subsystem), where multiple Ultra Wideband (UWB) sensing units are used to determine Time of Flight, TOF, distance, by measuring the distance between the UWB units; abstract; figures 4, 6; paragraphs [0025], [0028], [0041], [0045], [0064], [0072]).

As per claim 8, Carlson discloses the system of claim 7, additionally, Carlson discloses wherein the first vehicle-mounted subsystem is further configured to: generate an alert if the distance between the first vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold (a collision avoidance system communicates with a vehicle mounted module 402 (first vehicle-mounted subsystem), and if there is a violation of a predetermined separation criteria (first threshold), an alert is generated; abstract; figure 4; paragraphs [0028], [0030], [0041], [0112], [0121]); and generate an alert if the distance between the first vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold (a vehicle mounted module 402 (first vehicle-mounted subsystem) communicates with a plurality of vehicle mounted modules 404 (second vehicle-mounted subsystem), and if there is a violation of a predetermined separation criteria, or a hard threshold (second threshold) was reached, and a hard alarm is generated; abstract; figure 4; paragraphs [0025], [0028], [0041], [0106], [0112], [0121]).

As per claim 9, Carlson discloses the system of claim 7, additionally, Carlson discloses wherein the first vehicle-mounted subsystem is further configured to: cause the braking system of the vehicle to activate if the distance between the first vehicle-mounted subsystem and the control signal interface subsystem is less than a first threshold (a collision avoidance system communicates with a vehicle mounted module 402 (first vehicle-mounted subsystem), and if there is a violation of a predetermined separation criteria (first threshold), and brakes are activated; abstract; figure 4; paragraphs [0041], [0112], [0121]); and cause the braking system of the vehicle to activate if the distance between the first vehicle-mounted subsystem and the second vehicle-mounted subsystem is less than a second threshold (a vehicle mounted module 402 (first vehicle-mounted subsystem) communicates with a plurality of vehicle mounted modules 404 (second vehicle-mounted subsystem), and if there is a violation of a predetermined separation criteria, or a hard threshold (second threshold) was reached, and brakes are activated; abstract; figure 4; paragraphs [0041], [0106], [0112], [0121]).

As per claim 10, Carlson discloses the system of claim 7, additionally, Carlson discloses wherein the first vehicle-mounted subsystem further comprises: a radio-frequency identification (RFID) subsystem configured to scan at least one RFID tag external to the vehicle to retrieve information stored on the at least one RFID tag (a vehicle mounted module (vehicle-mounted subsystem) includes an RFID communication device uses a sensor to scan a field and may be attached to a worker's badge, while worker is standing on the tracks (RFID tag external to the vehicle) to monitor the workers (retrieve information); paragraphs [0024], [0028], [0121]); and wherein the first vehicle-mounted subsystem is further configured to determine a distance between the first vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag (a collision avoidance communicates a vehicle mounted module 402 (first vehicle-mounted subsystem), and an RF radio is used, and the separation distance between vehicles is monitored by utilizing RFID sensors stored information; abstract; figure 4; paragraphs [0039], [0041], [0044], [0047], [0121]).
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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

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As per claim 11, Carlson discloses the system of claim 10, additionally, Carlson discloses wherein: the first vehicle-mounted subsystem is further configured to substantially continuously receive information relating to speed of the first vehicle (a vehicle mounted module 402 (first vehicle-mounted subsystem) continuously calculates distances and information regarding the host speed (speed of the first vehicle), abstract; figure 4; paragraphs [0024], [0028], [0041], [0099], [0100]); and the first vehicle-mounted subsystem determines a changing distance between the first vehicle-mounted subsystem and the control signal interface subsystem based on the information stored on the at least one RFID tag and the information relating to speed of the first vehicle (a collision avoidance system communicates with a vehicle mounted module 402 (first vehicle-mounted subsystem), to monitor the separation distance between vehicles by utilizing mounted sensors, an RFID communication device (RFID tag), and the location information that is stored related to host speed (speed of the first vehicle); abstract; figure 4; paragraphs [0039], [0041] [0044], [0100], [0121]).

As per claim 12, Carlson discloses the system of claim 7, additionally, Carlson discloses further comprising: an access point external to the vehicle (a data link (access point) transmits data, and saved logs may be downloadable by an authorized person via a laptop computer (external to the vehicle); paragraphs [0067], [0120]); and wherein the first vehicle-mounted subsystem is further configured to: store data relating to prior behavior of the vehicle (a vehicle mounted module 402 (first vehicle-mounted subsystem) logs and stores data related to the vehicle positioning over time (prior behavior of the vehicle); abstract; figure 4; paragraphs [0028], [0041], [0120], [0128]); and communicate the data relating to prior behavior of the vehicle with the access point (a data link (access point) transmits data, and log information includes data related to the vehicle positioning over time (prior behavior of the vehicle), paragraphs [0067], [0120]).

Claims 16 and 17 lack novelty under PCT Article 33(2) as being anticipated by US 2011/0046845 A1 (KOZLAY).

As per claim 16, Kozlay discloses a system for vehicle speed management (a system for tracking and managing a vehicle's speed; abstract; paragraphs [0017], [0089]), wherein the system comprises: a control signal interface subsystem (a transportation safety system transmits control signals and information (control signal interface subsystem); paragraph [0034]); and a vehicle-mounted subsystem configured to: communicate with the control signal interface subsystem to receive information corresponding to a status of the control signal (a vehicle mounted transportation safety apparatus (subsystem) is configured to communicate wirelessly with the transportation safety system (control signal interface subsystem) to transmit (receive) information corresponding to the vehicles operation and control (status of the control signal); figures 1, 5; paragraphs [0017], [0036], [0093]); determine a rule for behavior of the vehicle according to the information corresponding to the status of the control signal (the apparatus determines whether the predefined transportation safety policies (rule for behavior of the vehicle) are being followed, based on (according to) the information transmitted to and from (status of the control signal) the transportation safety system; paragraphs [0034], [0035]); and observe operation of the vehicle to evaluate compliance with the rule (the apparatus monitors the train's operator (operation of the vehicle) to determine (evaluate) compliance or non-compliance with the restrictions (rule); paragraphs [0034], [0094]).

As per claim 17, Kozlay discloses the system of claim 16. Kozlay additionally discloses wherein the rule corresponds to the status of the control signal being at least one of red, double red, yellow, or double yellow (based on compliance to operation restrictions (rule), based on (corresponds to) signals received (status of the control signal) the mounted transportation safety apparatus may indicate non compliance using a red LED; figures 6A, 6B; paragraphs [0114], [0115]).

Claims 13-15 lack an inventive step under PCT Article 33(3) as being obvious over US 5675190 A (MORITA) in view of US 2008/0114519 A1 to DUFAUX et al. (hereinafter "DuFaux").

As per claim 13, Morita discloses a vehicle-mounted system for interfacing with a brake loop of a vehicle (a vehicle mounted automatic brake system for engaging (interfacing) with the brake system (loop) of the vehicle; abstract; column 1, lines 7-14), wherein the vehicle-mounted system comprises: a switch including a first contact configured to connect to a first side of the brake loop and a second contact configured to connect to a second side of the brake loop (the automatic braking system (vehicle-mounted system) comprises a parking brake switch, including a first contact point, 1A, connected to the brake system (a first side of the brake loop) and second contact point, 1D, also connected to the brake system (a second side of the brake loop); figure 1; column 4, lines 1-14; column 7, lines 6-28); and at least one processor in electrical communication with the switch and configured to (a CPU (processor) may be used control (in electrical communication) the parking brake switch; figure 6; column 6, lines 55-66): open the switch upon an occurrence of the braking event, thereby electrically disconnecting the first contact from the second contact (the CPU may be configure to open the parking brake switch, when the engine is powered off (upon an occurrence of the braking event), thereby disconnecting the electrical contacts (first contact from the second contact), to engage the parking brake; column 6, line 64 through column 7, line 5); and close the switch upon an expiration of the braking event, thereby electrically connecting the first contact with the second contact (the CPU may close the switch, when a release flag is set (upon an expiration of the braking event), thereby electrically connecting contact points 1A (first contact) and 1D (second contact); figures 1 and 7; column 7, lines 6-28). Morita does not disclose a system configure to, automatically determine a braking event without receiving information about a status of an operator-controlled actuator. DuFaux discloses a system configure to automatically determine a braking event without receiving information about a status of an operator-controlled actuator (the processor is configured to automatically detect (determine) an actuation signal indicating that the vehicles is operating outside a designated parameters (a braking event), the system is completely independent of any operator actuated braking systems (without receiving information about a status of an operator-controlled actuator); paragraphs [0015], [0132]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified the method of Morita, with the teaching of DuFaux, because by doing so, the method of Morita would provide an automatic brake actuator system for a wheeled vehicle, thereby providing a more efficient and a more robust braking system.

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As per claim 14, Morita and DuFaux, in combination, disclose the vehicle-mounted system of claim 13. Morita does not disclose the system wherein the at least one processor is further configured to cause an alert to be generated upon occurrence of the braking event. DuFaux discloses the system wherein the at least one processor is further configured to cause an alert to be generated upon occurrence of the braking event (the processor is configured to generate an alert action, to alert the operator of an impending braking action, upon a detected braking event; paragraphs [0015], [0144]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified the method of Morita, with the teaching of DuFaux, because by doing so, the method of Morita would provide an automatic brake actuator system for a wheeled vehicle, thereby providing a more efficient and a more robust braking system.

As per claim 15, Morita and DuFaux, in combination, disclose the vehicle-mounted system of claim 13. Morita additionally discloses the system wherein the at least one processor is configured to determine the expiration of the braking event based on a change in status of an operator-controlled input (the CPU (processor) is configured to determine when the release flag has been set (expiration of the braking event), when the (based on) parking brake switch has been operated to the reset position (change in status of an operator-controlled input); column 7, lines 19-28)

Claims 18-20 lack an inventive step under PCT Article 33(3) as being obvious over Kozlay in view of Carlson.

As per claim 18, Kozlay discloses the system of claim 16. Kozlay does not disclose the system wherein the rule specifies a stop-time duration for the vehicle. Carlson discloses the system wherein the rule specifies a stop-time duration for the vehicle (a threshold (rule) that specifies how quickly the rail line vehicle can stop under the current conditions (a stop-time duration for the vehicle); paragraph [0033]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified the method of Kozlay, with the teaching of Carlson, because by doing so, the method of Kozlay would provide a collision avoidance system using sensor technologies, thereby providing a more reliable and a more robust braking system.

As per claim 19, Kozlay and Carlson, in combination, disclose the system of claim 18. Kozlay does not disclose the system wherein the rule specifies a speed for the vehicle. Carlson discloses the system wherein the rule specifies a speed for the vehicle (a preliminary threshold (rule) that specifies a speed for the rail line vehicle; figure 15; paragraph [0111]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified the method of Kozlay, with the teaching of Carlson, because by doing so, the method of Kozlay would provide a collision avoidance system using sensor technologies, thereby providing a more reliable and a more robust braking system.

As per claim 20, Kozlay and Carlson, in combination, disclose the system of claim 19. Kozlay does not disclose the system wherein the rule specifies a maximum speed for the vehicle after an expiration of the stop-time. Carlson discloses the system wherein the rule specifies a maximum speed for the vehicle after an expiration of the stop-time (the thresholds (rule) may be dynamic and may indicated that the speed threshold (maximum speed for the vehicle) may change as the vehicle stopping distance threshold changes based on the current conditions (after an expiration of the stop-time); figure 15, paragraphs [0107], [0110], and [0111]). It would have been obvious to a person of ordinary skill in the art, at the time of the invention, to have modified the method of Kozlay, with the teaching of Carlson, because by doing so, the method of Kozlay would provide a collision avoidance system using sensor technologies, thereby providing a more reliable and a more robust braking system.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

PCT Recordation of Search History

Case/PCT Application Number: PCT/US14/53900

CLIN Number/Technical Field of PCT Application: 3

Date(s) during which the search was conducted: 5 January 2015 – 28 January 2015

Date of Completion of Recordation of Search History Form: 28 January 2015

Research Analyst Initials: RAH, TWM

Search Approval Official (SAO) Initials: HKP

Field of Search/Classification Information:

IPC(8) Classification(s): G08G 1/16; B61L 27/00, B61L 25/02, B61L 23/00; B60T 7/12 (2015.01)

CPC Classification(s): G08G 1/161; B61L 27/00, 27/0022, 2205/04, 25/025, 15/0027, 23/34; B60T 7/12

USPC Classification(s): 701/301, 19, 117

Database(s) Searched (Patent and Non-Patent Literature (NPL), Including Sub-Databases and Files Searched) and Search Terms Used:

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC); ProQuest; IEEE/IEEEXplore; Google/Google Scholar:

rail, train, vehicle, signal, length, distance, crash, collision, disaster, accident, alert, warning, stop, brake, ultra wideband, UWB, mount, install, radio frequency, RFID

Database Search String Recordation, Including Dates of Searches):
Patent Database Search Strategy/Results:

PatSeer (28 January 2015):

ID	Search String	Records	Created Date
L13	TACD :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w3 contact*) AND (processor* OR CPU* OR computer*) AND (detect* w15 event*) AND (vehicle* OR truck* OR train*) AND (open w4 circuit*))	50	28-Jan-15
L12	TACD :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w3 contact*) AND (processor* OR CPU* OR computer*) AND (detect* w15 event*) AND (vehicle* OR truck* OR train*))	92	28-Jan-15
L11	TACD :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w3 contact*) AND (processor* OR CPU* OR computer*) AND (detect* w5 event*))	40	28-Jan-15
L10	TACD :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w3 contact*) AND (processor* OR CPU* OR computer*) AND detect*)	1129	28-Jan-15
L9	TACD :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w3 contact*))	3743	28-Jan-15
L8	TAC :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w2 contact))	141	28-Jan-15
L7	TA :(automatic* AND (brake w2 (switch* OR loop* OR emergenc*)) AND (electric* w2 contact))	15	28-Jan-15
L6	ASNN :(Metrom w2 Rail) TACD :(automatic* AND brake*)	3	28-Jan-15
L5	ASNN :(Metrom w2 Rail)	8	28-Jan-15
L4	INV :(Delia w2 Domiguez)	0	28-Jan-15
L3	INV :(Andrew w2 Bernard w2 Karp)	0	28-Jan-15

PatSeer (7 January 2015):

ID	Search String	Records	Created Date
L28	TACD :((rail* OR train* OR vehic*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) IC :(G08G1/16 OR B61L27/00 OR B61L25/02 OR B61L23/00)	102	7-Jan-15
L27	TACD :((rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) IC :(G08G1/16 OR B61L27/00 OR B61L25/02 OR B61L23/00)	100	7-Jan-15
L26	TACD :((rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) CPC :(G06G1/161 OR B61L27/0022 OR B61L2205/04 OR B61L25/025 OR B61L15/0027 OR B61L23/34)	4	7-Jan-15
L25	TACD :(((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)) AND (rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) CPC :(G06G1/161 OR B61L27/0022 OR B61L2205/04 OR B61L25/025 OR B61L15/0027 OR B61L23/34)	4	7-Jan-15

L24	TAC :((rail* OR train* OR vehic*)) TACD :(((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)) AND (rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) CPC :(B60T7/12 OR G06G1/161 OR B61L27/0022 OR B61L2205/04 OR B61L25/025 OR B61L15/0027 OR B61L23/34)	4	7-Jan-15
L23	TACD :(((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)) AND (rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) UC :(701/301 OR 701/19 OR 701/117)	34	7-Jan-15
L22	TACD :(((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)) AND (rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) IC :(G08G1/16 OR B61L27/00 OR B61L25/02 OR B61L23/00)	47	7-Jan-15
L21	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*)) TACD :(((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)) AND (rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) IC :(G08G 1/16 OR B61L 27/00 OR B61L 25/02 OR B61L 23/00 OR B60T7/12)	6	7-Jan-15

L20	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*)) TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (mount* OR install*) AND ((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)))	54	7-Jan-15
L19	TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (mount* OR install*) AND ((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*))) TA :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*))	8	7-Jan-15
L18	TACD :((rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (mount* OR install*) AND ((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*))) TA :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*))	8	7-Jan-15
L17	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*)) TACD :((rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (mount* OR install*) AND ((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)))	54	7-Jan-15

L16	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*)) TACD :((rail* OR train* OR vehic*) AND ((signal* w3 enforce*) OR (signal* w3 control*)) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (mount* OR install*) AND ((radio*frequenc*) OR (radio* w2 frequenc*) OR (RFID) OR barcod* OR (bar w2 code*)))	21	7-Jan-15
L15	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (rail* OR train* OR vehic*)) TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)))	87	7-Jan-15
L14	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)))	343	7-Jan-15
L13	TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)))	3168	7-Jan-15
L12	TACD :((length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) ASN :(METROM)	3	7-Jan-15

L11	TACD :((rail* OR train* OR vehic*) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) ASN :(METROM)	3	7-Jan-15
L10	TACD :((rail* OR train* OR vehic*) AND ((signal* w3 enforce*) OR (signal* w3 control*)) AND (length* OR distance*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) ASN :(METROM)	0	7-Jan-15
L9	TAC :((rail* OR train* OR vehic*)) ASN :(METROM)	8	7-Jan-15
L8	TAC :(((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB))) ASN :(METROM)	3	7-Jan-15
L6	INV :((Andrew Karp) OR (Delia Dominguez))	0	7-Jan-15
L5	TAC :((rail* OR train* OR vehic*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (length* OR distance*)) INV :((Andrew w2 Karp) OR (Delia W2 Dominguez))	0	7-Jan-15
L4	TAC :((rail* OR train* OR vehic*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (length* OR distance*))	314	7-Jan-15
L3	TAC :((rail* OR train* OR vehic*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (length* OR distance*) AND (stop* OR brak*))	38	7-Jan-15
L2	TA :((rail* OR train* OR vehic*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (length* OR distance*) AND (stop* OR brak*))	0	7-Jan-15
L1	TA:(rail* OR train* OR vehic*) AND ((ultra*wideband*) OR (ultra 2W wideband*) OR (UWB)) AND (length* OR distance*)	47	7-Jan-15

Non-Patent Literature (NPL) Search Strategy/Results:

ProQuest (6 January 2015):

- (rail? OR train? OR vehic?) AND ((ultra?(4W) wideband?) OR (UWB)) AND (length? OR distanc?)
- (rail? OR train? OR vehic?) AND ((ultra?(4W) wideband?) OR (UWB)) AND (length? OR distanc?) AND (crash? OR collision? OR collide? OR disast? OR accident?) AND (alert? OR warn? OR notif?) AND (stop? OR brak?)
- (rail? OR train? OR vehic?) AND ((ultra?(4W) wideband?) OR (UWB)) AND (length? OR distanc?) AND (crash? OR collision? OR collide? OR disast? OR accident?) AND (alert? OR warn? OR notif?) AND (stop? OR brak?) AND (mount? OR install?) AND ((radio?(4W) frequenc?) OR (RFID) OR barcod? OR (bar?(4W) code?))

Google/Google Scholar (6 January 2015):

- Rail vehicle signal enforcement and separation control
- Vehicle collision avoidance UWB signal
- Vehicle management using UWB communications
- automatic "brake switch", contacts, processor

IEEE/IEEEXplore (6 January 2015):

- (rail* OR train* OR vehic*) AND ((ultra NEAR/4 wideband) OR (UWB)) AND (length* OR distanc*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra NEAR/2 wideband) OR (UWB))
- (rail* OR train* OR vehic*) AND ((ultra NEAR/4 wideband) OR (UWB)) AND (length* OR distanc*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND ((ultra NEAR/2 wideband) OR (UWB))
- (rail* OR train* OR vehic*) AND ((ultra NEAR/4 wideband) OR (UWB)) AND (length* OR distanc*) AND (crash* OR collision* OR collide* OR disast* OR accident*) AND (alert* OR warn* OR notif*) AND (stop* OR brak*) AND (mount* OR install*) AND ((radio NEAR/2 frequency) OR (RFID) OR barcod* OR (bar NEAR/2 code))

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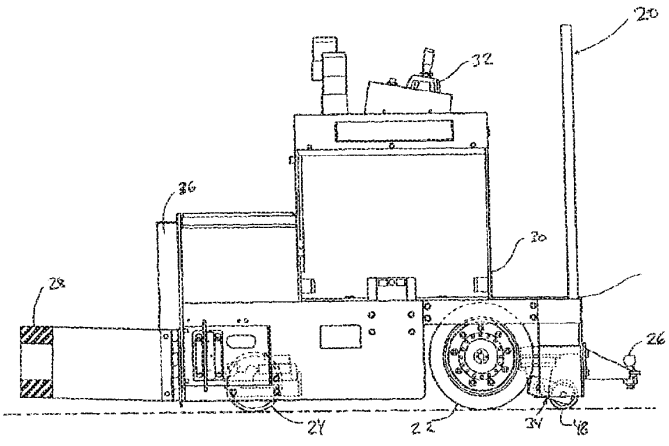
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[Continued on next page]

(54) Title: MATERIAL HANDLING SYSTEMS WITH HIGH FREQUENCY RADIO LOCATION DEVICES



(57) Abstract: A material handling system uses high-frequency location devices, such as ultra-wideband (UWB) devices, for determining the location of mobile units, such as AGVs, overhead mono-rails, conveyor components, or individual articles being transported by such units. The high-frequency location devices may also be used to identify the contents and/or routing information for material being moved within a facility. AGVs may incorporate the high-frequency location devices into their navigation systems to utilize the position and/or heading updates provided by the location devices in guiding the vehicle. The location devices work in cooperation with a number of stationary location devices, such as beacons, that are positioned within the environment at known locations, such as in or adjacent the ceiling of the workplace environment. High-frequency radars may also be used to provide electronic bumpers to the AGVs, allowing them to sense obstacles and take appropriate action to avoid collisions with the obstacles.

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MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

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MATERIAL HANDLING SYSTEMS WITH HIGH FREQUENCY RADIO LOCATION DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to commonly-assigned U.S. provisional applications 60/309,568 entitled Ultra-Wideband AGV System, filed August 2, 2001, and 60/318,029, entitled Ultra-Wideband Material Handling System, filed September 10, 2001, the disclosures of which are both hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates generally to material handling systems, including sortation systems, monorail systems and the like and more particularly to navigation and/or communication systems for material handling systems.

Automatic guided vehicles, or AGVs for short, are used extensively today in a wide variety of material handling applications. AGVs come in a wide variety of types, from those that carry cargo on their back, to those that tow trains of cargo behind them on carts, to still other types. In order for each AGV to be able to automatically guide itself throughout a factory or plant, it must be able to determine its position within the factory. In the past, the determination of the vehicle's position has been carried out in several different ways. Some AGVs use laser targets positioned at known locations throughout the factory to reflect a laser beam emitted from the AGV. The reflection of the laser beams are detected by the AGV and used to determine the position of the AGV relative to the targets. Using three or more targets, the vehicle can then calculate its position. An example of such a prior art AGV system is disclosed in U.S. Patent 4,790,402 issued to Field et al., the disclosure of which is hereby incorporated herein by reference.

In another type of AGV, the vehicle uses a combination of incremental sensors and one or more beacon sensors to determine its position. The incremental sensors detect changes in the vehicle's position or bearing, while the beacon sensors make absolute measurements of the vehicle's position or heading with respect to one or more fixed beacons positioned throughout the factory. By combining the use of both incremental and beacon sensors, the vehicle is able to determine its position and/or heading sufficiently often and with sufficient accuracy to guide itself to its intended destination. Examples of incremental sensors used on AGVs include wheel encoders that measure the rotations of

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one or more wheels on the AGV, and gyroscopes that measure changes in the vehicle's orientation. Examples of beacons include magnets buried in the floor, transponders positioned at known locations, laser targets such as those described above, and various other detectable marks or objects. One prior art AGV system that uses wheel encoders, a gyro, and magnets positioned in the floor for navigation is disclosed in U.S. Patent 5,281,901 issued to Yardley et al., the disclosure of which is hereby incorporated herein by reference.

In the past, the various types of AGV systems have each suffered from certain disadvantages. In virtually all of the prior AGV systems, the measurement of the position of the beacons during their installation—whether they are magnets, transponders, reflectors, or other types—has often been a labor-intensive and expensive task. In addition, with respect to the laser-reflector AGVs, these systems require a visual line-of-sight between the vehicle and the target which can often be difficult to obtain in a crowded factory or plant environment. The use of magnets or transponders buried in the floor requires drilling or other operations that can be disruptive to the operation of the factory, and which can have significant costs. Further, the magnets or transponders must be placed on or adjacent to the vehicle pathways in order for the vehicle to be able to detect them. Changes in the pathway therefore often require the installation of additional magnets.

In addition to the foregoing disadvantages of the various navigation systems, prior art AGV systems have also had certain disadvantages in their communications systems. For example, some prior art AGV systems rely on a central controller or repeater that issues or repeats communications received from vehicles. In such systems, the vehicles do not directly contact each other, but instead channel their messages to the central controller or repeater. If a communications failure occurs with the central controller or repeater, then the whole communications system fails. Such single point of failure communication systems are desirably avoided, if possible. Additionally, prior art AGV systems have often used RF communications which are susceptible to interference, especially in plants that have extensive metal structures and electrical/electronic equipment that may emit its own radiation. These problems are also desirably avoided. The need can therefore be seen for an AGV system which overcomes the aforementioned disadvantages.

Prior AGVs have also typically included one or more bumpers on their front and/or back ends that allow the vehicle to safely stop or slow down when objects in its path are detected. Such bumpers may consist of a physical structure that produces an electric signal when impacted, optical sensors that optically detect obstacles in the vehicle's path,

laser sensors that detect laser signals emitted from the vehicle and reflected off of obstacles, or combinations of these various types of sensors. One such system is described in more detail in U.S. Patent No. 5,048,637 issued to Lomasney. While such systems have proven to be adequate, they are often expensive to implement. Furthermore, their detection range for detecting obstacles is often limited such that it is possible for small objects to escape detection by the sensor and possibly cause damage to the vehicle, the undetected object, or both. More inexpensive sensors with a broader field of vision are therefore desirable.

In addition to the use of AGVs to move material between different locations within a warehouse, conveyors and other types of material handling equipment are often used. In order to ensure that the materials are properly moved to their intended destination, they often include a bar code on one of their sides. These bar codes are read by a scanner which is in communication with the appropriate control circuitry to ensure that, after reading the bar code, the material handling system will deliver the article to its intended destination. In order for the bar code scanner to work properly, it is often necessary to make sure that all of the articles are properly oriented so that their bar codes can be read by the scanner. Further, it is often necessary to re-scan articles whose bar codes have become covered in dirt, wrinkled, or otherwise unreadable. A method of tagging articles such that these and other difficulties could be overcome is also desirable.

Sortation systems, such as of the type described in commonly assigned patent application serial no. 10/163,788 filed June 6, 2002 by Zeitler et al., use a distributed control having modules that are distributed along a conveying surface. The relative position of the modules is often desirably known so that a higher level controller can properly control the various components of the conveyor system. In the past, the relative position of such components was often determined by normal surveying or measuring technologies. Those techniques are labor–intensive and expensive. A method of reducing those costs is therefore desirable.

Material handling systems that employ overhead electrified monorails to transport material typically use hard-wired communications to communicate with a master controller. These hard wire connections decrease the ease at which the system is installed and/or modified. These systems also typically employ relatively expensive sensors for allowing the monorail vehicle to determine when it has arrived at a particular workstation. The desirability of overcoming these and other disadvantages can be seen.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides improved material handling methods that overcome the aforementioned disadvantages, as well as others. The present invention includes a material handling system that utilizes high frequency radio location transmitters and receivers, also known as transceivers or beacons, for use in navigation, communication, and/or guidance. The use of these types of transmitters and receivers eases the installation of the material handling systems, enhances the ability of the particular types of material handling systems to determine position, and allows for improved guidance of the material handling vehicles. The present invention also includes high-frequency radio tags that can be attached to articles, pallets, or other containers for tracking, routing, and monitoring of material movement in a material handling system.

According to one aspect of the present invention, a navigation system for determining the location of an automatic guided vehicle is provided. The navigation system includes a plurality of electromagnetic energy emitting beacons which are positioned at known locations in a factory or plant. At least one electromagnetic energy sensor is provided on-board the vehicle and is capable of detecting signals from the plurality of beacons, or emitting signals to the beacons. A processor in communication with either said sensor, said beacons, or both determines location of the sensor with respect to the beacons based upon the electromagnetic signals passed between the sensor and the beacons.

According to another aspect of the present invention, a kit may be provided for modifying the navigation system of an automatic guided vehicle that uses one or more incremental navigation sensors in combination with at least one beacon sensor to estimate the vehicle's position. The beacon sensor is adapted to detect beacons positioned at known locations. The kit includes a plurality of electromagnetic energy emitting beacons for positioning at known locations throughout an environment. At least one electromagnetic energy sensor is also included in the kit. The sensor is to be placed on a vehicle and it adapted to detect the signals emitted from the plurality of electromagnetic energy emitting beacons. The kit further includes a controller adapted to use the one or more incremental navigation sensors in combination with the detected beacon signals to generate an estimate of the vehicle's position.

According to another aspect of the present invention, a method is provided for installing an AGV system within an environment. The method includes providing a plurality of electromagnetic energy emitting beacons and at least one automatic guided vehicle that includes at least one sensor for detecting transmissions from the plurality of

beacons. At least three of the beacons are placed within the environment in a roughly triangular geometry and the location of the beacons are measured. Thereafter, additional beacons are placed in the environment and the measured beacons are used to determine the location of the additional beacons within the environment. The position of the additional beacons is communicated to the automatic guided vehicle.

According to yet another aspect of the present invention, an automatic guided vehicle is provided that includes a body, at least one navigation sensor, a motor, an ultra-wideband radar, and a controller. The ultra-wideband radar is capable of detecting objects located off of the vehicle, and the controller is adapted to control the movement of the vehicle based, at least partially, on any objects detected by the ultra-wideband radar.

According to still another aspect of the present invention, a communications system is provided for an automatic guided vehicle. The communications system includes an ultra-wideband transmitter positioned on the vehicle that transmits information from the vehicle via ultra-wideband signals, and an ultra-wideband receiver positioned on the vehicle that receives information transmitted via ultra-wideband signals from other sources.

According to still another aspect of the present invention, a material handling system is provided that includes a plurality of automatic guided vehicles with ultra-wideband communication systems. At least one ultra-wideband transmitter is positioned on or adjacent to a load of material to be moved by one of the plurality of vehicles. The transmitter is adapted to transmit a message to the plurality of vehicles indicating that the load of material is to be moved to a destination. A controller is also provided and adapted to determine which of the plurality of automatic guided vehicles is to retrieve the load in response to the message.

According to yet another aspect of the present invention, a plurality of high-frequency electromagnetic energy tags are positioned on articles within a facility. As these articles are moved, a sensor reads the information contained in the tags and uses the information to determine where the articles are to be moved within the facility. The sensor reads the information contained in the tags by a unique pattern of reflection of the electromagnetic energy emitted by the sensor toward the tags.

The AGVs, communications systems, navigation systems, and other aspects of the present invention provide various improved features for material handling systems. Among these improved features are reduced costs, better control of material movement, easier installation of material handling systems, such as AGV systems, improved

communications ability, more flexible usage of material handling equipment, and increased safety. These and other benefits of the present invention will become apparent to one skilled in the art in view of the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side, elevational view of one embodiment of an AGV to which the present invention finds application;

FIG. 2 is a plan, schematic view of selected components of the AGV of FIG. 1;

FIG. 3 is a perspective view of an AGV system according to one embodiment of the present invention;

FIG. 4 is a schematic view of an AGV and a plurality of beacons, illustrating a first method by which the AGV determines its position and/or heading;

FIG. 5 is a schematic view of an AGV and a plurality of beacons, illustrating a second method by which the AGV determines its position and/or heading;

FIG. 6 is a flowchart of one method of determining heading and/or position information of a mobile unit;

FIG. 7 is a flowchart of another method of determining heading and/or position information of a mobile unit; and

FIG. 8 is a perspective view of an ultra-wideband radar bumper for a mobile vehicle;

FIG. 9 is a perspective view of a conveyor sortation bed in which the present invention may be embodied;

FIG. 10 is plan, schematic view of a conveyor sortation system in which the present invention may be embodied; and

FIG 11 is a partial perspective view of a monorail system in which the present invention may be embodied.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with reference to the accompanying drawings wherein like reference numerals correspond to like elements in the several drawings. An illustrative example of a material handling system, which may be in the form of an automatic guided vehicle (AGV) 20, to which the present invention can be applied is depicted in FIG. 1. AGV 20 may be the type of vehicle which is described in more detail in U.S. Patent No. 5,764,014 issued to Jakeway, the disclosure of which is hereby incorporated herein by reference. AGV 20 includes a plurality of drive wheels 22

which are powered by motors 23 (FIG. 2) and drive the vehicle 20. AGV 20 further includes a front, steerable wheel 24, a hitch 26 for towing trailers of material, a mechanical front bumper 28, a battery storage compartment 30 for storing the batteries that provide power to the drive wheels 22, and a local operator console 32 that allows the vehicle to be operated manually by a user. When local operator console 32 is not in use, AGV 20 guides itself automatically from destination to destination. AGV 20 may also include a ground track sensor 34 that provides navigation information to the vehicle in a manner described more fully in U.S. Patent No. 5,764,014, and an ultra-wideband radar bumper 36 that will be described in more detail herein. It will, of course, be understood that the present invention finds equal application to other types of AGVs and that AGV 20 is only one example of the many different types of AGVs to which the present invention may be applied.

AGV 20 includes a navigation system 38 that is illustrated in block diagram form in FIG. 2. The navigation system 38 includes ground track sensor 34, a heading reference sensor 40, a distance measuring encoder 42, an angle encoder 44, and a high frequency radio transceiver 46. The operation of ground track sensor 34, heading reference sensor 40, distance measuring encoder 42, and angle encoder 44 is described in more detail in U.S. Patent No. 5,764,014. Suffice it to say that ground track sensor 34 measures the rotation and angular position of a unloaded ground wheel 48. This information is fed to a navigation computer 50 which uses the information, in conjunction with other navigation information, to determine the vehicle's location and heading. Navigation computer 50 outputs commands to a steer board to steer front wheel 24 to cause the vehicle to stay on an intended path. Angle encoder 44 measures the angular orientation of a caster wheel assembly on which front, steerable wheel 24 is mounted. This angular information is also fed into navigation computer 50. Distance measuring encoder 42 measures the number of rotations of front wheel 24 and feeds this information to navigation computer 50 for use in determining the vehicle's position and heading. Heading reference sensor 70 provides information about the heading of the vehicle to navigation computer 50, and may include a gyroscope.

The gyroscope, angle and distance encoders, and ground track sensor may all be incremental sensors. That is, they may not, by themselves, be able to determine an absolute position or heading of the vehicle within a given frame of reference, but instead may only be able to sense changes in position and heading. In order to determine an absolute heading or position of the vehicle 20 within a given frame of reference, high-

frequency radio transceiver 46 is provided. Transceiver 46 may be a device that sends and receives high-frequency radio signals, such as ultra-wideband signals, or other signals. Transceiver 46 may have multiple antennae placed at various points on the vehicle, allowing measurement of relative angles. These signals are used to determine the vehicle's absolute position and/or heading in a given frame of reference. In the illustrated navigation system, the absolute heading and/or position information provided by transceiver 46 to navigation computer 50 merely supplements that provided by the other navigation sensors. In this embodiment, transceiver 46 therefore does not need to provide position and heading information updates as quickly as it would if some or all of the other navigation sensors were removed. It will be understood by one skilled in the art that some or all of the other navigation sensors on vehicle 20 can be removed by simply increasing the rate at which transceiver 46 receives accurate position and heading measurement information. For example, if transceiver 46 provides updated heading information as quickly and accurately as the gyroscope in heading reference sensor 40, then heading reference sensor 40 could be discarded. Therefore, navigation system 38 may or may not include sensors other than transceiver 46. The operation of transceiver 46 will be described in more detail below.

An illustrative example of an AGV system 52 is depicted in FIG. 3. The AGV system 52 includes at least one AGV, such as AGV 20, which travels on a floor 55 throughout a plant or factory and which is adapted to carry loads. The loads may be carried on the top of the AGV, on one or more carts towed behind the AGV, or in any other manner. The AGV is able to steer itself automatically from one location to another based on instructions received from an off-board controller or from a person who manually enters an intended destination into an interface on the vehicle. As discussed above, AGV 20 includes one or more incremental navigation sensors on-board which the vehicle uses to help determine its position and/or heading. The types and number of incremental sensors are not limited within the scope of the present invention, but include such sensors as gyroscopes, wheel encoders, potentiometers, and others. Other low grade position sensors, such as flux gate compasses or magnet position sensors may also be employed. In addition to the one or more incremental and position navigation sensors, AGV 20 includes at least one transceiver 46 adapted to detect one or more stationary beacons 54 positioned at known locations throughout an environment. In the example of FIG. 3, beacons 54 are positioned along a ceiling 56. Beacons 54 could alternatively be

placed at any other locations that are within range of detection by AGV 20, as will be explained in more detail below.

AGV 20 uses one or more of beacons 54 to periodically determine its position and/or heading. While AGV 20 receives information about its location and heading from the one or more incremental sensors it has on-board, these incremental sensors have to be initialized and also tend to produce errors that increase over time. Beacons 54 provide sufficient information to AGV 20 to allow itself to both initially determine its position, and to update its position and/or heading periodically as it travels throughout the plant. AGV 20 detects the one or more beacons 54 by way of one or more transceivers 46 positioned on-board vehicle 20. (FIG. 2). In one embodiment of the present invention, beacons 54 may be various types of high frequency radio location devices such as the ultra-wideband transceivers disclosed in U.S. Patent 6,054,950, issued to Fontana, the disclosure of which is hereby incorporated herein by reference. Transceivers 46 on-board the vehicle may be ultra-wideband receivers/processors, such as those disclosed in U.S. Patent 6,054,950. In another embodiment of the present invention, beacons 54 are FMCW devices, such as those disclosed in U.S. Patents 6,255,984 issued to Kreppold, et al. and 6,278,398 issued to Vossiek, et al., the disclosures of which are both hereby incorporated herein by reference. Any other types of high frequency location devices that fall within the 3-6 Gigahertz range, which was recently approved for ultra-wideband uses in the United States by the U.S. Federal Communications Commission, could also be used, although frequencies outside this range may also be used. Still other types of high frequency location devices may also be used, such as frequency modulated radar systems and the like.

Beacons 54 are installed at known locations throughout an environment in which one or more AGVs 20 are to operate. The location of beacons 54 is communicated to each of the AGVs 20 in any known manner, such as by wireless transmission, manual entry, downloading, or by any other means. Each AGV 20 uses signals transmitted between one or more beacons 54 and the transceiver(s) 46 it has on-board to determine its position and/or heading. An example of the manner in which the AGV is able to determine its position from the beacons 54 is depicted in FIG. 4. Each beacon 54 emits a short, electromagnetic pulse that is detected by the one or more transceivers 46 located on AGV 20. By determining the time of flight for the emitted pulse to travel from one beacon 54 to a transceiver 46, AGV 20 is able to calculate the distance between the beacon 54 which emitted the pulse and the transceiver 46 which detected the pulse. By determining the

transceiver's distance to three or more beacons 54, the vehicle is able to determine its position within the facility.

For example, if beacon 54a in FIG. 4 emits a pulse that takes 5 nanoseconds to travel to transceiver 46a, then a distance 31a between transceiver 46a and beacon 54a can be computed by multiplying the propagation speed of the pulse by the time-of-flight. If the propagation speed is taken to be 300,000,000 meters/second, then the distance 31a is 1.5 meters (300,000,000 m/s times .000000005 s). It is therefore known that transceiver 46a lies somewhere on a sphere having a radius of 1.5 meters centered at beacon 54a. In order to further pinpoint the location of transceiver 46a within the facility, additional distance measurements can be taken from other beacons, such as distances 31b and 31c, which correspond to the distances to beacons 54b and 54c (FIG. 4). Taking such measurements from at least three beacons should provide sufficient information for AGV 20 to be able to calculate its position within the facility, as would be understood by one skilled in the art. Such calculations can take place by any conventional means, such as by using one or more microprocessors, or by other means. In the illustrated embodiment, navigation computer 50 may be programmed to carry out these calculations. Alternatively, a separate processor associated directly with transceiver(s) 46 can perform these calculations and communicate the result to navigation computer 50. The details by which transceiver 46 determine their position from beacons 54, in one embodiment, are described more fully in U.S. Patent 6,054,950.

In order to improve the accuracy of the measurement of the distance between vehicle 20 and beacon 54a, AGV 20 may include a plurality of transceivers 46 arranged in an array of known configurations. The distances of each transceiver 46 to beacon 54a can first be determined and then combined together, such as by averaging or other methods, to produce an estimate of vehicle position relative to beacon 54a with greater accuracy. For example, if each transceiver 46a-d in FIG. 4 measures it position away from beacon 54a by determining the time of flight of a pulse emitted from beacon 54a, these four distance determinations can be combined to produce a better estimate of the vehicle's distance from beacon 54a, provided the location of each of the transceivers on-board the vehicle is known. After making a measurement of the vehicle's distance from beacon 54a, vehicle 20 can proceed to make additional distance measurements from other beacons 54 in a like manner and use these distance measurements to determine its position. As would be understood by one skilled in the art, the multiple measurements of vehicle distance should be made simultaneously, or nearly simultaneously, before they are combined together in

order to avoid the need for accounting for possible movement of the vehicle between distance measurements. If the measurements are not made nearly simultaneously, such movement can be accounted for prior to combining the multiple measurements by way of the other navigation sensors, or by other methods, as would be understood by one skilled in the art.

In addition to determining the position of AGV 20, beacons 54 and transceivers 46 can be used to calculate the vehicle's heading. Such heading calculations can be accomplished, in one embodiment, by determining the location within the facility of two transceivers 46 on-board AGV 20. Provided the orientation of the vehicle transceivers with respect to the vehicle is known, the heading of the vehicle can be calculated. For example, suppose transceivers 46a and 46b are mounted to a vehicle such that a line drawn between the two transceivers points in the direction considered to be the heading of the vehicle 20. Suppose further that the vehicle determines the position of transceiver 46a within a facility to be (x_a, y_a), and the position of transceiver 46b to be (x_b, y_b), where the letters x and y refer to the two-axes of a coordinate frame of reference. The vehicle can compute its heading within this frame of reference according to the following formula:

$$\text{heading} = \text{tangent}[(y_a-y_b)/(x_a-x_b)]$$

The computed heading will be an angular measurement from the x-axis of the coordinate frame of reference. An infinite heading will correspond to the vehicle pointing parallel to the y-axis, while a heading of zero will correspond to the vehicle pointing parallel to the x-axis. The sign of the heading can be used to determine which end of the vehicle is pointing in the direction of the calculated heading, as would be understood by one skilled in the art. By making heading determinations based upon measurements from each of the four transceivers 46a-d on-board vehicle 20, six different heading measurements can be made. (The four transceivers 46a-d can be combined into six different unordered pairs, and each unordered pair used to calculate the vehicle's heading.) Combining these six measurements, such as by averaging, can yield an improvement in the accuracy of the resulting heading estimate.

The calculation of heading according to the above equation will produce a result that corresponds to the direction in which the vehicle is pointing. As is known in the art, the direction in which the vehicle is pointing does not always equal the direction in which the vehicle is moving. For example, during turns or situations in which the vehicle may slip sideways, the vehicle may move in directions other than the direction in which it is pointed. In order to calculate the direction of the vehicle's movement in such situations,

successive determinations in time of the vehicle's position can be used, as would be known by one skilled in the art.

The transmission of signals from beacons 54 can be synchronized in a wide variety of manners. One such manner uses a synchronization pulse that is transmitted to the beacons in either a wire or wireless fashion. The propagation time of the synchronization pulses to the various beacons should, of course, be taken into account when using this method. Other synchronization methods are disclosed in the prior art, such as in U.S. Patent 6,054,950 that can be used. In order to differentiate between pulses emitted from different beacons 54, each beacon 54 may be assigned a unique pulse pattern that is communicated to, and stored in the memory of vehicle 20, preferably at the time of the system installation. When transceiver 46 detects a particular pattern of pulses, it checks its memory for that signature pulse pattern to determine which beacon 54 emitted the pulse. Further, because vehicle 20 also stores the location of each beacon 54 in memory, it can correlate the detected pulse pattern to a particular location within the facility, thus enabling the vehicle to use the transmitted signals for position and heading determinations. In order to avoid conflicting signals being broadcast, beacons 54 are designed to emit pulses only during defined time periods. When pulse patterns are emitted from beacons 54, the particular pulse which is used for time of flight or time or arrival measurements can be any one or more of the multiple pulses emitted in the pattern.

As an alternative to emitting pulse patterns, beacons 54 could simply be assigned certain time slots in which they broadcast one or more pulses. The assignment of time slots to individual beacons 54 is communicated to vehicle 20 so that vehicle 20 can determine which beacons' signals transceiver(s) 46 may be detecting at any given moment and correlate this information to the correct position location of the beacon. The assignment of time slots may preferably include time slots in which communications other than those in which time of flights or time of arrivals are measured. For example, some time slots may be used to send synchronization signals between beacons 54 and/or transceiver 46 in order to allow the flight times and/or arrival times of various signals to be accurately measured and utilized. As another example, some time slots may be used to send communications to and from a central controller, other vehicles, or other devices.

The time it takes for signals detected by transceiver(s) 46 to be processed should be known. One manner of doing this involves knowing the physical distance between each transceiver and a processor that processes the detected signals so that the time it takes for signals to travel along the one or more wires to the processor can be accounted for.

Alternatively, each transceiver 46 may be programmed to time-stamp each signal it detects from a beacon 54. The time stamp can be used to ensure that accurate measurements of flight times or arrival times are made. If multiple transceivers 46 are on-board a vehicle, such it is important to ensure that such time stamping each transceiver 46 is synchronized with the other transceivers. Such synchronization can be carried out using a synchronization pulse, or by other means. The on-board synchronization can be further enhanced by using interferometric methods. Such interferometric methods can significantly increase the precision of the synchronization of the transceivers, thereby increasing the precision by which the differences in arrival times are measured, which in turn increases the accuracy of the vehicle's position and/or heading measurement.

As an alternative to the above-described methods for determining the heading and position of AGV 20, the heading and position of the vehicle can be determined without calculating the flight times of signals emitted from beacons 54. In such an alternative embodiment, the position and heading of the vehicle 20 is determined by comparing the differences in time in which one or more signals from a beacon 54 are detected by three or more transceiver antennae 46 positioned on the vehicle at known locations. This method is illustrated in FIG. 5. By using this method, it is not necessary to know precisely when a signal was emitted from a beacon 54. For example, suppose beacon 54b in FIG. 5 emits a signal. This signal will travel a distance 33a before it reaches, and is detected by, transceiver 46a. Likewise, the signal will travel distances 33b-d before it reaches, and is detected by, transceivers 46b-d, respectively. Because the distances 33a-d are different from each other, the time at which transceivers 46a-d will detect the emitted signal will be different from each other. By comparing the relative times at which the signal is detected by the different transceivers, the position of the vehicle with respect to beacon 54b can be determined. This is true regardless of whether the time of detection of the signal at each of the transceivers 46a-d is different or simultaneous. Of course, it is necessary to know the relative positions of transceivers 46a-d with respect to each other on the vehicle.

The exact number of transceivers 46a-d necessary to determine the position of the vehicle will be partially dependent upon the arrangement of the beacons 54. If all of the beacons are placed above the vehicle, the vehicle can use this information when the calculations of the vehicle's position yield two possible solutions, one of which is knowingly impossible—such as where one solution indicates the beacons are below the vehicle when in fact they are all positioned above the vehicle. In such a case, the vehicle would know that only the solution yielding a beacon position above the vehicles could be

valid. If beacons are to be placed both above and below the vehicle, it may be necessary to add one more transceiver on vehicle 20 than would otherwise be necessary in order to determine the vehicle's position. Further, if all of the beacons 54 are placed in a plane, the vehicle can use this information to reduce the number of transceivers 46 which the vehicle would otherwise require, particularly if the vehicle only travels on a floor that is planar and parallel to the plane of the beacons. The number of transceivers 46 on vehicle 20 necessary for the vehicle to determine its position is therefore dependent upon the arrangement of beacons 54, as would be known by one skilled in the art.

The heading of the vehicle can also be determined by measuring the differences in arrival times of a beacon signal at the multiple transceivers 46 on the vehicle. Such a heading computation can be carried out, in one embodiment, by first determining the position of one of the transceivers 46 relative to the beacon 54 which emitted the signal. The heading can be computed by calculating the location of at least one other transceiver and then comparing its position to the position of the first transceiver.

In order to improve the accuracy by which the vehicle determines it position and/or heading based on differences in arrival times of an emitted signal, multiple signals can be transmitted from different beacons. The multiple signals should be transmitted in a time interval that is small enough such that the vehicle's position will remain substantially the same -- or will have changed by an amount that can be measured or estimated -- over the span of this time interval. For example, beacon 54a might transmit a single signal that is detected by multiple transceivers 46 on vehicle 20. Based on the times at which this signal arrives at each of the multiple transceivers, the vehicle can calculate its position and heading. Immediately after beacon 54a broadcasts its signal, another beacon, such as beacon 54b, could then emit a signal. The vehicle 20 could then use this signal from beacon 54b to perform another calculation of its position and heading. Assuming that the vehicle's position or heading has changed negligibly—or by an amount that can be estimated or measured—in the time interval between the signals from beacons 54a and 54b, the two calculations of the vehicle's position and heading could be combined to produce a more accurate measurement of heading and position. The combining of the calculations could be done by a simple averaging process, a least square method, or other methods. The accuracy of the determination of the vehicle's position and heading could be further enhanced by using measurements based on additional beacons, such as a third, a fourth, or even more beacons. As noted above, the calculations of the vehicle's heading

and/or position can be performed by one or more processors, or by any other suitable means.

The different methods for determining the vehicle's position and heading are summarized in flowcharts in FIGS. 6 and 7. In a first method 57 for determining the vehicle's position and reading illustrated in FIG. 6, one or more pulses are emitted at a step 58. The pulses may be emitted from a transceiver 46 aboard the vehicle, or they may be emitted from a beacon 54. At step 60, the time of flight of the emitted pulse to a first sensor is determined. The reference to a sensor in FIGS. 6 and 7 refers to transceiver 46 if the emitted signal came from a beacon 54, or to a beacon 54 if the emitted pulse came from transceiver 46. It will be understood by those skilled in the art that the present invention finds equal application to those systems in which times of flight or arrival times are measured based on signals emitted from the vehicle to the beacons, or vice versa. At step 60a, the time of flight of the emitted signal to a second sensor is determined. At step 60c, the time of flight of the emitted signal to another sensor is determined (the Nth sensor). The total number of sensors used to measure time of flights is represented by the variable N, and N may be any integer greater than or equal to one. Steps 60b and c therefore may be optional in some embodiments. After all of the time of flight measurements have been made, the distances from the pulse emitter to each pulse sensor is determined at step 62. The distance information is used to determine a positional relationship between the emitter and at least one sensor at step 64. The positional relationship may be an absolute measurement of the vehicle's position within a facility, or only a relative measurement of the vehicle's position to one or more beacons 54, depending on the number of time of flight measurements used. After step 64, method 57 may include an optional step 66 in which multiple positional relationships between the emitter and multiple sensors are combined into a single positional relationship. This optional step may be used when multiple sensors are present. By combining the positional relationship from multiple sensors into a single measurement, which may be done by averaging, a least square method, or other means, a more accurate positional relationship may be generated. The measurements are combining based upon the knowledge of the physical location of each of the sensors relative to each other. At another optional step 68, the heading of the vehicle may be determined based upon multiple position determinations from either step 64 or step 66. Optional step 68 is implemented after method 57 has cycled through steps 58-64 a sufficient number of times to provide sufficient position information by which the heading of the vehicle can be determined.

A second method 69 of determining position and/or heading is illustrated in FIG. 7. In method 69, one or more electromagnetic pulses are emitted at step 70 in the same manner as in step 58. At steps 72a,b,c, the arrival times of the emitted pulse at one or more sensors are determined. The number of sensors can be varied between two or more. The differences in the arrival times are determined at step 74, and these differences are used to calculate an angular orientation between the emitter and sensors at step 76 in a manner that would be known to one skilled in the art. At step 78, which is optional, multiple angular orientations calculated in step 76 can be combined together into a single calculation of angular orientation, such as by averaging, a least square method, or other means. The angular orientation measurements from steps 76 and 78 can optionally be used to determine the vehicle's position at step 80. Step 80, like step 68 in method 57, can take place only after method 69 has cycled through steps 70-76 multiple times. The steps of methods 57 and 69 may take place completely on-board vehicle 20, completely off-board vehicle 20, or some combination thereof.

While the above-description of beacons 54 and transceivers 46 has been based upon these devices communicating via ultra-wideband signals, it will be understood that the scope of the invention is not limited to the use of only ultra-wideband signals. Rather, the invention finds application in any electromagnetic energy emitting transmitters and receivers wherein the transmitted signals are sufficiently defined to be able to accurately determine when the signal was emitted, when the signal was detected, or both. Alternatively, frequency modulated continuous wave radar systems can be used for position and heading determinations, although other systems will suggest themselves to be skilled artisans. In addition to the beacons 54 and transceivers 46 described above, beacons 54 and transceivers 46 could alternatively comprise the localizers described in U.S. Patent 6,002,708 issued to Fleming et al., the disclosure of which is hereby incorporated herein by reference.

The use of beacons 54 and transceivers 46 for the navigation of AGV 20 can be augmented by using one or more incremental sensors, as noted above. Such incremental sensors are particularly desirable if beacons 54 and transceivers 46 do not provide fresh measurements of position or heading with sufficient frequency to properly guide the vehicle. The measurements of heading and/or position obtained from beacons 54 and transceivers 46 can be combined with the position and heading information from the one or more incremental sensors to produce a more accurate estimate of the vehicle's heading and/or position. The combination of the incremental sensor information and the

beacon/sensor information can be accomplished in any conventional manner, including through the use of a Kalman filter. A Kalman filter can be used with any of the methods for determining heading or position described above.

Navigation system 38 utilizes beacons 54, transceiver(s) 46, and one or more processors, either separate from or part of navigation computer 50, for combining and processing the signals received by transceivers 46. The navigation system can be used either alone or in combination with other navigation sensors, such as the incremental sensors described above. If used in combination with other incremental sensors, the navigation system can be installed on original vehicles, or it can be added to existing AGVs. For example, the navigation system of the present invention could be installed as a retrofit kit on pre-existing vehicles, such as, for example, those described in U.S. Patent 5,280,901. Such vehicles use a gyroscope, wheel encoders, and a magnet sensor that detects magnets positioned at known locations on the floor of a plant to navigate. By installing the navigation system of the present invention on such a vehicle, one or more of the gyroscope wheel encoders and magnet sensors can be removed and replaced with the beacon/transceiver system of the present invention, which would provide the same or comparable navigation as the removed sensor or sensors. A navigation kit according to the present invention provides periodic updates of the vehicle's position and heading that allow it to replace one or more of these sensors. The navigation system of the present invention could therefore replace the magnet sensors of the vehicles disclosed in the '901 patent. Instead of using magnets for periodic updates, the vehicle would use the beacons and sensors for periodic updates of position and heading. Because the magnets have to be positioned on or adjacent to the AGV's pathway, and the beacons 54 do not, such a replacement would allow the vehicle's pathways to be easily changed without having to re-locate magnets or beacons. The navigation system of the present invention could also eliminate the need for the gyroscope and one or more of the wheel encoders. The navigation kit of the present invention could also be used to replace one or more navigation sensors on other types of vehicle's, such as those that use laser reflectors or those that use transponders buried in the floor, as well as other types.

The installation of AGV system 52 can be easily accomplished. Beacons 54 are mounted in any known manner at locations throughout the facility, such as on a ceiling, on the tops of racks or other stationary structures, in the floor, or in still other locations. Once one or more of these beacons have been installed, the position of at least three beacons are determined by surveying or other means. After the location of these first beacons are

determined, the position of the other beacons can be determined in a variety of manners using common surveying techniques for measurement of beacon relative locations and subsequent error reducing analytical algorithms. The need to physically survey every single beacon in the facility during installation can therefore be avoided. In order for the beacons to be able to determine their positions with respect to each other, it is necessary for them to be able to both transmit and receive signals, i.e. to be transceivers. Transceivers that can be used for this purpose are described in the 6,054,950 patent.

It will be understood that the foregoing description of the use of one or more transceiver 46 on board AGV 20 does imply that only transceivers can be used on board vehicle 20 in accordance with the present invention. For example, in situations in which beacons 54 emit signals detected by transceivers 46 and used to determined the vehicle's position and/or heading, transceivers 46 could simply be receivers. Alternatively, in situations in which transceivers 46 were used to emit signals detected by beacons 54, transceivers 46 could simply be transmitters. Likewise, beacons 54 could be either transmitters or receivers in these different situations. The term "beacon" as used in this application is therefore intended to cover receivers, transmitters, and transceivers.

In addition to using ultra-wideband signals for determining the location and/or heading of AGV, ultra-wideband signals can be used for communication in material handling systems, such as AGV system 52. Using previously disclosed embodiments as an example, each AGV includes an ultra-wideband transceiver that may or may not be the same as a transceiver 46. The communication can be directly between vehicles, between each vehicle and a central station, or some combination thereof. The communications can include any type of information, such as destination information, load information, blocking information, or other information. By using ultra-wideband signals for communication, the communications can be more secure from interference. Such communication could be accomplished by transmissions during the intervals between navigation signals from the beacons, or the navigation signals from the beacons could themselves be sent with a certain order and/or frequency that defined one or more messages. The ultra-wideband communications could also be implemented on AGVs that did not use ultra-wideband navigation techniques.

High frequency radio transmitters, such as ultra-wideband transmitters, can also be placed on or adjacent to loads to be picked up by an AGV. Such transmitters may broadcast one or more messages indicating that a load is to be transported, the contents of the load, the destination of the load, or other information concerning the load. The

initiation of such signals can be implemented by a worker pressing a button on the transmitter, or by taking other steps to cause the transmitter to transmit such a message. The transmitter may also broadcast its location, or signals sufficient for the AGVs to determine its location. Each AGV may include a controller for determining which of the available AGVs should respond to the message, or a central controller may dictate which AGV should respond to the message. Such transmitters allow loads to be monitored by a central control system throughout their movement in the facility. The transmitters may also respond to a centralized request for information in order to allow automatic inventories to be taken of material in a facility.

Beacons 54 could also be placed on individual AGVs, other mobile vehicles in the facility—such as driver-guided fork-lift trucks—or on stationary objects, in order to avoid collisions with these objects. By being able to determine its location with respect to beacons 54, vehicles 20 steer themselves accordingly to avoid collisions with certain designated beacons, such as those on fork-lift trucks or at other occupied locations. When vehicle 20 detects that it is within a certain vicinity of a beacon 54 that it should avoid, such as one on a fork-lift truck, a controller on vehicle 20 implements an appropriate velocity change to help avoid a collision with the fork-lift truck. In this manner, plant safety can be improved while minimizing the costs associated with collisions.

According to another aspect of the present invention, AGV 20 includes a high frequency radio radar module or bumper 36 located at a position on the vehicle that enables it to detect nearby objects (FIG. 1). The high frequency radio radar can be any conventional module, such as the ultra-wideband radar modules disclosed in U.S. Patent 5,805,110 issued to McEwan, the disclosure of which is hereby incorporated herein by reference. Alternatively, the radar bumper could comprise a phased array of high frequency radio antennas 82 (FIG. 8). A high frequency pulse is emitted from one of the individual antennas 84 and it reflects off of an object 86 back to the array 82. The antennas 84 detect the reflected signal at different times based upon the location of object 86. A processor compares these different detection times to determined the position of the object in a manner that would be known to one skilled in the art. While radar bumper 36 is depicted as a single bumper on the front of vehicle 20 in FIG. 1, it will be understood that multiple radar bumpers could be incorporated onto a vehicle, such as at the back of the vehicle, which is particularly useful for vehicles that are capable of bi-directional travel. For vehicles capable of side-to-side movement, additional radar bumpers 36 could be placed on the sides of the vehicle to determine whether obstacles are blocking the

vehicle's side-to-side movement. The detectable range of the radar bumpers 36 can be set to any desirable distance, but would preferably be very close to the vehicle for side bumpers 36, in front of mechanical bumper 28 for the front bumper 36, and close to the back end of the vehicle for rear bumper 36. Object detection range can also be controllable during operation to allow a safety zone tailored to the vehicle's current task. The detected information from bumper 36 could be forwarded to navigation computer 50, which would issue any appropriate steering commands to make in light of the detected object.

The high frequency radio radar module 36 can be used for a variety of purposes. The radar can be used to detect objects that obstruct the path of the vehicle, such as other vehicles, fork-lift trucks, pallets, personnel, or any other objects that might get in the way of a vehicle's path. In such situations, AGV 20 may be programmed to either stop and wait until the obstruction is removed, or to follow an alternate route to avoid the obstacle. Alternatively, the radar can be used for accurately stopping the vehicle at transfer stations, battery recharging stations, or any other locations where the vehicle must be accurately positioned. When accurately stopping at a station, the radar indicates to the vehicle its distance from a reference structure at or near the station. The vehicle stops itself at a predetermined location with respect to the reference structure. The reference structure can be any structure which is detectable by high frequency radio radar, including structures that exist within the facility prior to the AGV installation, or structures that are specifically added to provide references for the AGVs. The reference structures may be different for different stations, and AGV 20 is programmed to store the appropriate data concerning the reference structure for each station.

The high frequency radio radar module can also be used for picking up loads that are not oriented at pre-determined orientations, such as loads that are deposited on the floor or other structure from a fork-lift truck. If AGV 20 is equipped with a fork-lifting capability, the high frequency radio radar module can be positioned to detect the orientation of the pallet. Based on the detected orientation of the pallet, AGV 20 steers itself appropriately to insert its fork-lift prongs into the pallet, pick it up, and transport it to an intended destination. The various uses for the high frequency radio radar module described above are not mutually exclusive, but rather a single AGV can use one or more radar modules to perform each of the functions described above, as well as other functions.

According to still another aspect of the present invention, beacons 54 and transceivers 46 can be used as a position monitoring system for monitoring the position of AGVs, manned vehicles, such as fork-lift trucks, material loads, or a mix of these items. Such monitoring systems can be used independently of any navigation functions provided by beacons 54 and transceivers 46, or they can be used in combination with such navigational functions. For example, a plurality of beacons 54 can be positioned at known locations throughout an environment and one or more transceivers 46 can be positioned on-board the vehicle(s) and/or loads, or vice versa. The vehicle may be either an AGV, a manned vehicle, or some other type of mobile unit. The load may be a fork-lift pallet, a carton, an individual package, or some other material unit whose position may change in the facility. The position of the load and/or the vehicle is determined in accordance with one of the methods previously described. The heading of the vehicle can also be determined in accordance with one of the methods previously described.

The location of the vehicle and/or load may then be periodically transmitted to a processor, such as a central control station, a computer, or some other type of processor. FIG. 2 illustrates a computer, 116 which may receive wireless transmissions via antenna 120 from transceivers 46 of vehicle 20's location and/or heading. The processor may visually display the location of the vehicle and/or load, such as via a computer monitor; may record the movement of the vehicle and/or load over a given time period for later viewing or analysis; or may perform a combination of both of these functions. In FIG. 2, computer 116 includes a display 118 for displaying the position of vehicle 20, and computer 116 may be programmed to record and analyze the movement of vehicle 20 over time. If the processor includes a visual display, such as display 118, the movement of the mobile units and material throughout the environment can be monitored by a person. If the processor records the movements of the mobile units, this information can later be analyzed to determine the efficiency of the movement of the mobile units, the amount of usage of certain vehicles, and other aspects. The processor may be located anywhere, including on one of the vehicles, off of the vehicles at a location within the environment, or even outside the environment of the mobile units. The transmission of the position information to the processor may be accomplished by radio signals, ultra-wideband signals, hard wires, or by other means. In addition to transmitting the position information of the mobile unit to a processor for monitoring purposes, the position information can also be used by a controller on-board the vehicle for navigation and steering, as discussed above.

The monitoring of mobile units and/or material can be accomplished by having the individual transceivers 46, and associated circuitry, determine their position and/or heading, and then transmit this information to a central monitoring device. Alternatively, the central monitoring device can determine the mobile unit's and/or material's location directly. Because transceivers 46 and beacons 54 are only being used to monitor the location of mobile object, rather than to provide navigation information, in this embodiment, the rate at which updated position information is provided can be substantially less than for those applications in which navigation information is generated. For example, for the monitoring of mobile loads, it may be sufficient to provide updated position information every five seconds where the vehicle travels up to one meter/second and the location information is accurate to approximately thirty seconds. If the vehicles travel up to nine/meters per second, and the position accuracy is less, such as one meter, it may be desirable to increase the position updates, such as up to one per second. These update rates are only illustrative examples, and other update rates can, of course, be used with the present invention.

In addition to the foregoing uses of high frequency radio location signals in conjunction with automatic guided vehicles, high frequency radio location signals may also be used in accordance with the present invention to identify material being moved throughout a warehouse or other facility. In such a situation, each article—or grouping of articles, such as a pallet of stacked articles—has a tag attached to it. An example of such a tag 88 is depicted attached to an article 90 traveling on a conveyor 92 in FIG. 9. The high frequency radio location tag 88 is manufactured in a known manner to reflect high frequency radio location signals it receives according to a predefined patterns. The signals that are received and reflected may be ultra-wideband signals. A tag reader emits a high frequency radio location signal which is reflected by the tag and detected by the tag reader. The tag reader passes this information onto appropriate controls in the material handling environment to ensure that the article is properly routed throughout the facility. The controls may be aware of the correlation between the unique reflective pattern of an individual tag and the information associated with that tag. The high frequency radio location tags may therefore be used to replace bar codes, which require optical alignment for reading, and relatively clean surfaces on which the bar codes are printed. By using high frequency radio location, no particular orientation of the article is necessary for reading the information contained on the high frequency radio location tag. Such high frequency radio location tags find particular suitability with articles traveling on conveyor

systems throughout a warehouse. The high frequency radio location tags are preferably constructed so that they do not require any power to operate, either directly or by induction. Their unique signal is merely the result of their unique reflection pattern of the emitted signal or signals. In the example of FIG. 9, the tags 88 may be read by a reader positioned upstream of conveyor 92. The read information may be passed to a divert controller 94 (FIG. 10) which uses the information to determine which of the multiple branch conveyors the article 90 should be diverted to. Divert controller 94 sends commands to activate the appropriate divert shoes 98 which cause the package 90 to be appropriately diverted. The construction and generation of divert shoes 98 may be made in accordance with the system described in commonly assigned, co-pending U.S. patent application serial no. 09/968,743 filed September 28, 2001, or the system described in U.S. Patent No. 5,127,510 issued to Cotter et al., the disclosures of both of which are incorporated herein by reference. Conventional constructions and operations may also be used.

UWB transceivers, such as transceivers 46, can also be used in other material handling applications outside AGVs. Such transceivers can be incorporated into components of material handling systems for automatic identification and configuration of components of the material handling system. For example, in sortation systems for conveyors, there may be a number of individual divert control modules 100 associated with each branch conveyor 96 on a given sortation conveyor 92 (FIG. 10). The control modules 100 control, by way of example, the mechanisms for positively displacing articles 90 off of the sortation conveyor onto an adjacent branch conveyor 96. The precise number and location of each of the sortation modules 100 may vary according to the particular installation. During the installation of the sortation system, it is often necessary for a higher level controller of the overall sortation system, such as divert controller 94, to know the position of each of the control modules 100 so that the higher level controller 94 can send divert signals to the correct control module 100 when a particular article 90 is to be diverted to a particular branch conveyor 96. This is discussed in further detail in commonly assigned, U.S. patent application serial no. 10/163,788, filed June 6, 2002, and entitled Tiered Control Architecture For Material Handling, the disclosure of which is hereby incorporated herein by reference. In the past, the physical location of such divert control modules 100 was manually input into the higher level controller 94 during installation of the sortation system. By placing transceivers 46 in each divert control module, the distance of each control module down the length of the sortation conveyor can

automatically be determined. Such distances are determined in any one of the manners previously described herein, and can be determined in conjunction with a transceiver 46 placed at a reference location, such as the upstream end of the sortation conveyor 92. The transceivers 46 can also be used as wireless communication devices. The higher level controller is also provided with a UWB transceiver that communicates wirelessly with the UWB transceivers 46. The communications can include commands from the higher level controller to the divert modules, status requests, feedback from the modules to the controller, and other sorts of information. The use of such wireless communications eliminates the need for hard wiring connections, such as communications bus 102, between the higher level controller 96 and each divert control module 100.

Beacons 54 and transceivers 46 can also be used with monorail material handling systems, such as overhead electrified monorails. An illustrative example of one such monorail is depicted in FIG 11. Monorail 104 extends throughout a facility or plant in a pre-defined arrangement. Monorail 104 includes a number of buss bars 106 which supply power and/or communications to a vehicle 108 that is attached to, and hangs downwardly from, rail 104. Vehicle 108 includes a number of wheels 110 that allow it to move along rail 104 and transport articles 90, such as via a platform 112, or by other means. At least one motor 114 is included and powers one of the wheels 110 for movement on rail 104. Vehicles 108 may carry articles 90 undergoing manufacture between workstations. Vehicle 108 may stop at one or more of these workstations to allow time for robots or workers to perform work on the item being manufactured. Vehicle 108 may include a transceiver 46 attached at any suitable location that communicates with beacons 54 placed throughout the facility. The beacons 54 emit signals which transceiver 46 uses to determine its position with respect to the beacons 54. The position may be a one-dimensional, two-dimensional or three-dimensional position determination. Vehicle 108 may use the position determination to determine precisely where it should stop within a given workstation. Vehicle 108 may also use transceiver 46 as a communications device for wirelessly transmitting information between itself and a controller. Such communications may be ultra-wideband communications, or other types of high frequency communications.

While the present invention has been described in terms of the embodiments depicted in the drawings and described herein, it will be understood by one skilled in the art that the present invention is not limited to these particular embodiments,

but includes any and all such modifications that are within the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A system for determining the location of material handling system components:

a plurality of stationary high frequency electromagnetic energy emitting and detecting beacons (54) positioned in an area at known locations, said stationary beacons (54) emitting and detecting high frequency radio electromagnetic energy;

at least one mobile electromagnetic energy beacon (46) positioned on-board the material handling system component, said mobile beacon capable of communicating with said plurality of stationary beacons using high frequency radio electromagnetic energy; and

a controller (50) adapted to determine at least a location of said mobile beacon (46) based upon the communications between said stationary beacons (54) and said mobile beacon (46).

2. The system of claim 1 wherein said mobile material handling component is an automatic guided vehicle (20).

3. The system of claim 2 further including an incremental sensor (34, 40, 42, or 44) adapted to measure changes in the vehicle's position wherein said controller (50) uses the measurements from said incremental sensor in combination with the mobile beacon (46) to determine the vehicle's position.

4. The system of claim 2 further including a second mobile beacon (46) positioned on-board the vehicle (20) wherein said controller utilizes the mobile beacons (46) to generate an estimate of the vehicle's heading.

5. The system of claim 2 wherein said mobile beacon (46) and said stationary beacons (54) emit ultra-wideband signals.

6. The system of claim 4 wherein the outputs from said incremental sensor (34, 40, 42, or 44) and said mobile beacon (46) are input into a Kalman filter to produce an estimate of the vehicle's position.

7. The system of claim 4 wherein said incremental sensor measures the rotations of at least one wheel (24) on said vehicle (20).

8. The navigation system of claim 7 further including a gyroscope (40) on-board said vehicle (20).

9. The sensor of claim 2 further including a second mobile beacon (46) on-board said vehicle (20), said mobile beacons being used by said controller (50) to generate an estimate of the vehicle's position which is more precise than if only a single one of the

mobile beacons on-board said vehicle were used to generate an estimate of the vehicle's position.

10. The system of claim 2 wherein said mobile beacon (46) is adapted to determine its position in three dimensions with respect to said plurality of stationary beacons (54).

11. The system of claim 2 wherein said mobile beacon (46) and said plurality of stationary beacons (54) communicate with each other by emitting at least one pulse having a duration of less than one microsecond.

12. The system of claim 11 wherein said mobile beacon (46) and said plurality of stationary beacons (54) communicate with each other by emitting at least one pulse having a duration of less than 100 nanoseconds.

13. The system of claim 2 further including a second and third mobile beacon (46) positioned on said vehicle (20) at known, separated locations wherein said controller (50) is adapted to determine the vehicle's heading based upon the differences in time in which each of the mobile beacons (46) detect a signal from one of said stationary beacons.

14. The system of claim 2 wherein said controller (50) is further adapted to issue commands to steer the vehicle (20) based upon the location of the mobile beacon (46) as determined by the controller (50).

15. The system of claim 14 wherein said controller (50) determines the position of the vehicle (20) in three dimensions.

16. The system of claim 5 further including at least a second mobile beacon (46) positioned on said vehicle (20) at a known location, said controller (50) using said mobile beacons (46) to determine the vehicle's heading.

17. The system of claim 2 wherein said controller (50) determines the location of said mobile beacon (46) based upon time of flight measurements of signals emitted from at least one of said stationary beacons (54) to said mobile beacon (46).

18. The system of claim 17 wherein said controller (50) further determines the heading of the vehicle (20) based upon time of flight measurements of multiple signals emitted from at least one of said stationary beacons (54) to said mobile beacons (46).

19. The system of claim 2 wherein said vehicle (20) includes multiple mobile beacons (46) positioned on said vehicle (20) at known locations and said controller (50) is adapted to determine the vehicle's heading based upon time of arrival measurements of a signal emitted from at least one of said stationary beacons (54) at said mobile beacons (46).

20. The system of claim 19 wherein said controller (50) is further adapted to determine the vehicle's position based upon time of arrival measurements of multiple signals emitted from at least one of said stationary beacons (54) at said mobile beacons (46).

21. The system of claim 2 wherein said controller (50) determines the position of said vehicle based upon time of flight measurements of a signal emitted from said mobile beacon to different ones of said stationary beacons.

22. The system of claim 21 wherein said controller (50) further determines the heading of said vehicle (20) based upon time of flight measurements of multiple signals emitted from said mobile beacon (46) to different ones of said stationary beacons (54).

23. The system of claim 2 wherein said controller (50) determines the heading of said vehicle based upon time of arrival measurements of a signal emitted from said mobile beacon to different ones of said stationary beacons.

24. The system of claim 23 wherein said controller (50) further determines the position of said vehicle (20) based upon time of arrival measurements of multiple signals emitted from said mobile beacon (46) to different ones of said stationary beacons (54).

25. The system of claim 2 wherein said controller (50) is positioned on-board said automatic guided vehicle (20).

26. The system of claim 2 wherein each one of said plurality of stationary beacons (54) emit signals that can be differentiated by said mobile unit from other ones of said stationary beacons (54).

27. The system of claim 2 further including an off-board display adapted to display the position of said automatic guided vehicle (20).

28. The system of claim 1 wherein said mobile material handling component is a vehicle (108) that travels on an electrified monorail (104).

29. They system of claim 28 wherein said stationary beacons (54) are placed at workstations at which said vehicle (108) may stop.

30. The system of claim 1 wherein said mobile material handling component is a tag (88) attached to an article (90) traveling on a conveyor system.

31. The system of claim 1 wherein said mobile material handling component is a user-driven fork-lift vehicle.

32. A kit for modifying a navigation system of an automatic guided vehicle (20) that uses one or more incremental navigation sensors (34, 40, 42, or 44) in combination with at least one fixed reference sensor to estimate the vehicle's position, said fixed reference

sensor being adapted to detect references positioned at known locations, said kit comprising:

a plurality of electromagnetic energy emitting beacons (54) for positioning at known locations throughout an environment;

at least one electromagnetic energy sensor (46) for positioning on a vehicle (20), said electromagnetic energy sensor adapted to detect signals emitted from said plurality of electromagnetic energy emitting beacons (54); and

a controller (50) adapted to use said detected signals in combination with said one or more incremental navigation sensors to generate a position estimate of said vehicle (20).

33. The kit of claim 32 wherein said one or more incremental navigation sensors include at least one wheel encoder (42) adapted to measure the number of rotations of at least one wheel (24) on said vehicle (20).

34. The kit of claim 33 wherein said one or more incremental navigation sensors further includes at least one gyroscope (40).

35. The kit of claim 32 wherein said controller (50) uses a Kalman filter to estimate the vehicle's position based upon said detected signals and said one or more incremental navigation sensors.

36. The kit of claim 32 wherein said electromagnetic energy sensor (46) is adapted to detect ultra-wideband transmissions and said plurality of electromagnetic energy emitting beacons (54) are adapted to emit ultra-wideband transmissions.

37. The kit of claim 32 wherein said controller (50) is further adapted to generate an updated position estimate of the vehicle (20) at least five times per second.

38. The kit of claim 32 further wherein said beacons (54) and said sensor (46) are adapted to send wireless messages between themselves.

39. A method of installing an AGV system comprising:

providing a plurality of electromagnetic energy emitting beacons;

providing at least one automatic guided vehicle (20) that includes at least one sensor for detecting transmissions from said plurality of beacons (54);

placing at least three of said beacons (54) at known locations within an environment;

measuring the location of the at least three beacons (54) within the environment;

placing additional ones of the beacons (54) within the environment;

using the at least three beacons (54) to measure the location of said additional ones of said beacons (54) within the environment; and

communicating the location of said plurality of beacons to said automatic guided vehicle (20).

40. The method of claim 39 wherein said communicating of the location of said plurality of beacons (54) to said automatic guided vehicle (20) occurs via a wireless transmission.

41. The method of claim 39 further including programming said at least one automatic guided vehicle (20) to travel along a first pathway.

42. The method of claim 41 further including programming said at least one automatic guided vehicle (20) to travel along a second pathway without having to change the position of any of said beacons (54), said second pathway being different from said first pathway.

43. The method of claim 39 wherein said environment is a factory, and said method further includes positioning a sufficient number of said beacons (54) throughout the factory in a configuration that enables the automatic guided vehicle (20) to be able to determine its position at substantially any location within the factory.

44. An automatic guided vehicle (20) comprising:

a body;

at least one navigation sensor on said body for use in determining the vehicle's location;

a motor (30) for moving the vehicle (20);

a high frequency radio location radar (36) positioned on said body, said radar capable of detecting objects located off of the vehicle (20); and

a controller (50) which controls the movement of the vehicle (20) based, at least partially, on objects detected by the radar (36).

45. The vehicle of claim 44 wherein said vehicle (20) includes fork-lift fingers, said radar (36) is adapted to detect the orientation of a pallet, and said controller (50) is adapted to steer said vehicle (20) such that said fork-lift fingers are properly inserted into or under said pallet.

46. The vehicle of claim 44 further including an ultra-wideband sensor adapted to detect the location of ultra-wideband transmitters (54) wherein said controller (50) is further adapted to steer the vehicle (20) based, at least occasionally, on the detected location of at least one ultra-wideband transmitter (54).

47. The vehicle of claim 46 wherein at least one of said ultra-wideband transmitters is positioned on a driver guided vehicle.

48. The vehicle of claim 44 wherein said at least one navigation sensor (34, 36, 42, 44, or 46) includes an ultra-wideband sensor (46) adapted to determine the vehicle's position based upon detecting ultra-wideband signals emitted from beacons (54) positioned at known locations.

49. The vehicle of claim 44 further including a set of wheel (22 or 24) on said vehicle (20), at least one of said wheels (22 or 24) being powered by said motor (23), and

50. A communications system for an automatic guided vehicle (20) comprising:

an ultra-wideband transmitter (54) positioned off the vehicle (20) that transmits information to the vehicle via ultra-wideband signals; and

an ultra-wideband receiver (46) positioned on said vehicle (20) that receives information transmitted via ultra-wideband signals from said transmitter.

51. The system of claim 51 wherein said communications system is further adapted to communicate via ultra-wideband signals directly with other automatic guided vehicles (20).

52. The system of claim 51 wherein said communications system is adapted to transmit the present location of the vehicle (20).

53. The system of claim 51 wherein said ultra-wideband transmitter (54) is used to transmit at least one navigational signal used by the vehicle (20) for determining its position or heading.

54. The system of claim 53 wherein said transmitter (54) is further adapted to transmit communication signals during time intervals between successive ones of said navigational signals.

55. The system of claim 53 wherein said transmitter (54) is further adapted to transmit a plurality of said navigational signals in a particular sequence wherein the sequence identifies a message.

56. The system of claim 53 wherein said receiver (46) is further adapted to distinguish between navigational signals transmitted from said transmitter and communication signals transmitted from said transmitter (54).

57. A material handling system comprising:

a plurality of automatic guided vehicles (20), each of said plurality of automatic guided vehicle (20) including an ultra-wideband communications system (46);

at least one ultra-wideband transmitter (54) positioned on or adjacent to a load of material to be moved by one of said plurality of automatic guided vehicles (20), said transmitter (54) adapted to transmit a message to said plurality of automatic guided vehicles indicating that the load of material is to be moved to a destination; and

a controller (50) adapted to determine which of said plurality of automatic guided vehicles (20) is to retrieve said load in response to said message.

58. The system of claim 57 wherein said controller (50) is further adapted to determine which of said plurality of automatic guided vehicles (20) is to retrieve said load based at least partially upon the physical proximity of each of said vehicles (20) to the load.

59. The system of claim 58 wherein each said automatic guided vehicle (20) includes a queue for storing tasks to be performed by the vehicle (20), and each of said controllers (50) is further adapted to determine which of said plurality of automatic guided vehicles (20) is to retrieve said load based at least partially upon the number of tasks in each vehicle's queue.

60. The system of claim of 57 further including a plurality of ultra-wideband beacons (54) positioned at known locations throughout an area through which said vehicles move, and a plurality of ultra-wideband sensors (46) positioned on each of said vehicles, said sensors being adapted to determine their position with respect to said beacons.

61. A high frequency radio location determination system for determining the position of at least one mobile unit in a material handling system comprising:

at least one high frequency beacon and at least one high frequency sensor (46), one of said at least one beacon (54) and said at least one sensor (46) being positioned at a known location within an environment, the other of said at least one beacon and said at least one sensor being positioned so as to move with the mobile unit; and

at least one controller (50) for determining the location of the mobile unit by way of either time of flight or time of arrival measurements of at least one high frequency signal communicated between said at least one beacon and said at least one sensor; and

a transmitter that transmits the location of the mobile unit to a processor (116).

62. The system of claim 61 wherein said processor includes a display (118) adapted to visually display the location of the mobile unit.

63. The system of claim 61 wherein said processor (118) is adapted to record the movements of the mobile unit.

64. The system of claim 61 wherein said mobile units include driver-manned vehicles.

65. The system of claim 61 wherein said mobile units include at least one automatic guided vehicle (20).

66. The system of claim 61 wherein said system includes at least three high frequency transmitters (54) positioned at known locations off-board said mobile unit.

67. The system of claim 61 wherein said system includes at least three high frequency sensors (46) positioned at known locations off-board said mobile unit.

68. The system of claim 61 wherein said transmitter (54) transmits the location of the mobile unit to the processor (116) by way of radio signals.

69. The system of claim 61 wherein said processor (116) is adapted to determine the distance traveled by the mobile unit over a given time period.

70. The system of claim 61 wherein said mobile units include at least one AGV (20) in which said controller (50) is adapted to control the steering of the AGV (20) based at least partially upon the location of the mobile unit as determined by the at least one beacon (54) and the at least one sensor (46).

71. The system of claim 70 wherein said controller (50) is further adapted to use said at least one beacon (54) and said at least one sensor (46) to determine the heading of the AGV (20) and control the steering of the AGV based at least partially upon this determination of heading.

72. The system of claim 61 wherein said mobile unit is a material load.

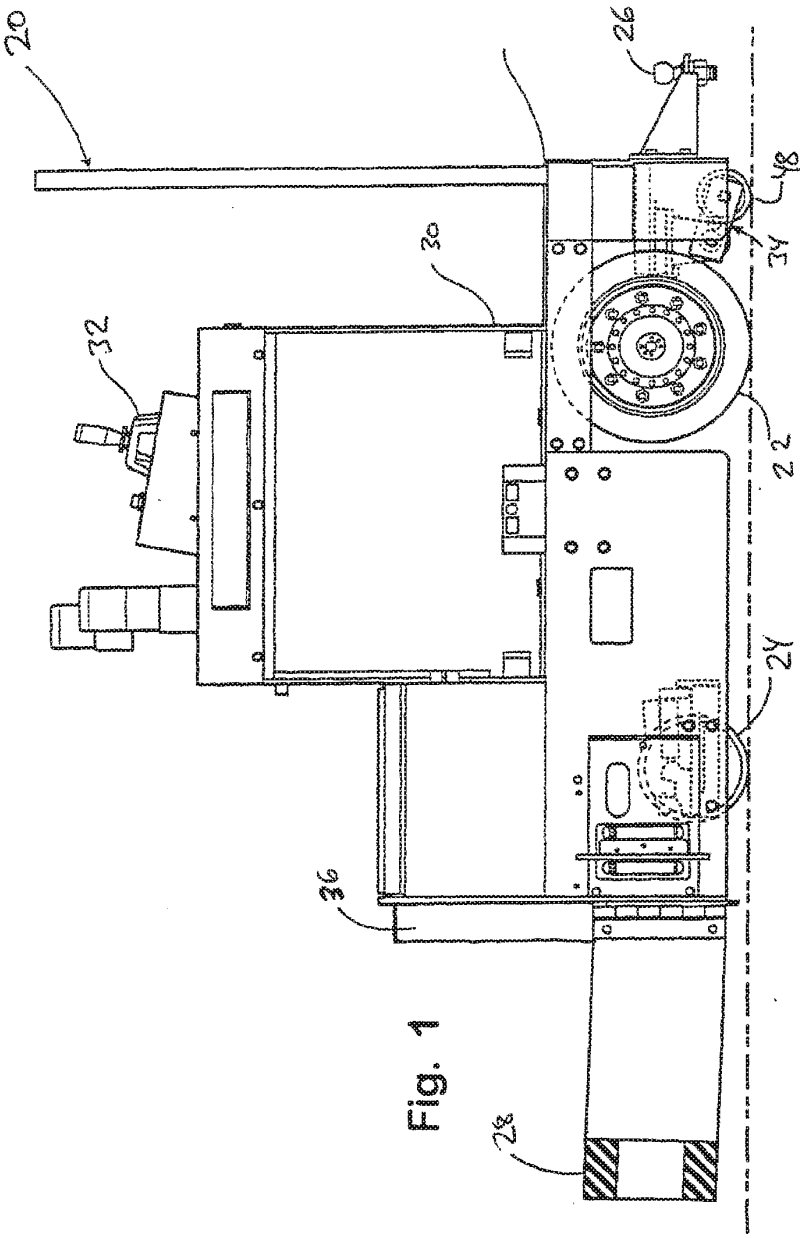


Fig. 1

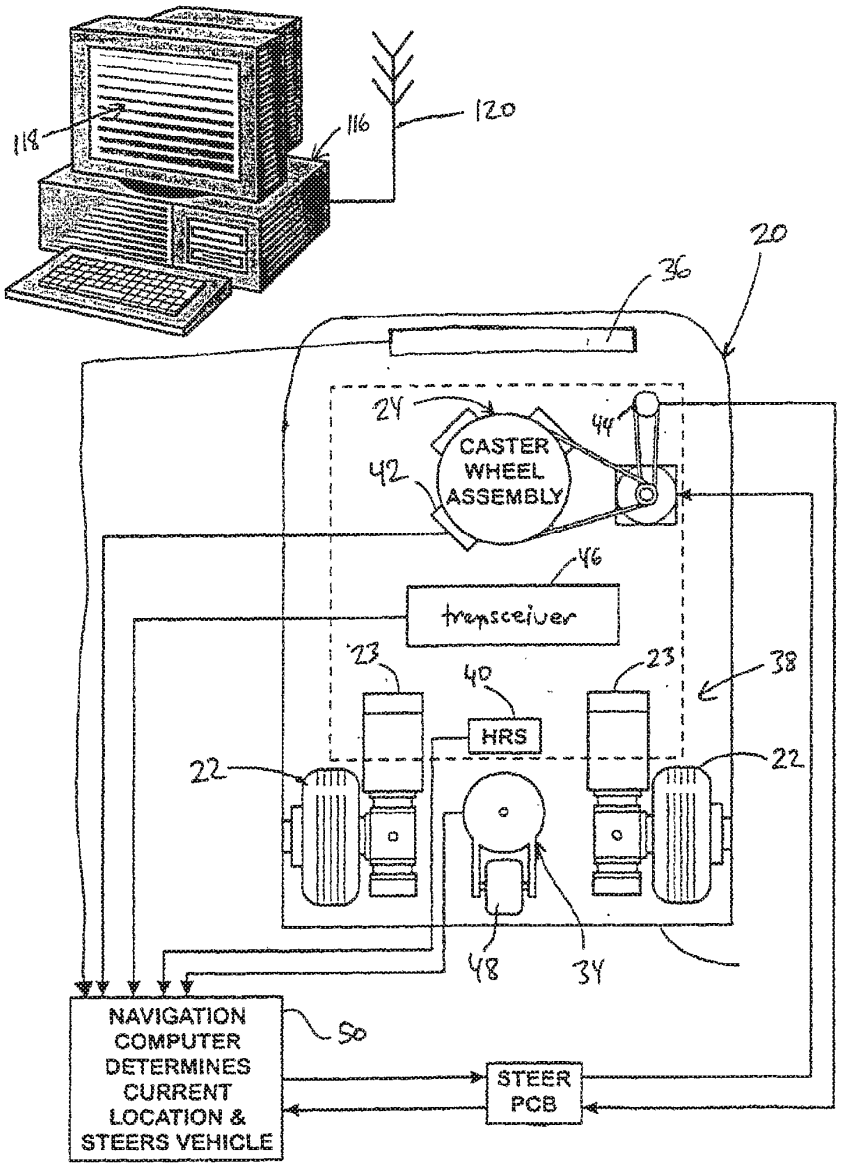

118
116
120
20
36
24
CASTER WHEEL ASSEMBLY
42
44
46
transceiver
23
40
HRS
23
38
22
22
48
34
NAVIGATION COMPUTER DETERMINES CURRENT LOCATION & STEERS VEHICLE
50
STEER PCB

Fig. 2

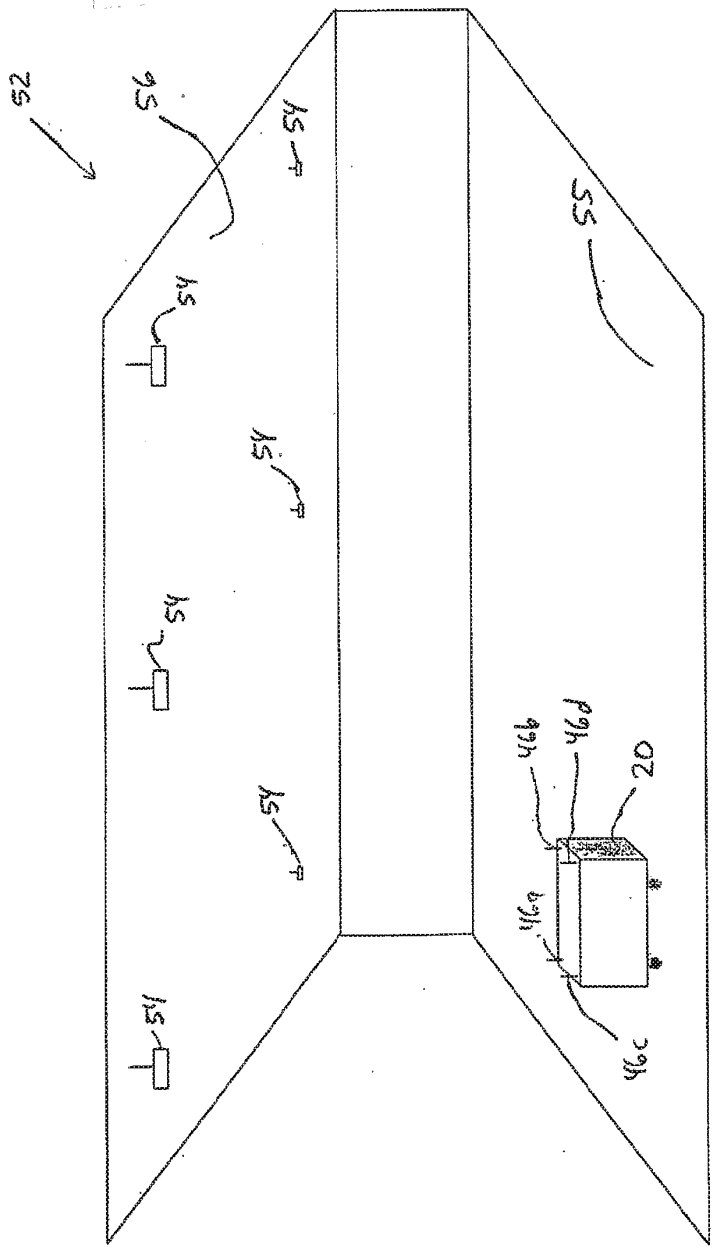


FIG. 3

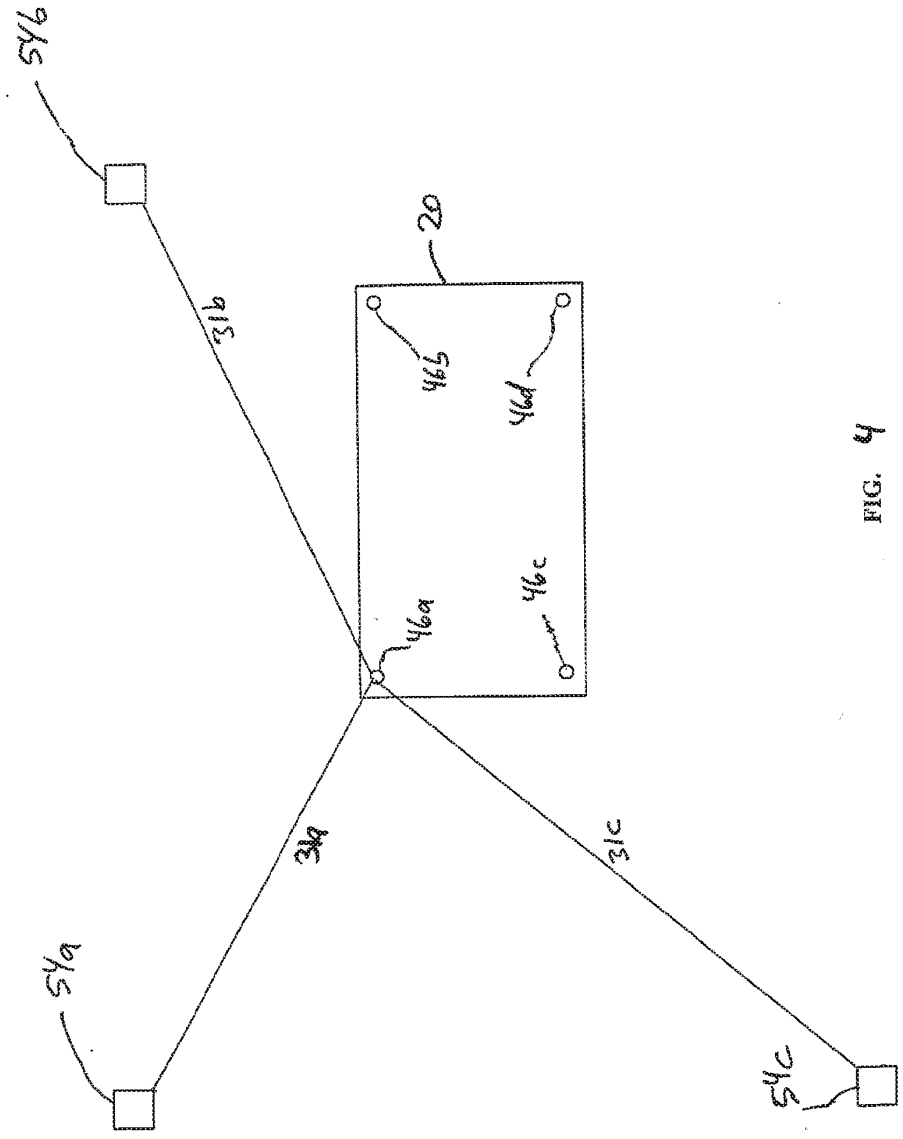


FIG. 4

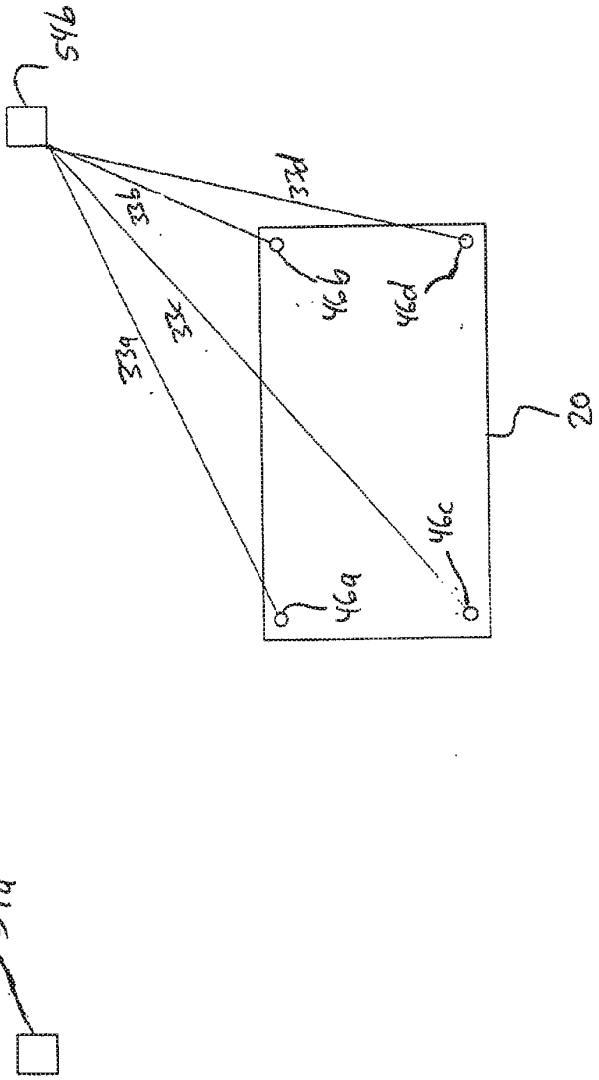


FIG. 5

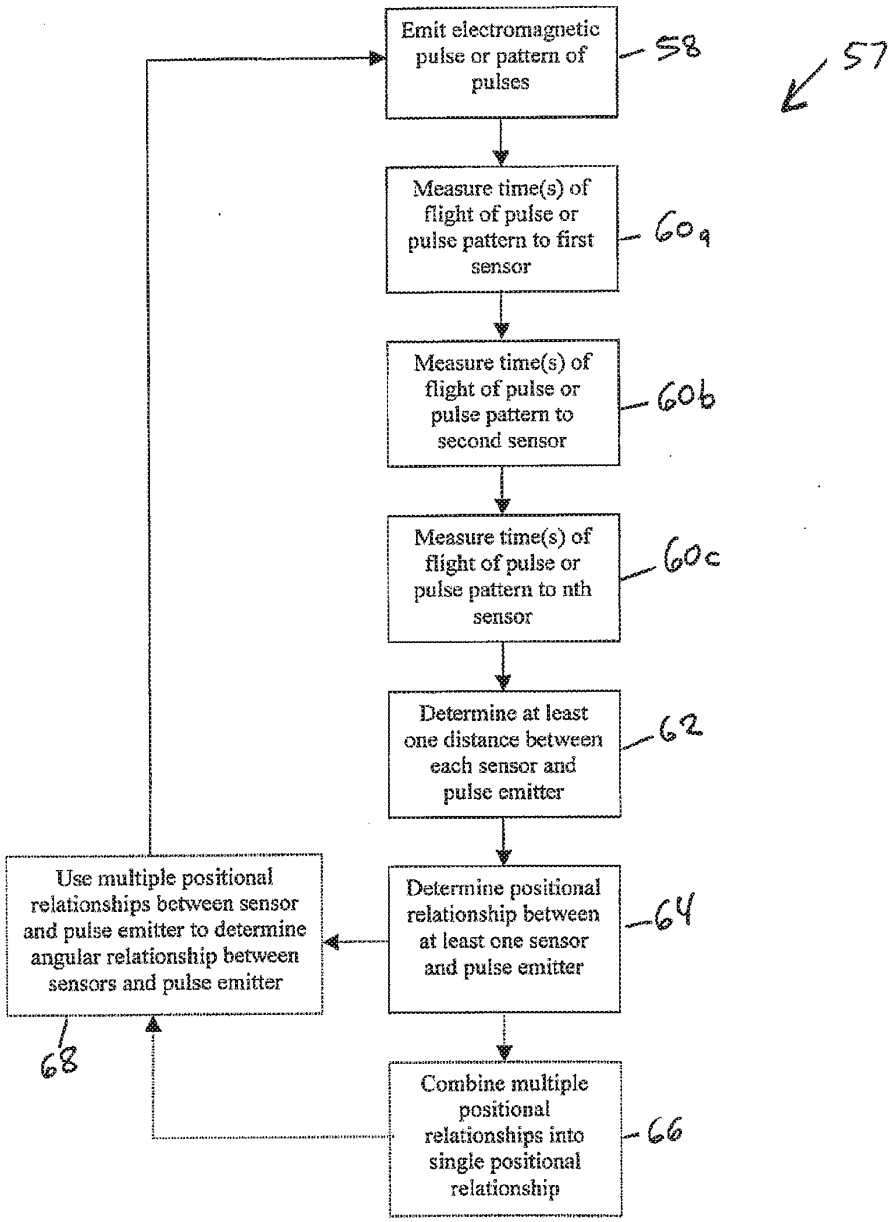

Emit electromagnetic pulse or pattern of pulses
58
57
Measure time(s) of flight of pulse or pulse pattern to first sensor
60a
Measure time(s) of flight of pulse or pulse pattern to second sensor
60b
Measure time(s) of flight of pulse or pulse pattern to nth sensor
60c
Determine at least one distance between each sensor and pulse emitter
62
Determine positional relationship between at least one sensor and pulse emitter
64
Use multiple positional relationships between sensor and pulse emitter to determine angular relationship between sensors and pulse emitter
68
Combine multiple positional relationships into single positional relationship
66

FIG. 6

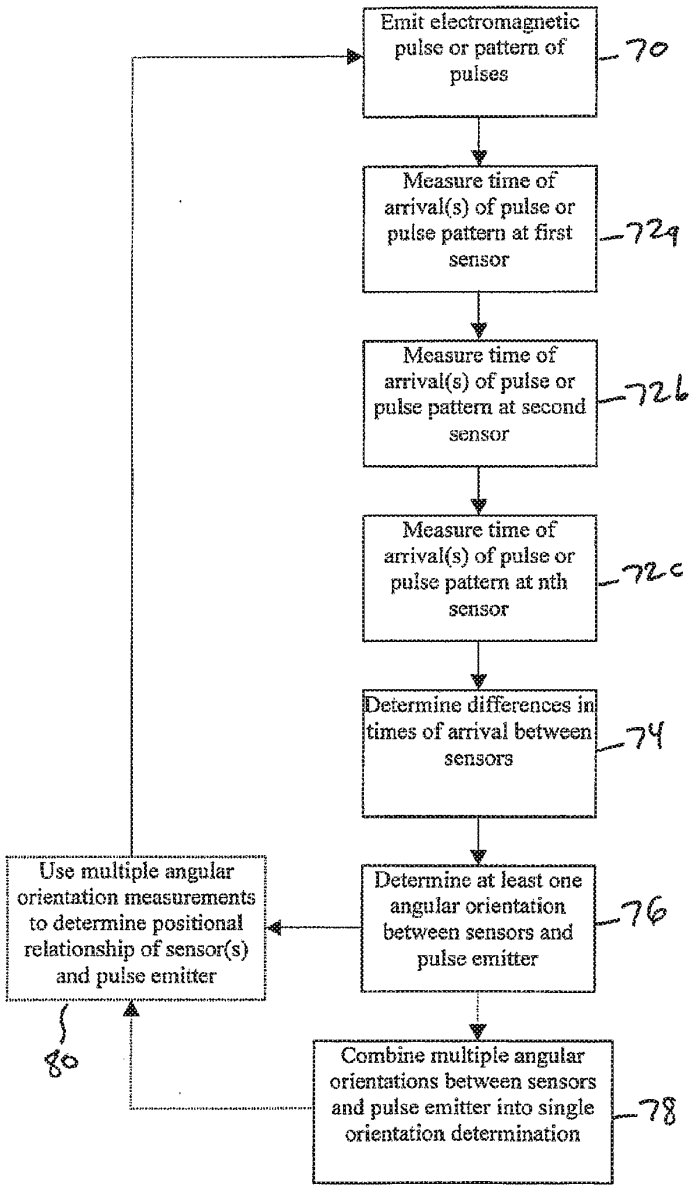

Emit electromagnetic pulse or pattern of pulses
70
69
Measure time of arrival(s) of pulse or pulse pattern at first sensor
72a
Measure time of arrival(s) of pulse or pulse pattern at second sensor
72b
Measure time of arrival(s) of pulse or pulse pattern at nth sensor
72c
Determine differences in times of arrival between sensors
74
Determine at least one angular orientation between sensors and pulse emitter
76
Use multiple angular orientation measurements to determine positional relationship of sensor(s) and pulse emitter
80
Combine multiple angular orientations between sensors and pulse emitter into single orientation determination
78

FIG. 7

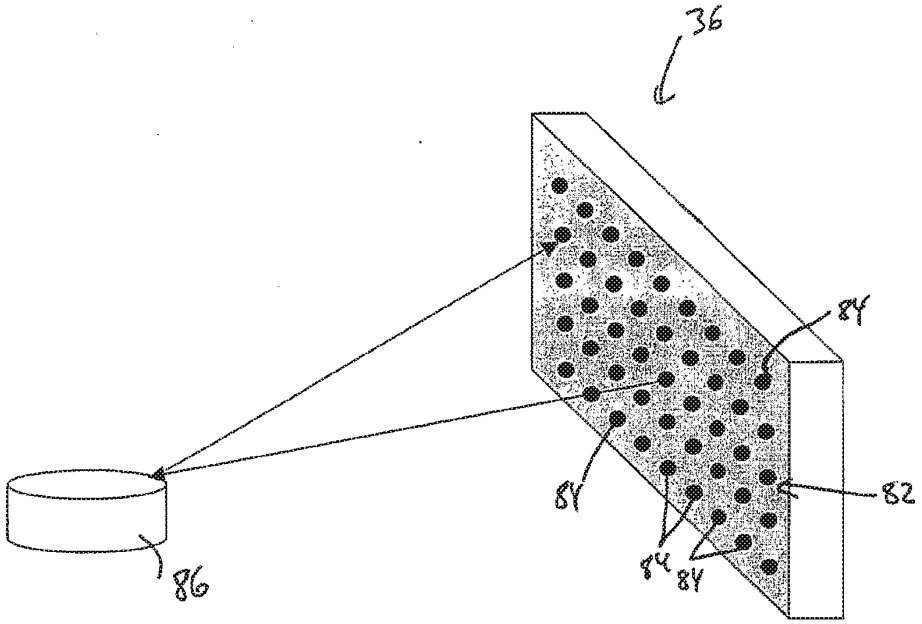


FIG. 8

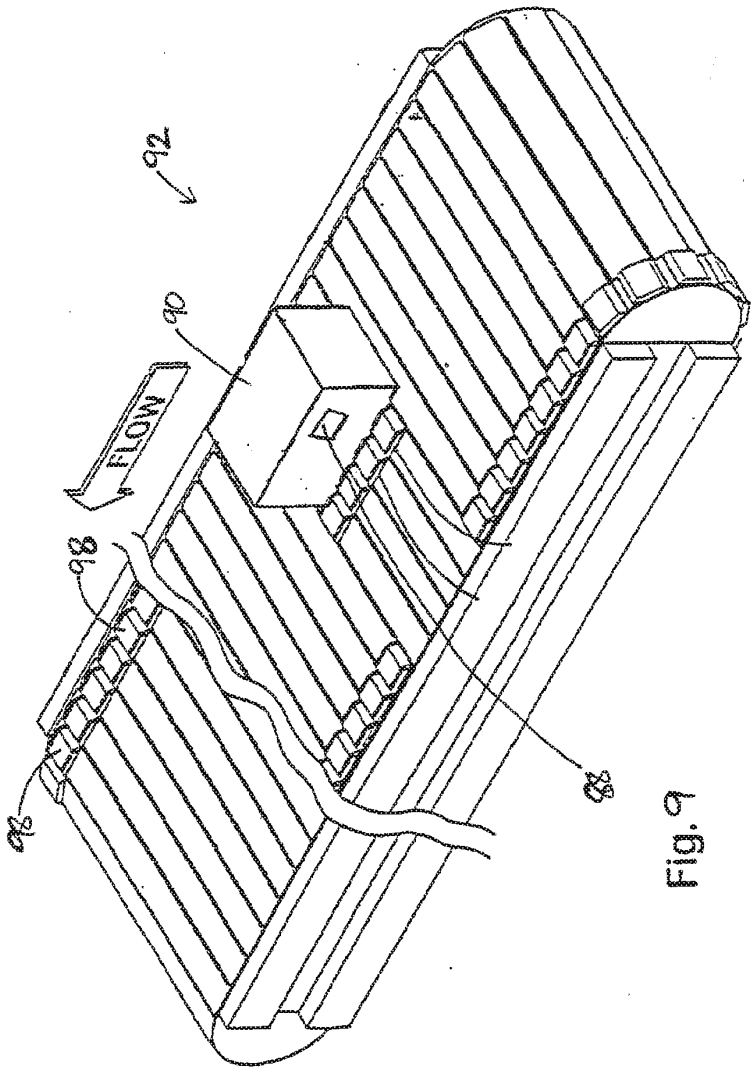


Fig. 9

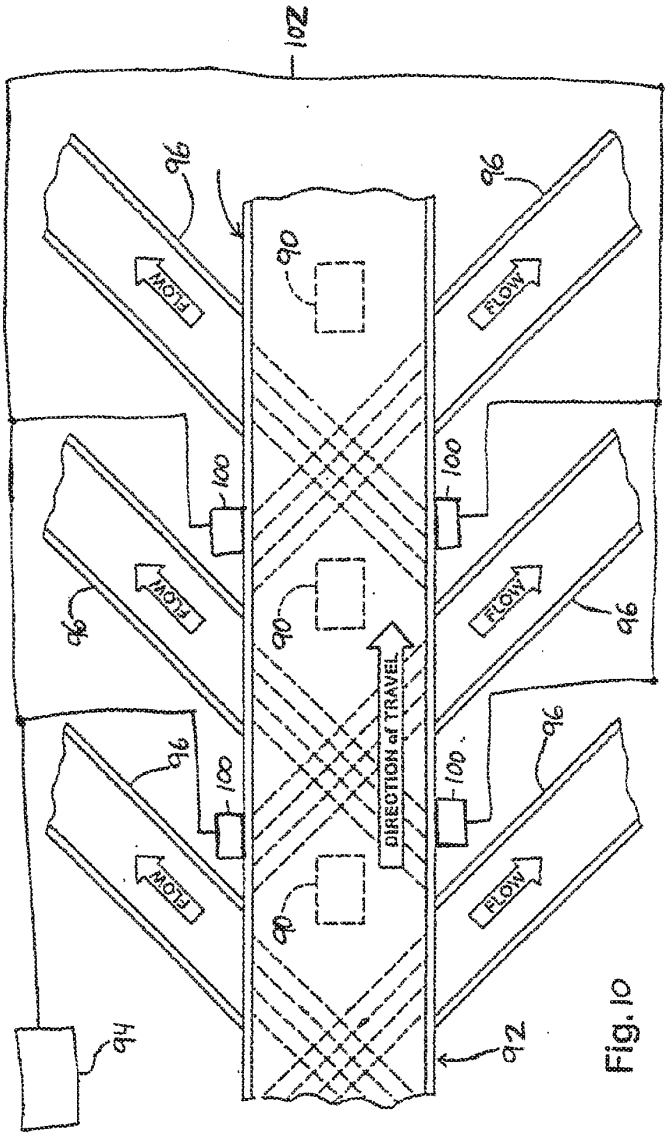

102
96
96
90
FLOW
FLOW
100
100
FLOW
FLOW
96
96
90
DIRECTION of TRAVEL
96
100
100
96
FLOW
FLOW
90
94
92

Fig. 10

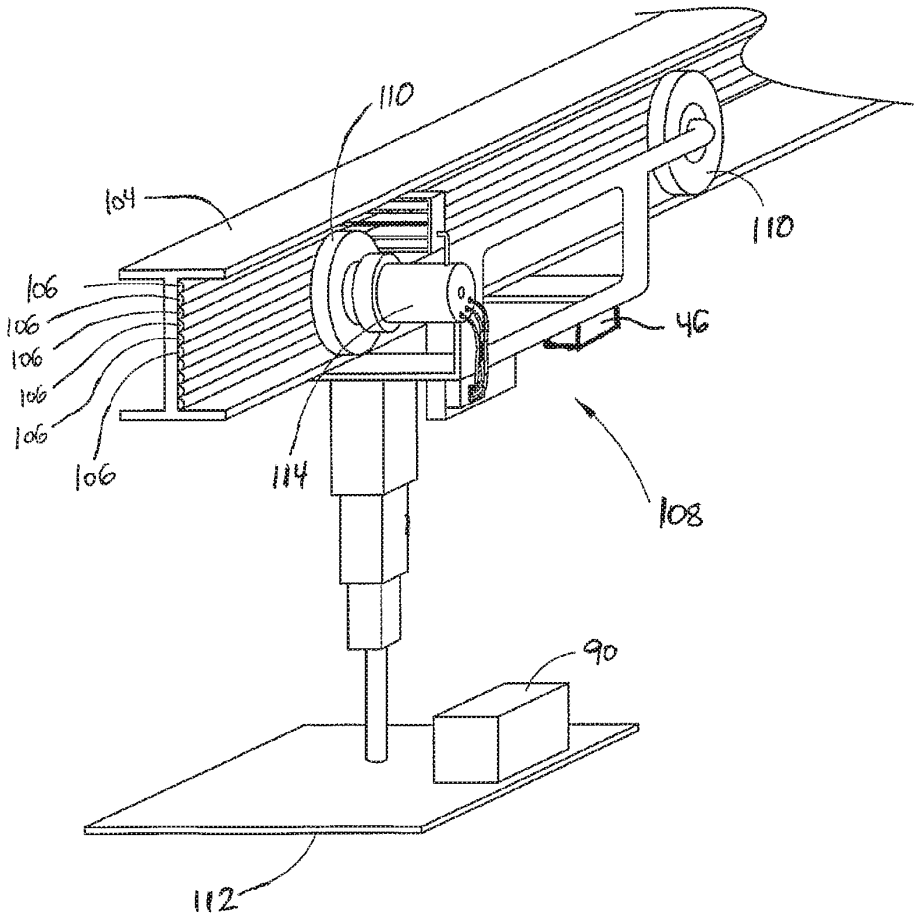


FIG. 11

Electronic Acknowledgement Receipt

EFS ID:	36730336
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	30-JUL-2019
Filing Date:	
Time Stamp:	15:28:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	63154US03_SB08a.pdf	615445 023ed6fa591217da33ef0709159bf7102930 3bc2	no	13

Warnings:

Information:					
2	Foreign Reference	AU2012227260.pdf	1494197 8a4ec013274fb4b6c54511046fce2c2abb211ad8	no	41
Warnings:					
Information:					
3	Foreign Reference	AU2015201462A1.pdf	3615642 7dd947017446bcc7f121ddc9278808227a4c5ecc	no	30
Warnings:					
Information:					
4	Non Patent Literature	Chinese_Office_Action_201710 0744496.pdf	3138249 c9b151e7c78243f3e16ece0c7954c19a5e1ae8f9	no	22
Warnings:					
Information:					
5	Foreign Reference	CN1417071A.pdf	872342 a46249280d356b9c05d6287aeae92154c190e656	no	22
Warnings:					
Information:					
6	Foreign Reference	CN1676375A.pdf	466012 04942107c349d8b6cc240a063e0d287704efb8b7	no	11
Warnings:					
Information:					
7	Foreign Reference	CN102923158A.pdf	414225 1043bb8c08c5c26aab9b0237940dc987178e82b4	no	7
Warnings:					
Information:					
8	Other Reference-Patent/App/Search documents	ISR_and_Written_Opinion_for_ PCTUS1920385.pdf	2625786 02e72cd7a0852851e6c7c502d23563dd91921caa	no	15
Warnings:					
Information:					

9	Other Reference-Patent/App/Search documents	ISR_and_Written_Opinion_for_PCTUS2018045388.pdf	3279247 18f3897d117eafec4f8ce544a8d04d2780ecfa55	no	16
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	ISR_and_Written_Opinion_for_PCTUS2018049062.pdf	2396007 518b14b49f874805502e09f3faba3fcf6fbc1f71	no	13
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	ISR_for_PCTUS2016023754.pdf	196762 ff3527e4cad70cb4180b4218efd3bcd9ce7beb57	no	10
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	PCTUS2014053900_ISR-WO_150218.pdf	3992379 911699838584cd0c41f615d8acd6c66eb435e40e	no	21
Warnings:					
Information:					
13	Foreign Reference	WO03012470A2.pdf	6560130 e57595459f6e746960781000c6e3b5fd56773f23	no	46
Warnings:					
Information:					
		Total Files Size (in bytes):	29666423		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/515,903

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	785		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/515,903	07/18/2019	3659	785	63154US03	20	3

CONFIRMATION NO. 2880

23446
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

FILING RECEIPT

OC000000110052878

Date Mailed: 08/01/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Richard C. Carlson, Palatine, IL;
Kurt Alan Gunther, Woodstock, IL;
Sara Jo Woitel, Lake Zurich, IL;
Marc Wayne Cygnus, Mundelein, IL;

Applicant(s)

Metrom Rail, LLC, Crystal Lake, IL;

Power of Attorney: The patent practitioners associated with Customer Number 23446

Domestic Priority data as claimed by applicant

This application is a CON of 16/290,576 03/01/2019
which is a CIP of 16/055,905 08/06/2018
which claims benefit of 62/541,454 08/04/2017
and said 16/290,576 03/01/2019
claims benefit of 62/637,774 03/02/2018

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/31/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/515,903**

Projected Publication Date: 11/07/2019

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Preliminary Class

475

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Richard C. Carlson
Art Unit	3617
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5995881		1999-11-30	Kull	
	2	6135396		2000-10-24	Whitfield et al.	
	3	6666411		2003-12-23	Hart et al.	
	4	8998149		2015-04-07	Takahashi et al.	
	5	9022325		2015-05-05	Tsukamoto	
	6	8126035		2012-02-28	Hashimoto et al.	
	7	6732023		2004-05-04	Sugita et al.	
	8	8344877		2013-01-01	Sheardown et al.	

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	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	9	8423240		2013-04-16	Mian	
	10	8245983		2012-08-21	Gilbertson	

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	1	20060015224		2006-01-19	Hilleary	
	2	20090212168		2009-08-27	Kumar	
	3	20120123617		2012-05-17	Noffsinger et al.	

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	1	100975289	KR		2010-08-12	KRRI	English Language Abstract provided	☓
	2	20140017157	KR		2014-02-11	Hyundai Rotem Co.	English Language Abstract provided	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	3	100733599	KR		2007-07-03	Kyong Bong Technology Co., Ltd.	English Language Abstract provided	☒
	4	20050097843	KR		2005-10-10	Shalom Engineering Co., Ltd.	English Language Abstract provided	☒
	5	201323574	CN		2009-10-07	Signal & Communication Research Institute, et al.	English Language Abstract provided	☒
	6	22220819	CA		2000-01-11	Union Switch & Signal Inc.	English Language Abstract provided	☒
	7	4755521	JP		2011-08-24	Railway Technical Res. Inst.	English Language Abstract provided	☒
	8	2001106074	JP		2001-04-17	Tokimec Inc; Nishinippon Ryokaku Tetsudo KK; et al	English Language Abstract provided	☒
	9	4917313	JP		2012-04-18	Hitachi Ltd.	English Language Abstract provided	☐

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-08-12
Name/Print	Rami N. Moussa	Registration Number	69528

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Bibliographic data: KR100975289 (B1) — 2010-08-12

alarm system for train access using bone conduction speaker and method thereof

Inventor(s): HWANG, JONG KYU, ; JO, HYUN JUNG, ; YOON, YONG KI

Applicant(s): KRRI

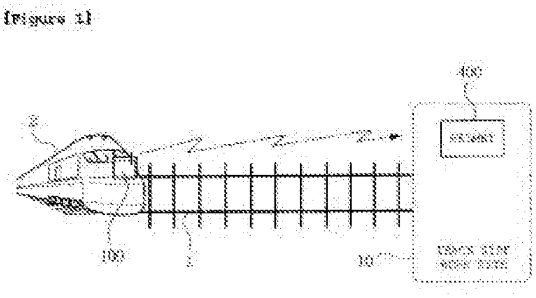
Classification: **- international:** ***G08B21/00; G08B21/02***
- cooperative: **G08B21/02; G08B3/10**

Application number: KR20080049496 20080528 Global Dossier

Priority number(s): KR20080049496 20080528

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Abstract of KR20090123427 (A)



PURPOSE: An alarm system for train access using bone conduction speaker and method thereof are provided to accurately recognize approach existence and nonexistence of the train in the work area. CONSTITUTION: The signal projector(100) is installed in the train(2). The signal projector transmits the train approach signal to the radio system. The signal receiver is attached to the worker in the railway line side work area(10). The signal receiver receives a message of the train approach signal from the signal projector approaching to the sensing distance within. According to the reception status of the train approach signal, the bone conduction speaker outputs the oscillation sound informing the train approach. The receiver signal and bone conduction speaker are attached to the helmet(400) of worker.

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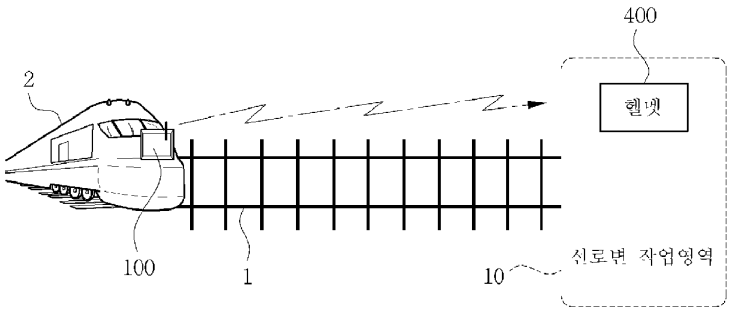
(54) 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법

(57) 요 약

본 발명은 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법에 관한 것으로서; 열차에 설치되어 열차접근신호를 무선송출하는 신호송신기와, 선로변 작업영역에서 유지보수작업을 수행하는 유지보수자가 착용하되 상기 신호송신기가 감지거리 이내로 접근하면 상기 열차접근신호를 수신하는 신호수신기와, 상기 신호수신기가 상기 열차접근신호를 수신하면 열차접근을 알리는 진동음으로 출력하는 골전도 스피커로 구성되며, 그와 같은 구성에 의해 철도선로변 유지보수자에게 열차의 접근 유무에 대한 경보음을 출력하는 방법을 제공한다.

본 발명에 따르면, 철도의 선로변에서 선로나 신호설비에 대한 유지보수 작업을 수행하는 경우 열차의 진입 유무에 대한 경고정보를 유지보수가 행해지고 있는 선로변 작업영역에서 정확하고도 신속하게 인지할 수 있어 열차와 충돌하는 사상사고의 발생을 현저하게 줄일 수 있는 장점이 있다.

대 표 도 - 도1



특허청구의 범위

청구항 1

열차접근신호를 생성하는 신호생성부와, 상기 신호생성부에서 생성된 열차접근신호를 무선송출하는 신호송신부로 구성되어 열차에 설치되는 신호송신기와;

선로변 작업영역에서 유지보수작업을 수행하는 유지보수자가 착용하되, 상기 신호송신기에서 무선송출되는 열차접근신호를 수신하는 신호수신부와, 상기 신호수신부를 통해 열차접근신호가 수신되면 골전도 스피커로 열차접근으로 인한 경고음을 출력하도록 제어하는 신호제어부로 구성되는 신호수신기와;

상기 신호수신기가 상기 열차접근신호를 수신하면 열차접근을 알리는 진동음으로 출력하는 골전도 스피커;로 구성되고,

상기 신호수신기와 골전도 스피커는 상기 유지보수자의 헬멧에 부착되는 것을 특징으로 하는 골전도 스피커를 이용한 열차접근 경보 시스템.

청구항 2

삭제

청구항 3

삭제

청구항 4

삭제

청구항 5

열차접근신호를 생성하는 신호생성부와, 상기 신호생성부에서 생성된 열차접근신호를 무선송출하는 신호송신부로 구성되는 신호송신기가 설치되는 열차가 감지거리 이내로 접근하면, 상기 신호송신기에서 무선송출되는 열차접근신호를 수신하는 신호수신부와, 상기 신호수신부를 통해 열차접근신호가 수신되면 골전도 스피커로 열차접근으로 인한 경고음을 출력하도록 제어하는 신호제어부로 구성되는 신호수신기가 열차접근신호를 수신하는 단계; 및

상기 열차접근신호가 수신되면 열차가 접근중임을 알리기 위해 골전도 스피커를 제어하여 경고음을 출력하는 단계;를 포함하여 구성되고,

상기 골전도 스피커는 선로변 작업영역에서 유지보수작업을 수행하는 유지보수자가 착용하는 헬멧에 부착되는 것을 특징으로 하는 골전도 스피커를 이용한 열차접근 경보 방법.

청구항 6

삭제

명 세 서

발명의 상세한 설명

기 술 분 야

[0001] 본 발명은 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법에 관한 것으로서, 보다 구체적으로는 철도의 선로변에서 선로나 신호설비에 대한 유지보수작업을 하는 경우 유지보수자의 사상사고 예방을 위해 열차가 일정거리 전방에 접근 시 경고를 위한 진동음을 출력하여 유지보수자가 대처하도록 하여 안전사고를 예방하는 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법에 관한 것이다.

배 경 기 술

[0002] 일반적으로 철도의 선로변에서 선로나 신호설비에 대한 유지보수작업을 할 경우에는 유지보수자의 안전을 확보하기 위한 방안의 일환으로 선로변 작업영역의 전후방 일정 거리에 열차와의 충돌사고를 예방하기 위해 유지보수자와는 별도로 안전경보자를 배치시킨다.

[0003] 이때, 상기 안전경보자는 선로변의 작업영역에 열차가 접근하는지 여부를 감시하여 열차의 접근이 인식되면 유지보수자에게 열차의 접근을 알리게 된다.

[0004] 예를 들어 상기 안전경보자는 주간(晝間)에는 깃발을 이용한 수신호를 이용해 유지보수자에게 열차의 접근정보를 전달하고, 야간(夜間)에는 경광등을 이용한 수신호를 이용해 유지보수자에게 열차의 접근정보를 전달하고 있다.

[0005] 이처럼 선로변의 작업영역 전후방 일정거리에 있는 안전경보자를 통한 열차접근의 정보를 하더라도 장시간 지속적으로 단조로운 유지보수 작업을 수행하는 유지보수자는 감각 차단 현상이 발생하여 깃발 또는 경광등에 의한 안전경보자의 경보신호를 인지하지 못하여 열차가 유지보수 작업영역 인근까지 접근하여도 열차의 접근을 인식하지 못하여 열차와의 충돌로 인한 사상사고가 발생하고 있는 실정이다.

[0006] 특히, 유지보수자는 유지보수작업을 하는 중에도 지속적으로 안전경보자의 수신호 등을 인식해야 하므로 유지보수 작업의 효율성도 저하됨은 물론 유지보수자 이외에도 별도의 안전요원인 다수(多數)의 안전경보자를 더 배치해야 하므로 인건비의 상승이 유발되는 문제점도 있다.

[0007] 또한, 안전경보자 역시 열차의 접근 유무를 지속적으로 감시해야 함에도 집중력 저하 등의 감각 차단 현상에 의해 정확한 열차의 접근 유무를 전달하지 못하여 신뢰성을 가지는 열차 접근에 대한 정보를 제공하지 못하는 문제점도 있다.

[0008] 아울러, 소음이 심한 지역의 경우에는 안전경보자의 경고신호를 인지하기 어려워 열차와의 충돌 위험이 더욱 높은 문제점도 있다.

발명의 내용

해결 하고자하는 과제

[0009] 따라서, 본 발명은 이러한 문제점들을 해결하기 위한 것으로서, 본 발명은 철도의 선로변에서 선로나 신호설비를 유지보수하는 유지보수자들이 단조로운 유지보수 작업을 장시간 지속적으로 수행하여 감각 차단 현상이 발생하여도 열차의 진입을 인지시켜 대처하도록 하는 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법을 제공하는데 그 목적이 있다.

[0010] 또한, 본 발명은 철도의 선로변에서 선로나 신호설비의 유지보수자들의 안전확보를 위한 안전경보자가 필요 없거나 그 수를 최소화할 수 있어 유지보수를 위한 인건비를 최소화할 수 있고 소음이 심한 지역에서도 열차 진입 여부를 용이하게 인지할 수 있는 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법을 제공하는데에도 그 목적이 있다.

과제 해결수단

[0011] 이와 같은 목적을 달성하기 위해 본 발명은;

[0012] 열차에 설치되어 열차접근신호를 무선송출하는 신호송신기와; 선로변 작업영역에서 유지보수작업을 수행하는 유지보수자가 착용하되 상기 신호송신기가 감지거리 이내로 접근하면 상기 열차접근신호를 수신하는 신호수신기와; 상기 신호수신기가 상기 열차접근신호를 수신하면 열차접근을 알리는 진동음으로 출력하는 골전도 스피커;로 구성되는 것을 특징으로 하는 골전도 스피커를 이용한 열차접근 경보 시스템을 제공한다.

[0013] 이때, 상기 신호수신기와 골전도 스피커는 상기 유지보수자의 헬멧에 부착되는 것을 특징으로 한다.

[0014] 한편, 상기 신호송신기는; 상기 열차접근신호를 생성하는 신호생성부와, 상기 신호생성부에서 생성된 열차접근

신호를 무선송출하는 신호송신부로 구성되는 것을 특징으로 한다.

[0015] 또한, 상기 신호수신기는; 상기 신호송신기에서 무선송출되는 열차접근신호를 수신하는 신호수신부와, 상기 신호수신부를 통해 열차접근신호가 수신되면 상기 골전도 스피커로 열차접근으로 인한 경고음을 출력하도록 제어하는 신호제어부로 구성되는 것을 특징으로 한다.

[0016] 또한, 본 발명은;

[0017] 열차접근신호를 무선송출하는 신호송신기가 설치되는 열차가 감지거리 이내로 접근하면 열차접근신호를 수신하는 단계; 및 상기 열차접근신호가 수신되면 열차가 접근중임을 알리기 위해 골전도 스피커를 제어하여 경고음을 출력하는 단계;를 포함하여 구성되는 것을 특징으로 하는 골전도 스피커를 이용한 열차접근 경보 방법을 제공한다.

[0018] 이때, 상기 골전도 스피커는 선로변 작업영역에서 유지보수작업을 수행하는 유지보수자가 착용하는 헬멧에 부착되는 것을 특징으로 한다.

효 과

[0019] 본 발명에 따르면, 철도의 선로변에서 선로나 신호설비에 대한 유지보수 작업을 수행하는 경우 열차의 진입 유무에 대한 경고정보를 유지보수가 행해지고 있는 선로변 작업영역에서 정확하고도 신속하게 인지할 수 있어 열차와 충돌하는 사상사고의 발생을 현저하게 줄일 수 있는 장점이 있다.

[0020] 특히, 골전도 스피커를 이용함으로써 소음이 심한 작업영역에서도 열차의 접근 유무를 정확하게 인지할 수 있고, 열차가 작업영역의 전후방 어디로 접근하더라도 경보음을 발생시키므로 열차와의 추돌사고를 현격하게 줄일 수 있다.

[0021] 또한, 골전도 스피커 방식을 사용하여 귀를 덮지 않으므로 인해 유지보수작업에 전혀 지장을 주지 않으면서, 열차 접근을 알리는 경보음을 바로 들을 수 있고, 현재도 착용하고 있는 안전헬멧 이외에는 작업자가 추가적으로 착용하거나 설치할 장치가 없어 사용하기에도 매우 편리한 장점도 있다.

[0022] 그리고, 별도의 열차 진입 여부를 확인 및 감시하고 이를 유지보수자에게 전달하기 위한 안전경보자가 필요없거나 그 수를 최소화할 수 있어 유지보수에 필요한 비용을 절감할 수 있는 장점도 있다.

발명의 실시를 위한 구체적인 내용

[0023] 이하, 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템 및 방법을 첨부한 도면을 참고로 하여 상세히 기술되는 실시예에 의하여 그 특징들을 이해할 수 있을 것이다.

[0024] 이때, 도 1은 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템의 구성도이고, 도 2는 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템의 상세 회로 구성도이고, 도 3은 본 발명에 따른 골전도 스피커를 도시한 도면이고, 도 4는 본 발명에 따른 골전도 스피커의 착용상태를 설명하기 위해 도시한 도면이고, 도 5는 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 제어 흐름도이다.

[0025] 먼저, 도 1 내지 도 4에 의하면 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템은 철도의 선로변(1)에서 선로나 신호설비를 유지보수작업을 할 경우에는 유지보수자는 감각차단현상으로 인해 열차(2)의 접근을 인지하지 못하여 발생하는 사상사고를 저감하기 위한 안전설비 시스템이다.

[0026] 이와 같은 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템은 유지보수작업이 필요한 선로나 신호설비가 설치되어 있는 선로변 작업영역(10)으로 접근하는 열차(2)에 설치되어 열차접근신호를 무선송출하는 신호송신기(100)와, 상기 선로변 작업영역(10)에서 유지보수작업을 수행하는 유지보수자가 착용하되 상기 신호송신기(100)가 감지거리 이내로 접근하면 상기 신호송신기(100)에서 송출되는 열차접근신호를 수신하는 신호수신기(200)와, 상기 신호수신기(200)로부터 열차접근신호에 따라 유지보수자에게 열차접근 정보를 진동음으로 출력

Ex. 1002 - Page 378

하는 골전도 스피커(300)로 구성된다.

[0027] 이하, 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템의 구성을 좀 더 상세히 설명한다.

[0028] 먼저, 상기 신호송신기(100)는 상기 유지보수자의 안전을 확보하기 위해 상기 선로변 작업영역(10)으로 진입하는 열차(2)에 구비되어 일정주파수를 가지는 열차접근신호를 무선송출하는 것으로, 열차접근신호를 생성하는 신호생성부(110)와, 상기 신호생성부(110)에서 생성된 열차접근신호를 무선송출하는 신호송신부(120)로 구성된다.

[0029] 이때, 상기 신호생성부(110)는 열차가 접근하고 있음을 알리기 위한 열차접근신호 데이터를 저장할 수 있는 내장메모리를 가지는 마이컴으로 구성됨이 바람직하다.

[0030] 그리고, 상기 신호송신부(120)는 열차에 설치되는 상기 신호생성부(110)에서 항상 신호를 생성하는 열차접근신호를 무선 송출하는 것으로 공지(公知)의 무선송신모듈로 구성될 수 있다.

[0031] 한편, 상기 신호수신기(200)와 골전도 스피커(300)는 유지보수자의 헬멧(400)에 부착된다.

[0032] 이때, 상기 신호수신기(200)는 유지보수자의 안전을 확보하기 위해 상기 선로변 작업영역(10)으로 진입하는 열차(2)에 구비되어 일정주파수를 가지는 열차접근신호를 무선으로 수신하는 것으로, 상기 신호송신기(100)에서 무선송출되는 열차접근신호를 수신하는 신호수신부(210)와, 상기 신호수신부(210)를 통해 열차접근신호가 수신되면 상기 골전도 스피커(300)로 열차접근으로 인한 경고음을 출력하도록 제어하는 신호제어부(220)로 구성된다.

[0033] 물론, 상기 신호수신부(210)는 열차(2)가 감지거리 이내로 접근하는 경우 열차접근신호를 수신하는 것으로, 공지(公知)의 무선수신모듈로 구성될 수 있다.

[0034] 따라서, 열차(2)에 설치되는 신호송신기(100)는 계속해서 열차접근신호를 보내며, 작업자의 안전 헬멧(400)에 부착된 신호수신기(200)가 상기 열차접근신호를 감지하면 골전도 스피커(300)를 통해 작업자에게 경고음을 발생시켜 열차의 접근을 인지할 수 있도록 한다.

[0035] 이때, 선로의 반대편 열차(2)의 접근에 대해서도 수신이 가능하므로 선로의 어떤 위치에서도 유지보수자가 열차(2)가 현재의 작업 영역으로 접근하는지 여부를 인식할 수 있게 된다.

[0036] 한편, 상기 골전도 스피커(300)는 상기 신호수신기(200)의 신호제어부(220)의 제어에 의해 작업자에게 경고음을 출력시켜 유지보수자는 열차의 접근 전에 안전구역으로 대피할 수 있다.

[0037] 이와 같은 골전도 스피커(300)는 두개골의 진동을 통해 소리를 듣는 원리를 이용한 것으로, 일반적으로 널리 상용화되어 있는 공지(公知)의 구성요소이다.

[0038] 특히, 상기 골전도 스피커(300)는 귀 주위(3)에 부착되면 되는데, 안전 헬멧(400) 아래쪽에 부착하여 귀 주위에 덮는 방식으로 할 수도 있고, 안전 헬멧(400) 자체에 부착하여 안전 헬멧(400)의 아래 부분이 없는 형태로 할 수 있는 등 안전 헬멧(400)의 어느 부분에 부착하여도 되므로, 헤드셋이 귀를 덮지 않아 다른 소리를 청취하는데 전혀 방해가 없으며 또한 장시간 착용에도 청각에 전혀 무리가 없으며, 어떠한 소음환경에서도 열차접근 경보음의 인지가 가능하다.

[0039] 따라서 본 발명에서는 기존의 일반적인 안전용 헬멧(400)에 신호수신기(200)와 골전도 스피커(300)가 일체로 구비된다.

[0040] 이와 같은 골전도 스피커(300)는 도 3에 도시한 바와 같이 귀 주위(3)에 닫을 수 있는 형상으로 제작하여 헬멧에 부착 고정함이 바람직하다.

[0041] 이하, 도 1 내지 도 5를 참고로 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 제어 과정을 상세히 설명한다.

[0042] 먼저, 선로를 따라 이동하는 열차(2)는 신호송신기(100)를 통해 열차접근신호를 무선송출한다.(S100)

[0043] 상기 단계(S100)를 거치면서 지속적으로 열차접근신호를 무선 송출하면서 열차가 이동하게 되는데, 이동하던 열차(2)가 유지보수작업이 필요하거나 작업중인 선로나 신호설비가 설치되어 있는 선로변 작업영역(10)으로 접근하는 경우 선로변 작업영역(10)에 배치된 유지보수자의 헬멧(400)에 장착된 신호수신기(200)를 통해 열차접근신

호가 수신된다.(S110)

[0044] 상기 열차접근신호가 수신되면 상기 신호수신기(200)는 열차가 접근중임을 알리기 위해 골전도 스피커(300)를 제어하여 경고음을 출력하여 선로변 작업영역(10)의 유지보수자가 인지할 수 있도록 하며, 그와 같은 경고정보를 인식한 유지보수자는 선로변 작업영역(10)에서 벗어나거나 신속한 대처를 할 수 있게 된다.(S120)

[0045] 따라서, 유지보수자가 장시간 선로변 유지보수 등의 작업을 수행함으로 인해 감각 차단 현상이 발생하더라도 선로변 작업영역(10)에서 정확하고도 신속하게 열차의 진입 여부를 확인할 수 있어 열차(2)에 의한 충돌로 인한 사상사고를 예방할 수 있다.

[0046] 특히, 소음이 심한 선로변 작업영역(10)에서도 정확하게 경고음을 확인할 수 있어 열차와의 충돌 위험을 더욱 줄이는 장점도 있다.

[0047] 이상에서는 본 발명의 바람직한 실시예를 설명하였으나, 본 발명의 권리범위는 이에 한정되지 않으며, 본 발명의 실시예와 실질적으로 균등한 범위에 있는 것까지 본 발명의 권리범위가 미치는 것으로 본 발명의 정신을 벗어나지 않는 범위 내에서 당해 발명이 속하는 기술분야에서 통상의 지식을 가진 자에 의해 다양한 변형 실시가 가능한 것이다.

도면의 간단한 설명

[0048] 도 1은 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템의 구성도이고,

[0049] 도 2는 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 시스템의 상세 회로 구성도이고,

[0050] 도 3은 본 발명에 따른 골전도 스피커를 도시한 도면이고,

[0051] 도 4는 본 발명에 따른 골전도 스피커의 착용상태를 설명하기 위해 도시한 도면이고,

[0052] 도 5는 본 발명에 따른 골전도 스피커를 이용한 열차접근 경보 제어 흐름도이다.

[0053] *** 도면의 주요부분에 대한 부호의 설명 ***

[0054] 1: 선로변 2: 열차

[0055] 10: 선로변 작업영역 100: 신호송신기

[0056] 110: 신호생성부 120: 신호송신부

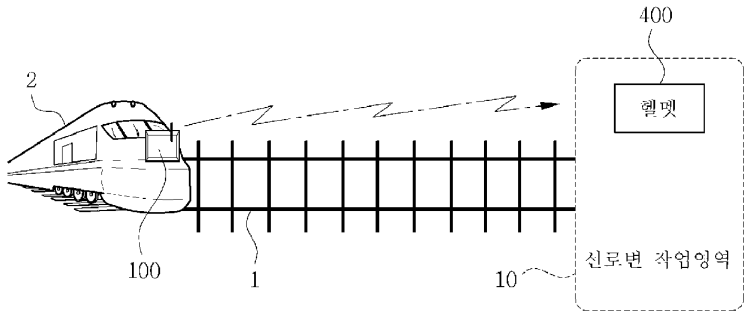
[0057] 200: 신호수신기 210: 신호수신부

[0058] 220: 신호제어부 300: 골전도 스피커

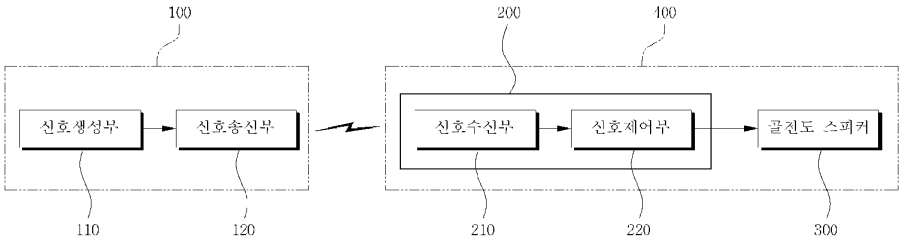
[0059] 400: 헬멧

도면

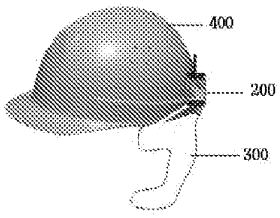
도면1



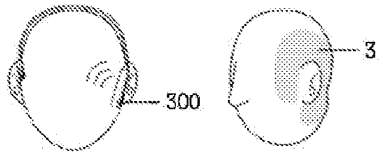
도면2



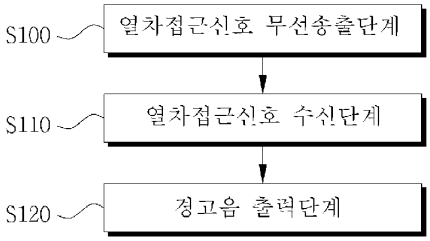
도면3



도면4



도면5



Espacenet

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A CREWLESS SERVICE SYSTEM FOR RAILWAY CAR

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Classification: **- international:** ***B61L23/14; B61L27/04***
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Application number: KR20120083620 20120731 Global Dossier

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Abstract of KR20140017157 (A)

The present invention relates to a driverless operation system for railway vehicles. The driverless operation system comprises: an onboard signaling device which is installed in a railway vehicle and transmits driving state information and vehicle error information of the railway vehicle; a wayside wireless communication device which is installed in a side of a railway track, and communicates with the onboard signaling device in a wireless manner; a wayside control device which is connected to the wayside wireless communication device by a wire and receives the state information and the vehicle error information of the railway vehicle via the wayside wireless communication device; and a central control device which is installed in a central control center that remotely controls driving of the railway vehicle, shows the driving state information and the vehicle error information of the railway vehicle, which is transmitted from the onboard signaling device via the wayside control device, to a controller, and transmits a vehicle control command that the controller inputs to the onboard signaling device of the railway vehicle via the wayside control device and the wayside wireless communication device. According to the present invention, it is possible to improve safety and efficiency of complete driverless operation of railway vehicles in which drivers and crews are not on board to operate the railway vehicles. [Reference numerals] (10) Onboard signaling device; (20,CC,EE) Wayside wireless communication device; (30,BB,DD) Wayside control device; (410) Central TCMS (Train Control & Monitoring

System); (420) Controller interface screen unit; (AA) DCS (Digital Cross connect system) network; (FF) Railway vehicle; (GG) Railway track

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(54) 발명의 명칭 **철도차량용 무인운행시스템**

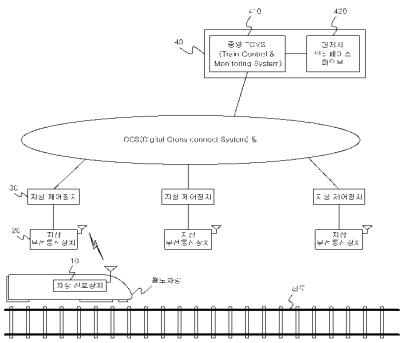
(57) 요 약

본 발명은 철도차량용 무인운행시스템에 관한 것이다.

본 발명에 따른 철도차량용 무인운행시스템은 철도차량에 설치되어 있으며 상기 철도차량의 운행상태정보와 차량고장정보를 전송하는 차상 신호장치, 상기 철도차량이 운행되는 선로 변에 설치되어 있으며 상기 차상 신호장치와 무선 통신하는 지상 무선통신장치, 상기 지상 무선통신장치와 유선으로 연결되어 있으며 상기 지상 무선통신장치를 매개로 상기 차상 신호장치로부터 상기 철도차량의 운행상태정보와 차량고장정보를 전송받는 지상 제어장치 및 상기 철도차량의 운행을 원격 제어하는 중앙 관제실에 설치되어 있으며 상기 지상 제어장치로부터 상기 철도차량에 설치된 차상신호가 전송하는 상기 철도차량의 운행상태정보와 차량고장정보를 관제사에게 표시하고 상기 관제사에 의해 입력된 차량 제어명령을 상기 지상 제어장치와 상기 지상 무선통신장치를 매개로 상기 철도차량의 차상 신호장치로 전송하는 중앙 관제장치를 포함하여 구성된다.

본 발명에 따르면, 철도차량의 운행을 위해 승무원이 철도차량에 탑승하지 않는 완전 무인 환경에서의 철도차량의 무인 운행의 안전성과 효율성이 향상되는 효과가 있다.

대 표 도 - 도1



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특허청구의 범위

청구항 1

철도차량용 무인운행시스템에 있어서,

철도차량에 설치되어 있으며 상기 철도차량의 운행상태정보와 차량고장정보를 전송하는 차상 신호장치;

상기 철도차량이 운행되는 선로 변에 설치되어 있으며 상기 차상 신호장치와 무선 통신하는 지상 무선통신장치;

상기 지상 무선통신장치와 유선으로 연결되어 있으며 상기 지상 무선통신장치를 매개로 상기 차상 신호장치로부터 상기 철도차량의 운행상태정보와 차량고장정보를 전송받는 지상 제어장치; 및

상기 철도차량의 운행을 원격 제어하는 중앙 관제실에 설치되어 있으며 상기 지상 제어장치로부터 상기 철도차량에 설치된 차상 신호장치가 전송하는 상기 철도차량의 운행상태정보와 차량고장정보를 관제사에게 표시하고 상기 관제사에 의해 입력된 차량 제어명령을 상기 지상 제어장치와 상기 지상 무선통신장치를 매개로 상기 철도차량의 차상 신호장치로 전송하는 중앙 관제장치를 포함하는, 철도차량용 무인운행시스템.

청구항 2

제1 항에 있어서,

상기 차상 신호장치는

상기 철도차량에 설치된 각종 장치들로부터 상기 철도차량의 운행상태정보와 차량고장정보를 수집하고 상기 중앙 관제장치로부터 전송받은 차량 제어명령에 따라 상기 철도차량의 운행을 제어하는 차량측 TCMS(Train Control & Monitoring System);

상기 지상 무선통신장치와의 무선 통신을 위한 차량측 무선통신모듈; 및

상기 차량측 TCMS와 직렬 통신 방식으로 인터페이스(interface)되어 있으며 상기 차량측 TCMS와 상기 중앙 관제장치와의 양방향 데이터 통신을 제어하는 차량측 컨트롤러를 포함하는 것을 특징으로 하는, 철도차량용 무인운행시스템.

청구항 3

제2 항에 있어서,

상기 중앙 관제장치는

상기 차량측 TCMS로부터 상기 철도차량의 운행상태정보와 차량고장정보를 전송받고 상기 관제사에 의해 입력된 차량 제어명령을 상기 차량측 TCMS로 전송하여 상기 철도차량의 무인운행을 실시간 제어하기 위한 중앙 TCMS; 및

상기 중앙 TCMS가 상기 차량측 TCMS로부터 전송받은 정보를 표시하고 상기 관제사가 상기 차량 제어명령을 입력하기 위한 인터페이스 화면을 제공하는 관제사 인터페이스 화면부를 포함하는 것을 특징으로 하는, 철도차량용 무인운행시스템.

청구항 4

제1 항에 있어서,

상기 관제사 인터페이스 화면부에는 차량정보표시용 인터페이스 화면과 제어명령입력용 인터페이스 화면이 표시되고,

상기 차량정보표시용 인터페이스 화면에는 상기 중앙 TCMS가 상기 차량측 TCMS로부터 전송받은 상기 철도차량의 운행상태정보와 차량고장정보가 표시되고,

상기 제어명령입력용 인터페이스 화면에는 상기 관제사가 상기 철도차량을 제어하기 위한 차량 제어명령을 입력하기 위한 인터페이스 화면이 표시되는 것을 특징으로 하는, 철도차량용 무인운행 시스템.

청구항 5

제1 항에 있어서,

상기 차상 신호장치와 상기 중앙 관제장치는 무선주파수 통신기반 열차 제어(Radio Frequency-Communication Based Train Control, RF-CBTC) 시스템을 위해 구성된 DCS(Digital Cross connect System)망을 통해 무선 통신하는 것을 특징으로 하는, 철도차량용 무인운행시스템.

청구항 6

제1 항 내지 제5 항 중 어느 한 항의 철도차량용 무인운행시스템에 의해 무인 운행되는 것을 특징으로 하는, 철도차량.

명 세 서

기 술 분 야

[0001] 본 발명은 철도차량용 무인운행시스템에 관한 것이다. 보다 구체적으로, 본 발명은 철도차량의 운행을 위해 승무원이 철도차량에 탑승하지 않는 완전 무인 환경에서의 철도차량의 무인 운행의 안전성과 효율성을 향상시킬 수 있는 철도차량용 무인운행시스템에 관한 것이다.

배 경 기 술

[0002] 최근 철도차량의 무인 운행 서비스가 제공되고 있으나, 현재까지 알려진 무인운행기술에 따르면, 철도차량의 운행을 위한 세부적인 제어 기능이 부족하다는 문제점이 있다.

[0003] 이러한 제어 기능의 부족은 결국 승객에 제공되는 서비스 품질의 저하로 이어지고, 경우에 따라서는 치명적인 사고로 이어질 수 있다는 문제점이 있다.

[0004] 따라서 보다 안전성이 강화되고 세부적인 제어를 할 수 있으며, 철도차량의 무인 운행 과정에서 발생하는 상황에 실시간으로 대처할 수 있는 방안이 요구된다.

발명의 내용

해결하려는 과제

[0005] 본 발명은 철도차량의 운행을 위해 승무원이 철도차량에 탑승하지 않는 완전 무인 환경에서의 철도차량의 무인 운행의 안전성과 효율성을 향상시킬 수 있는 철도차량용 무인운행시스템을 제공하는 것을 기술적 과제로 한다.

[0006] 또한, 본 발명은 철도차량의 무인 운행을 위한 정보들이 중앙 관제실에 구비된 관제사 인터페이스 화면부에 실시간으로 표시되도록 구성하여, 철도차량의 무인 운행을 위한 관리자 편의성을 향상시키고 무인 운행 서비스의 품질을 향상시킬 수 있는 철도차량용 무인운행시스템을 제공하는 것을 기술적 과제로 한다.

과제의 해결 수단

[0007] 이러한 과제를 해결하기 위한 본 발명에 따른 철도차량용 무인운행시스템은 철도차량에 설치되어 있으며 상기 철도차량의 운행상태정보와 차량고장정보를 전송하는 차상 신호장치, 상기 철도차량이 운행되는 선로 변에 설치되어 있으며 상기 차상 신호장치와 무선 통신하는 지상 무선통신장치, 상기 지상 무선통신장치와 유선으로 연결되어 있으며 상기 지상 무선통신장치를 매개로 상기 차상 신호장치로부터 상기 철도차량의 운행상태정보와 차량고장정보를 전송받는 지상 제어장치 및 상기 철도차량의 운행을 원격 제어하는 중앙 관제실에 설치되어 있으며 상기 지상 제어장치로부터 상기 철도차량에 설치된 차상 신호장치가 전송하는 상기 철도차량의 운행상태정보와 차량고장정보를 관제사에게 표시하고 상기 관제사에 의해 입력된 차량 제어명령을 상기 지상 제어장치와 상기 지상 무선통신장치를 매개로 상기 철도차량의 차상 신호장치로 전송하는 중앙 관제장치를 포함하여 구성된다.

[0008] 본 발명에 따른 철도차량용 무인운행시스템에 있어서, 상기 차상 신호장치는 상기 철도차량에 설치된 각종 장치들로부터 상기 철도차량의 운행상태정보와 차량고장정보를 수집하고 상기 중앙 관제장치로부터 전송받은 차량 제어명령에 따라 상기 철도차량의 운행을 제어하는 차량측 TCMS(Train Control & Monitoring System), 상기 지

상 무선통신장치와의 무선 통신을 위한 차량측 무선통신모듈 및 상기 차량측 TCMS와 직렬 통신 방식으로 인터페이스(interface)되어 있으며 상기 차량측 TCMS와 상기 중앙 관제장치와의 양방향 데이터 통신을 제어하는 차량측 컨트롤러를 포함하는 것을 특징으로 한다.

[0009] 본 발명에 따른 철도차량용 무인운행시스템에 있어서, 상기 중앙 관제장치는 상기 차량측 TCMS로부터 상기 철도차량의 운행상태정보와 차량고장정보를 전송받고 상기 관제사에 의해 입력된 차량 제어명령을 상기 차량측 TCMS로 전송하여 상기 철도차량의 무인운행을 실시간 제어하기 위한 중앙 TCMS 및 상기 중앙 TCMS가 상기 차량측 TCMS로부터 전송받은 정보를 표시하고 상기 관제사가 상기 차량 제어명령을 입력하기 위한 인터페이스 화면을 제공하는 관제사 인터페이스 화면부를 포함하는 것을 특징으로 한다.

[0010] 본 발명에 따른 철도차량용 무인운행시스템에 있어서, 상기 관제사 인터페이스 화면부에는 차량정보표시용 인터페이스 화면과 제어명령입력용 인터페이스 화면이 표시되고, 상기 차량정보표시용 인터페이스 화면에는 상기 중앙 TCMS가 상기 차량측 TCMS로부터 전송받은 상기 철도차량의 운행상태정보와 차량고장정보가 표시되고, 상기 제어명령입력용 인터페이스 화면에는 상기 관제사가 상기 철도차량을 제어하기 위한 차량 제어명령을 입력하기 위한 인터페이스 화면이 표시되는 것을 특징으로 한다.

[0011] 본 발명에 따른 철도차량용 무인운행시스템에 있어서, 상기 차상 신호장치와 상기 중앙 관제장치는 무선주파수 통신기반 열차 제어(Radio Frequency-Communication Based Train Control, RF-CBTC) 시스템을 위해 구성된 DCS(Digital Cross connect System)망을 통해 무선 통신하는 것을 특징으로 한다.

[0012] 본 발명에 따른 철도차량은 본 발명에 따른 철도차량용 무인운행시스템에 의해 무인 운행되는 것을 특징으로 한다.

발명의 효과

[0013] 본 발명에 따르면, 철도차량의 운행을 위해 승무원이 철도차량에 탑승하지 않는 완전 무인 환경에서의 철도차량의 무인 운행의 안전성과 효율성이 향상되는 효과가 있다.

[0014] 또한, 철도차량의 무인 운행을 위한 정보들이 중앙 관제실에 구비된 관제사 인터페이스 화면부에 실시간으로 표시되기 때문에, 철도차량의 무인 운행을 위한 관리자 편의성이 향상되고 무인 운행 서비스의 품질이 향상되는 효과가 있다.

도면의 간단한 설명

[0015] 도 1은 본 발명의 일 실시 예에 따른 철도차량용 무인운행시스템을 나타낸 도면이다.

도 2는 본 발명의 일 실시 예에 있어서, 차상 신호장치의 구성의 예를 나타낸 도면이다.

도 3은 본 발명의 일 실시 예에 있어서, 관제사 인터페이스 화면부에 표시되는 차량정보표시용 인터페이스 화면의 예를 나타낸 도면이다.

도 4는 본 발명의 일 실시 예에 있어서, 관제사 인터페이스 화면부에 표시되는 제어명령입력용 인터페이스 화면의 예를 나타낸 도면이다.

발명을 실시하기 위한 구체적인 내용

[0016] 이하에서는 첨부된 도면을 참조하여 본 발명의 바람직한 실시 예를 상세히 설명한다.

[0017] 도 1은 본 발명의 일 실시 예에 따른 철도차량용 무인운행시스템을 나타낸 도면이다.

[0018] 도 1을 참조하면, 본 발명의 일 실시 예에 따른 철도차량용 무인운행시스템은 차상 신호장치(10), 지상 무선통신장치(20), 지상 제어장치(30) 및 중앙 관제장치(40)를 포함하여 구성된다.

[0019] 차상 신호장치(10)는 철도차량에 설치되어 있으며 철도차량의 운행상태정보와 차량고장정보를 DCS(Digital Cross connect System) 망을 통해 중앙 관제장치(40)로 전송하는 기능을 수행한다. 또한 차상 신호장치(10)는 중앙 관제장치(40)가 설치된 중앙 관제실에서 근무하는 관제사에 의해 입력된 차량 제어명령을 전송받아 철도차량을 무인 자동 운행하는 기능을 수행한다.

[0020] 예를 들어 도 2에 개시된 바와 같이, 차상 신호장치(10)는 차량측 TCMS(Train Control & Monitoring System,

110), 차량측 무선통신모듈(120) 및 차량측 컨트롤러(130)를 포함하여 구성될 수 있다.

[0021] 차량측 TCMS(110)는 철도차량에 설치되어 있는 차량 운행을 위한 각종 장치들로부터 철도차량의 운행상태정보와 차량고장정보를 수집하고, 중앙 관제장치(40)로부터 전송받은 차량 제어명령에 따라 차량 운행을 위한 각종 장치들을 제어함으로써 철도차량의 운행을 제어하는 기능을 수행한다.

[0022] 차량측 무선통신모듈(120)은 지상 무선통신장치(20)와의 무선 통신을 위한 수단이다.

[0023] 차량측 컨트롤러(130)는 차량측 TCMS(110)와 직렬 통신 방식으로 인터페이스(interface)되어 있으며, 차량측 TCMS(110)와 중앙 관제장치(40)와의 양방향 데이터 통신을 제어하는 기능을 수행한다.

[0024] 지상 무선통신장치(20)는 철도차량이 운행되는 선로 변을 따라 일정 간격마다 설치되어 있으며 차상 신호장치(10)에 구비된 차량측 무선통신모듈(120)과 무선 통신하기 위한 수단이다.

[0025] 지상 제어장치(30)는 지상 무선통신장치(20)와 유선으로 연결되어 있으며, 지상 무선통신장치(20)를 매개로 차상 신호장치(10)로부터 철도차량의 운행상태정보와 차량고장정보를 전송받아 중앙 관제장치(40)로 전송하고, 중앙 관제장치(40)로부터 전송받은 차량 제어명령을 차상 신호장치(10)로 전송하는 기능을 수행한다.

[0026] 중앙 관제장치(40)는 철도차량의 운행을 원격 제어하는 중앙 관제실에 설치되어 있으며, 지상 제어장치(30)로부터 철도차량에 설치된 차상 신호장치(10)가 전송하는 철도차량의 운행상태정보와 차량고장정보를 관제사에게 표시하고, 관제사에 의해 입력된 차량 제어명령을 지상 제어장치(30)와 지상 무선통신장치(20)를 매개로 철도차량의 차상 신호장치(10)로 전송하는 기능을 수행한다.

[0027] 예를 들어, 이러한 차상 신호장치(10)와 중앙 관제장치(40)는 무선주파수 통신기반 열차 제어(Radio Frequency-Communication Based Train Control, RF-CBTC) 시스템을 위해 구성된 DCS(Digital Cross connect System)망을 통해 무선 통신하도록 구성될 수 있다.

[0028] 이러한 중앙 관제장치(40)는 중앙 TCMS(Train Control & Monitoring System, 410) 및 관제사 인터페이스 화면부(420)를 포함하여 구성될 수 있다.

[0029] 중앙 TCMS(410)는 차량측 TCMS(110)로부터 철도차량의 운행상태정보와 차량고장정보를 전송받고, 전송받은 정보가 관제사 인터페이스 화면부(420)에 표시되도록 제어하고, 관제사에 의해 입력된 차량 제어명령을 차량측 TCMS(110)로 전송함으로써 철도차량의 무인운행을 실시간 제어하는 기능을 수행한다.

[0030] 관제사 인터페이스 화면부(420)는 중앙 TCMS(410)가 차량측 TCMS(110)로부터 전송받은 정보를 표시하고, 관제사가 차량 제어명령을 입력하기 위한 인터페이스 화면을 제공한다.

[0031] 예를 들어, 관제사 인터페이스 화면부(420)에는 관제사의 선택에 따라 차량정보표시용 인터페이스 화면과 제어명령입력용 인터페이스 화면이 표시되도록 구성될 수 있다.

[0032] 도 3은 본 발명의 일 실시 예에 있어서, 관제사 인터페이스 화면부(420)에 표시되는 차량정보표시용 인터페이스 화면의 예를 나타낸 도면이다.

[0033] 도 3을 참조하면, 차량정보표시용 인터페이스 화면에는 중앙 TCMS(410)가 차량측 TCMS(110)로부터 전송받은 철도차량의 운행상태정보와 차량고장정보가 실시간으로 표시된다.

[0034] 관제사는 이 차량정보표시용 인터페이스 화면을 통해 차량의 모든 상태를 모니터링할 수 있으며, 중요 차량 장애 정보는 로그 창에 표시되는 동시에 알람을 발생하여 관제사에게 장애 발생을 알리도록 구성된다.차량정보표시용 인터페이스 화면을 통해 표시되는 정보는 다음 표 1에 개시되어 있다.

표 1

[0035]

번호	표시 기능	기능 설명
1	Self Test Result	열차 기동 후, 최초 전원공급 시 자기진단을 실시하고 현재 열차의 상태정보를 TCMS콘솔로 전송하는 기능.
2	TCMS Status	차량TCMS의 상태정보를 사령의 TCMS콘솔로 전송하는 기능.
3	Train Status	열차상태정보데이터를 사령의 TCMS콘솔로 전송하는 기능.
4	Emergency Passenger Door Handle Applied	비상출입문 핸들이 취급되었는지 여부를 사령의 TCMS콘솔로 전송하는 기능.
5	Fire/Smoke Detection	화재 정보/연기 정보 감지 기능.
6	Passenger Interphone	승객 인터폰정보.

7	Passenger Emergency Hammer released	승객 비상탈출용장비 상자 개방여부 감지기능
8	Train ECU Major Failure	열차 전자제어장치 주요 기능오류 검지기능
9	Brake Not Release Detected	제동해제 불능 검지기능
10	Train Status C/I Failure	차량컨버터 및 인버터 기능오류 검지기능
11	ESK/CM/ACM Status	ESK/CM/ACM 상태정보
12	AS&BC Status	AS&BC 상태정보
13	SIV Failure	static 인버터 오류검지기능
14	Train Status C/I Failure	차량컨버터 및 인버터 기능오류 검지기능
15	Interior room DC Light On	차량 내 전등 점멸상태정보
16	HVAC On/Off	차량 내 난방, 환기, 공조 설비 On/Off상태
17	MCB Status	main circuit brake
18	K Status	차량 세부 정보
19	Pantograph Status	판토그래프의 상태정보를 TCMS콘솔로 전송한다.
20	Line Earth Switch Service In Status	차량 세부 정보
21	DCU Door Status	DCU(Door Control Unit) Door상태정보를 TCMS콘솔로 전송한다.
22	DCU Door Failure Status	DCU(Door Control Unit) Door개폐실패 상태정보를 TCMS콘솔로 전송한다.
23	Fault Code	오류코드를 TCMS콘솔로 전송한다.
24	Detected Date	검지된 Time Stamp를 TCMS콘솔로 송신.

[0036] 도 4는 본 발명의 일 실시 예에 있어서, 관제사 인터페이스 화면부(420)에 표시되는 제어명령입력용 인터페이스 화면의 예를 나타낸 도면이다.

[0037] 도 4를 참조하면, 제어명령입력용 인터페이스 화면에는 관제사가 철도차량을 제어하기 위한 차량 제어명령을 입력하기 위한 인터페이스 화면이 표시된다.

[0038] 관제사는 이 제어명령입력용 인터페이스 화면을 통해 제어명령을 선택하고 실행시킬 수 있다.

[0039] 제어명령입력용 인터페이스 화면을 통해 표시되는 정보는 다음 표 2에 개시되어 있다.

표 2

[0040]

번호	제어 기능	기능 설명
1	Remote Self Test Command	원격 열차 Self-test 명령
2	DOOR Remote Command	출입문원격제어 명령
3	Train Status DCU Reset/Cutout Command	열차DCU Reset/Cutout 명령
4	Emergency End Door Command	비상 출입문 제어 명령
5	Emergency End Door Setting Point	비상출입문 설정 포인트 명령
6	Brake CPR Command	제동CPR명령
7	C/I Reset/Cutout Command	컨버터/인버터 Reset/Cutout 명령
8	C/I Select point	컨버터/인버터 선택 포인트 명령
9	SIV Reset/Cutout Command	SIV Reset/Cutout 명령
10	SIV Select point	SIV 선택 포인트 명령
11	ECU Reset/Cutout Command	전자제어유닛(ECU) Reset/Cutout 명령
12	ECU Select Point	ECU(전자제어유닛) 선택 명령
13	HVAC Auto ON/OFF Command	난방 환기 및 공조 설비 자동 ON/OFF명령
14	HVAC Select point	난방 환기 및 공조 선택 포인트 명령
15	HVAC Operation Mode Setting	난방 환기 및 공조 운영모드 설정
16	Room Temperature Setting Value	실내 온도설정 값
17	Remote Pantograph Command	원격 판토그래프 제어명령
18	Pantograph Setting point	판토그래프 설정 포인트
19	Remote MCB Command	원격 MCB명령
20	MCB Setting point	MCB설정명령
21	Head Light Command	열차 헤드라이트 명령
22	Head Light Setting point	열차 헤드라이트 설정명령
23	MSR Power On/Off Command	MSR 전원 ON/OFF명령
24	MSR Power Setting point	MSR전원설정 포인트
25	Electric Horn Command	경적 명령

26	Electric Horn Setting point	경적 설정 포인트

[0041] 이상에서 상세히 설명한 바와 같이 본 발명에 따르면, 철도차량의 운행을 위해 승무원이 철도차량에 탑승하지 않는 완전 무인 환경에서의 철도차량의 무인 운행의 안전성과 효율성이 향상되는 효과가 있다.

[0042] 또한, 철도차량의 무인 운행을 위한 정보들이 중앙 관제실에 구비된 관제사 인터페이스 화면부에 실시간으로 표시되기 때문에, 철도차량의 무인 운행을 위한 관리자 편의성이 향상되고 무인 운행 서비스의 품질이 향상되는 효과가 있다.

[0043] 이상에서 본 발명에 대한 기술 사상을 첨부 도면과 함께 서술하였지만, 이는 본 발명의 바람직한 실시예를 예시적으로 설명한 것이지 본 발명을 한정하는 것은 아니다. 또한, 이 기술 분야의 통상의 지식을 가진 자라면 누구나 본 발명의 기술 사상의 범주를 이탈하지 않는 범위 내에서 다양한 변형 및 모방이 가능함은 명백한 사실이다.

부호의 설명

[0044] 10: 차상 신호장치

20: 지상 무선통신장치

30: 지상 제어장치

40: 중앙 관제장치

110: 차량측 TCMS(Train Control & Monitoring System)

120: 차량측 무선통신모듈

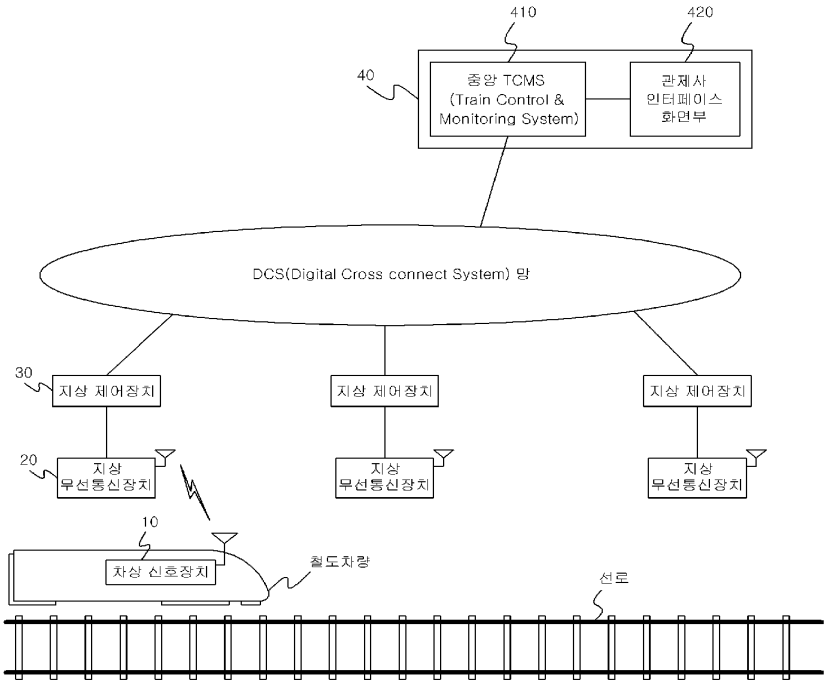
130: 차량측 컨트롤러

410: 중앙 TCMS(Train Control & Monitoring System)

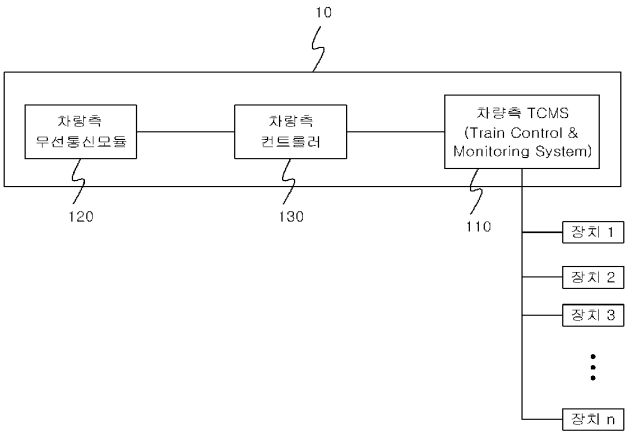
420: 관제사 인터페이스 화면부

도면

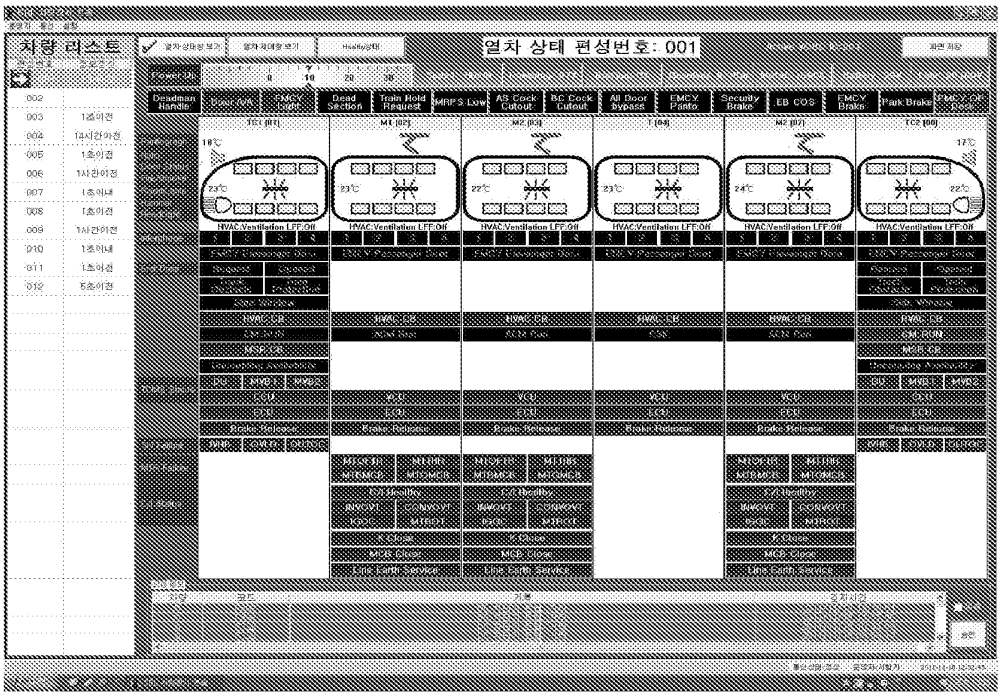
도면1


410
420
40
중앙 TCMS
(Train Control &
Monitoring System)
관제사
인터페이스
화면부
DCS(Digital Cross connect System) 망
30
지상 제어장치
지상 제어장치
지상 제어장치
20
지상
무선통신장치
지상
무선통신장치
지상
무선통신장치
10
차상 신호장치
철도차량
선로

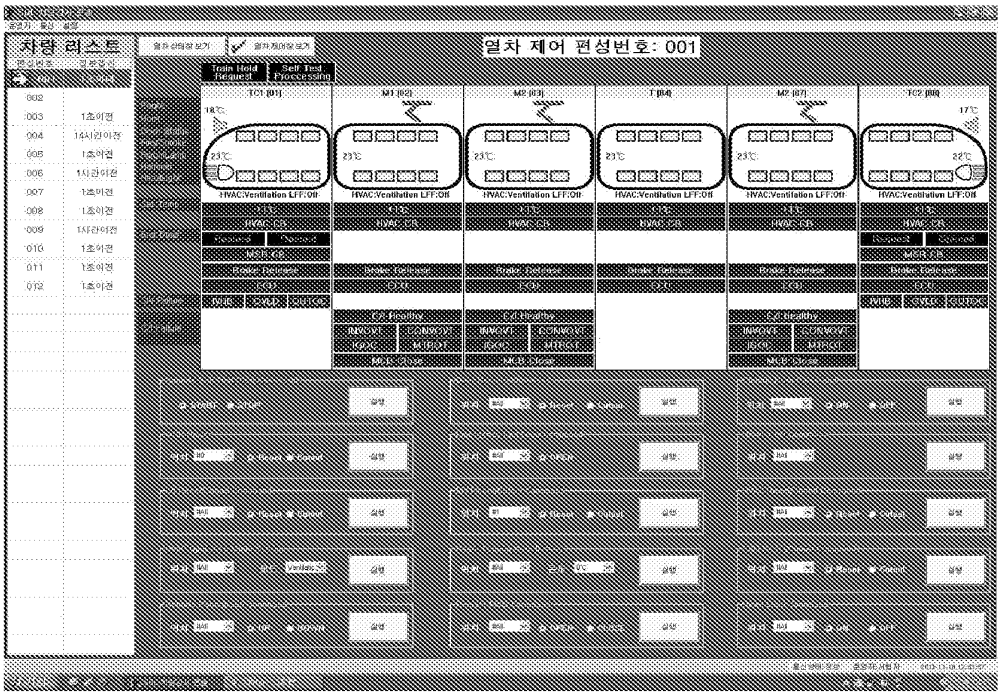
도면2


10
차량측
무선통신모듈
차량측
컨트롤러
차량측 TCMS
(Train Control &
Monitoring System)
120
130
110
장치 1
장치 2
장치 3
장치 n

도면3



도면4



Espacenet

Bibliographic data: KR100733599 (B1) — 2007-07-03

A warning system of dangerous area

Inventor(s):	JUNG, JAE OK	
Applicant(s):	KYONG BONG TECHNOLOGY CO., LTD	
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A danger predicting/alarm apparatus is provided to enable a driver to recognize danger of a railway through the alarm by monitoring the railway in real time through image analyzing algorithm. An image monitoring unit(200) is installed on a dangerous position of a railway to monitor the railway and transmit a signal to a ground wireless communication device(100). The ground wireless communication device analyzes the image signal received from the image monitoring unit, and compares the analyzed signal with information of a normal railway to determine a current status of the railway. A vehicle wireless communication device(300) receives the image information from the ground wireless communication device, and displays the image information on a liquid crystal display.

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(54) 위험요소 예측 경보 장치

(57) 요약

본 발명은 선로 상의 위험 지역에 설치되어 돌발적으로 발생하는 위험 요소를 미리 식별한 후, 이를 열차를 운전하는 기관사 혹은 선로 상에서 작업을 수행하는 현장의 작업자에게 영상 혹은 음향 신호로 알려줌으로서 열차의 기관사 혹은 현장의 작업자가 위험 상황을 미리 예측하고 그에 적절히 대처할 수 있도록 함으로서 예기치 못한 불시적 상황에 의해 야기되는 사고를 미연에 방지하기 위한 위험요소 예측 경보장치에 관한 것이다.

대표도

도 1

특허청구의 범위

청구항 1.

선로 상의 위험 개소에 설치되어 사고의 발생 여부를 상시 감시하고 그 감시 결과를 지상무선통신장치(100)로 전송하는 영상감시장치(200)와;

상기 영상감시장치(200)로부터 수신된 영상신호를 분석한 후, 이를 미리 입력되어 있는 정상적인 선로의 상태 정보와 비교하여 선로의 이상의 유무를 판단하는 한편, 열차의 진입 여부를 상시 감시하고 있다가 열차가 관할 구역 내로 진입하면 즉시 선로의 현재 상황에 대한 영상정보와 함께 현재의 선로상황의 이상 유무에 대한 판단 결과를 열차에 탑재된 차상무선통신장치로 전송하는 지상무선통신장치(100)와;

상기 지상무선통신장치(100)로부터 선로의 현재 상황에 관한 영상정보와 이상 유무에 대한 판단 결과가 수신되면 즉시 현재의 선로 상황에 대한 영상 정보를 LCD를 통해 디스플레이 함과 동시에, 선로의 상황에 대한 이상 유무 정보가 만일 선로에 이상이 있는 것을 알리는 신호이면 즉시 음향신호로 이 사실을 기관사에게 경보함으로서 기관사가 즉시 화면을 보고 적절히 대처할 수 있도록 하는 차상무선통신장치(300)로;

구성됨을 특징으로 하는 위험 요소 예측 경보 장치

청구항 2.

청구항 1에 있어서,

상기 지상무선통신장치(100)는 다시,

안테나모듈(110)로부터 출력된 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하는 한편, 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로부터 전송되어 온 신호를 수신하는 안테나(150)와;

와이어레스 모듈(120)로부터 출력된 MPEG 영상신호 및 위치송수신 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하기 위해 안테나(150)로 브리지 출력하는 한편, 다이버시티 안테나의 구조로 하나의 지상무선통신장치에 두 개의 구조로 구성되어 무선 커버리지 각도를 240도 이상을 커버할 수 있고, 불평형 전압에 대비하여 서지어레스터를 포함하여 구성된 안테나모듈(110)과;

IEEE 802.11을 기반으로 하는 무선통신 모듈로서 인접한 다른 지상무선통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 이중화된 안테나를 통해 수신되는 무선데이터는 대역통과필터를 통과하여 저잡음 증폭기를 통해 802.11의 표준으로 전송하는 와이어레스 모듈(120)과;

영상감시장치(200)로부터 NTSC신호를 수신받아 상기 수신된 NTSC신호를 MPEG4신호로 변환하여 이미지프로세스모듈(140)로 출력하고 상기 이미지프로세스 모듈(140)의 영상분석 결과를 입력받아 이를 다시 차상무선통신장치(300)로 전송하기 위해 와이어레스모듈(120)로 출력하는 한편, 와이어레스 모듈(120)로부터 수신된 위치표시 신호를 분석하여 작업의 위치와 작업의 내용을 파악한 후, 그 결과를 차상무선장치(300)로 전송하기 위해 와이어레스 모듈(120)로 출력하는 프로세스 모듈(130)과;

상기 프로세스 모듈(130)로부터 MPEG신호로 압축되어 수신된 신호를 패턴인식 알고리즘을 적용하여 미리 입력된 정상적인 선로의 신호와 분석 비교한 후, 선로상의 위험 요인을 실시간으로 판단한 다음 그 결과를 프로세스 모듈(130)로 다시 출력하는 이미지프로세스모듈(140)과;

본 지상무선통신장치(100)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(170)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 3.

청구항 1에 있어서,

상기 영상감시장치(200)는 다시,

선로의 위험개소에 설치되어 선로의 상황을 상시 감시 촬영하되, 자동 모드 조정에 의해 주간에 발생되는 상황은 컬러영상으로 출력하고 야간이나 조도가 현저히 낮은 상황에서는 CCD센서에 의해 적외선 영상으로 전환하여 NTSC신호의 형태로 출력하는 카메라모듈(230)과;

상기 카메라모듈(230)로부터 출력된 NTSC 영상신호를 지상무선통신장치(100)로 TCP/IP 방식으로 출력하는 네트워크 모듈(280)과;

본 영상감시장치에 필요한 전원을 정전압으로 변환하여 공급하는 파워서플라이모듈(270)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 4.

청구항 1에 있어서,

상기 차상무선통신장치(300)는 다시,

안테나모듈(110)로부터 입력된 신호를 2.4GHz의 RF대역으로 지상무선통신장치로 출력하고, 지상무선통신장치로부터 전송되어 온 무선신호를 수신하여 안테나 모듈(310)로 출력하는 안테나(350)와;

상기 안테나(350)를 통해 수신된 지상무선통신장치(100)로부터 전송되어 온 MPEG 영상 송신 및 위치송수신 신호를 와이어레스 모듈(320)로 출력하기 위한 안테나모듈(310)과;

IEEE 802.11을 기반으로 하며, 상기 안테나 모듈(310)을 통해 수신된 상기 MPEG 영상신호 및 위치송수신신호를 메인콘트롤모듈(360)로 출력하는 한편, 상기 메인콘트롤 모듈(360)에서 출력되는 열차정보신호를 안테나(350)를 통해 RF방식으로 지상무선통신장치(100)로 전송하기 위해 신호 처리하는 와이어레스 모듈(320)과;

산업용 컴퓨터로 구성되어 실시간 영상처리 및 TCP/IP 이더넷 콘트롤러를 제공하되, 현장의 영상정보를 LCD 콘트롤모듈(340)로 출력하거나, 현장의 위치정보신호를 음향경보모듈(380)로 출력하는 메인콘트롤모듈(360)과;

메인콘트롤모듈(360)에서 출력된 영상신호를 열차를 운전하는 기관사가 편리하게 볼 수 있도록 LCD에 표시되어야 할 화상의 출력을 제어하기 위한 것으로서 여러 개의 화상을 동시에 볼 수 있도록 멀티케스팅이 지원되며 최소 24비트 컬러 기반의 1024*768 이상의 해상도를 지원하도록 된 LCD 콘트롤모듈(340)과;

상기 LCD 콘트롤모듈(340)을 통해 현장으로부터 전송되어 온 영상을 디스플레이하는 LCD(330)와;

상기 메인콘트롤모듈(360)에서 출력된 위험 경보신호를 출력하여 열차를 운전하는 기관사에게 경보를 발하는 음향경보모듈(380)과;

본 차상무선통신장치(300)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(370)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 5.

가시거리가 확보되지 아니하는 심한 곡선구간에서 작업을 하기 위한 작업자가 선로 상에서 작업을 할 경우에 작업자가 직접 휴대하여 작업 현장에 비치할 수 있도록 휴대형으로 구성되며, 열차가 관할 구역 내로 진입을 하였음을 상시 감시하고 있다가 상기 지상무선통신장치(100)로부터 열차가 접근하고 있음을 알리는 신호가 수신되면 즉시 음향 신호를 발생하여

현장의 작업자에게 열차의 접근을 경보함으로서 작업자가 신속히 대피할 수 있도록 하는 한편, 현 위치에서 선로작업이 진행 중임을 알리는 신호를 상기 지상무선통신장치(100)를 통해 차상무선통신장치로 전송하는 위치표시 및 경보장치(400)와;

상기 위치표시 및 경보장치(400)로부터 송신된 위치표시 신호가 수신되면 수신된 신호를 미리 입력되어 있는 신호와 비교하여 선로상의 작업 여부 및 작업의 내용을 판단하는 한편, 열차의 진입 여부를 상시 감시하고 있다가 열차가 관할 구역 내로 진입하면 즉시 선로 상에 작업구간이 있음을 열차에 탑재된 차상무선통신장치(300)로 전송하는 지상무선통신장치(100)와;

상기 지상무선통신장치(100)로부터 선로 상에 현재 작업 구간이 있음과 그 작업의 내용을 알리는 정보가 수신되면 즉시 음향신호로 이 내용을 기관사에게 알려줌으로서 기관사가 속도를 줄이고 전방의 상황을 주시할 수 있도록 하는 차상무선통신장치(300)로;

구성됨을 특징으로 하는 위험 요소 예측 경보장치

청구항 6.

청구항 5에 있어서,

상기 지상무선통신장치(100)는 다시,

안테나모듈(110)로부터 출력된 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하는 한편, 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로부터 전송되어 온 신호를 수신하는 안테나(150)와;

와이어레스 모듈(120)로부터 출력된 MPEG 영상신호 및 위치송수신 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하기 위해 안테나(150)로 브리지 출력하는 한편, 상기 안테나(150)를 거쳐 수신된 영상신호 및 위치 송수신신호를 와어레스모듈(120)로 출력하되, 불평형 전압에 대비하여 서지어레스터를 포함하여 구성된 안테나모듈(110)과;

IEEE 802.11을 기반으로 하는 무선통신 모듈로서 인접한 다른 지상통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 프로세스 모듈(130)에서 출력된 신호를 RF방식으로 차상무선통신장치(300)로 전송하기 위해 신호 처리하는 한편, 와이어레스 모듈로부터 수신된 신호를 입력받아 프로세스 모듈(130)로 출력하는 와이어레스 모듈(120)과;

영상감시장치(200)로부터 NTSC신호를 수신받아 상기 수신된 NTSC신호를 MPEG4신호로 변환하여 이미지프로세스모듈(140)로 출력하고 상기 이미지프로세스 모듈(140)의 영상분석 결과를 입력받아 이를 다시 차상무선통신장치(300)로 전송하기 위해 와이어레스모듈(120)로 출력하는 한편, 와이어레스 모듈(120)로부터 수신된 위치표시 신호를 분석하여 작업의 위치와 작업의 내용을 파악한 후, 그 결과를 차상무선장치(300)로 전송하기 위해 와이어레스 모듈(120)로 출력하는 프로세스 모듈(130)과;

상기 프로세스 모듈(130)로부터 MPEG신호로 압축되어 수신된 신호를 패턴인식 알고리즘을 적용하여 미리 입력된 정상적인 선로의 신호와 분석 비교한 후, 선로상의 위험 요인을 실시간으로 판단한 다음 그 결과를 프로세스 모듈(130)로 다시 출력하는 이미지프로세스모듈(140)과;

본 지상무선통신장치(100)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(170)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 7.

청구항 5에 있어서,

상기 위치표시 및 경보장치(400)는 다시,

지상무선통신장치(100)를 통해 열차의 접근신호를 수신하는 한편, 위치표시 및 경보장치에서 발생하는 위치표시신호를 지상무선통신장치(100)로 전송하는 안테나(470)와;

와이어레스 모듈(320)로 입력되는 위치표시 신호를 안테나(470)를 통해 출력하고, 지상무선통신장치(100)로부터 수신되는 열차의 접근신호를 와이어레스 모듈(420)로 출력하는 안테나모듈(410)과;

상기 안테나 모듈(410)로부터 수신된 열차접근신호를 콘트롤 모듈(430)로 출력하고 상기 콘트롤 모듈(430)로부터 출력된 위치정보신호를 안테나 모듈(410)로 출력하기 위해 신호처리하는 IEEE 802.11을 기반으로 하는 와이어레스 모듈(420)과;

상기 안테나(470)를 통해 수신된 신호를 콘트롤모듈(430)을 통해 수신되는 열차접근 신호를 인지하여 음향 정보신호를 발생함으로서 열차의 접근을 작업자에게 알리는 음향경보모듈(450)과;

본 위치표시 및 음향경보장치(400)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(440)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 8.

청구항 5에 있어서,

상기 차상무선통신장치(300)는 다시,

안테나모듈(110)로부터 입력된 신호를 2.4GHz의 RF대역으로 지상무선통신장치로 출력하고, 지상무선통신장치로부터 전송되어 온 무선신호를 수신하여 안테나 모듈(310)로 출력하는 안테나(350)와;

상기 안테나(350)를 통해 수신된 지상무선통신장치(100)로부터 전송되어 온 MPEG 영상 송신 및 위치송수신 신호를 와이어레스 모듈(320)로 출력하기 위한 안테나모듈(310)과;

IEEE 802.11을 기반으로 하며, 상기 안테나 모듈(310)을 통해 수신된 상기 MPEG 영상신호 및 위치송수신신호를 메인콘트롤모듈(360)로 출력하는 한편, 상기 메인콘트롤 모듈(360)에서 출력되는 열차정보신호를 안테나(350)를 통해 RF방식으로 지상무선통신장치(100)로 전송하기 위해 신호 처리하는 와이어레스 모듈(320)과;

산업용 컴퓨터로 구성되어 실시간 영상처리 및 TCP/IP 이더넷 콘트롤러를 제공하되, 현장의 영상정보를 LCD 콘트롤모듈(340)로 출력하거나, 현장의 위치정보신호를 음향경보모듈(380)로 출력하는 메인콘트롤모듈(360)과;

메인콘트롤모듈(360)에서 출력된 영상신호를 열차를 운전하는 기관사가 편리하게 볼 수 있도록 LCD에 표시되어야 할 화상의 출력을 제어하기 위한 것으로서 여러 개의 화상을 동시에 볼 수 있도록 멀티케스팅이 지원되며 최소 24비트 컬러 기반의 1024*768 이상의 해상도를 지원하도록 된 LCD 콘트롤모듈(340)과;

상기 LCD 콘트롤모듈(340)을 통해 현장으로부터 전송되어 온 영상을 디스플레이하는 LCD(330)와;

상기 메인콘트롤모듈(360)에서 출력된 위험 경보신호를 출력하여 열차를 운전하는 기관사에게 경보를 발하는 음향경보모듈(380)과;

본 차상무선통신장치(300)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(370)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치

청구항 9.

안테나모듈(110)로부터 출력된 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하는 한편, 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로부터 전송되어 온 신호를 수신하는 안테나(150)와;

와이어레스 모듈(120)로부터 출력된 MPEG 영상신호 및 위치송수신 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하기 위해 안테나(150)로 브리지 출력하는 한편, 상기 안테나(150)를 거쳐 수신된 영상신호 및 위치 송수신신호를 와어레스모듈(120)로 출력하되, 불평형 전압에 대비하여 서지어레스터를 포함하여 구성된 안테나모듈(110)과;

IEEE 802.11을 기반으로 하는 무선통신 모듈로서 인접한 다른 지상통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 프로세스 모듈(130)에서 출력된 신호를 RF방식으로 차상무선통신장치(300)로 전송하기 위해 신호 처리하는 한편, 와이어레스 모듈로부터 수신된 신호를 입력받아 프로세스 모듈(130)로 출력하는 와이어레스 모듈(120)과;

영상감시장치(200)로부터 NTSC신호를 수신받아 상기 수신된 NTSC신호를 MPEG4신호로 변환하여 이미지프로세스모듈(140)로 출력하고 상기 이미지프로세스 모듈(140)의 영상분석 결과를 입력받아 이를 다시 차상무선통신장치(300)로 전송하기 위해 와이어레스모듈(120)로 출력하는 한편, 와이어레스 모듈(120)로부터 수신된 위치표시 신호를 분석하여 작업의 위치와 작업의 내용을 파악한 후, 그 결과를 차상무선장치(300)로 전송하기 위해 와이어레스 모듈(120)로 출력하는 프로세스 모듈(130)과;

상기 프로세스 모듈(130)로부터 MPEG신호로 압축되어 수신된 신호를 패턴인식 알고리즘을 적용하여 미리 입력된 정상적인 선로의 신호와 분석 비교한 후, 선로상의 위험 요인을 실시간으로 판단한 다음 그 결과를 프로세스 모듈(130)로 다시 출력하는 이미지프로세스모듈(140)과;

본 지상무선통신장치(100)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(170)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치의 지상무선통신장치

청구항 10.

선로의 위험개소에 설치되어 선로의 상황을 상시 감시 촬영하되, 자동 모드 조정에 의해 주간에 발생되는 상황은 컬러영상으로 출력하고 야간이나 조도가 현저히 낮은 상황에서는 CCD센서에 의해 적외선 영상으로 전환하여 NTSC신호의 형태로 출력하는 카메라모듈(230)과;

상기 카메라모듈(230)로부터 출력된 NTSC 영상신호를 지상무선통신장치(100)로 TCP/IP 방식으로 출력하는 네트워크 모듈(280)과;

본 영상감시장치에 필요한 전원을 정전압으로 변환하여 공급하는 파워서플라이모듈(270)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치의 영상감시장치

청구항 11.

안테나모듈(110)로부터 입력된 신호를 2.4GHz의 RF대역으로 지상무선통신장치로 출력하고, 지상무선통신장치로부터 전송되어 온 무선신호를 수신하여 안테나 모듈(310)로 출력하는 안테나(350)와;

상기 안테나(350)를 통해 수신된 지상무선통신장치(100)로부터 전송되어 온 MPEG 영상 송신 및 위치송수신 신호를 와이어레스 모듈(320)로 출력하기 위한 안테나모듈(310)과;

IEEE 802.11을 기반으로 하며, 상기 안테나 모듈(310)을 통해 수신된 상기 MPEG 영상신호 및 위치송수신신호를 메인콘트롤모듈(360)로 출력하는 한편, 상기 메인콘트롤 모듈(360)에서 출력되는 열차정보신호를 안테나(350)를 통해 RF방식으로 지상무선통신장치(100)로 전송하기 위해 신호 처리하는 와이어레스 모듈(320)과;

산업용 컴퓨터로 구성되어 실시간 영상처리 및 TCP/IP 이더넷 콘트롤러를 제공하되, 현장의 영상정보를 LCD 콘트롤모듈(340)로 출력하거나, 현장의 위치정보신호를 음향경보모듈(380)로 출력하는 메인콘트롤모듈(360)과;

메인콘트롤모듈(360)에서 출력된 영상신호를 열차를 운전하는 기관사가 편리하게 볼 수 있도록 LCD에 표시되어야 할 화상의 출력을 제어하기 위한 것으로서 여러 개의 화상을 동시에 볼 수 있도록 멀티케스팅이 지원되며 최소 24비트 컬러 기반의 1024*768 이상의 해상도를 지원하도록 된 LCD 콘트롤모듈(340)과;

상기 LCD 콘트롤모듈(340)을 통해 현장으로부터 전송되어 온 영상을 디스플레이하는 LCD(330)와;

상기 메인콘트롤모듈(360)에서 출력된 위험 경보신호를 출력하여 열차를 운전하는 기관사에게 경보를 발하는 음향경보모듈(380)과;

본 차상무선통신장치(300)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(370)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치의 차상무선통신장치

청구항 12.

지상무선통신장치(100)를 통해 열차의 접근신호를 수신하는 한편, 위치표시 및 경보장치에서 발생하는 위치표시신호를 지상무선통신장치(100)로 전송하는 안테나(470)와;

와이어레스 모듈(320)로 입력되는 위치표시 신호를 안테나(470)를 통해 출력하고, 지상무선통신장치(100)로부터 수신되는 열차의 접근신호를 와이어레스 모듈(420)로 출력하는 안테나모듈(410)과;

상기 안테나 모듈(410)로부터 수신된 열차접근신호를 콘트롤 모듈(430)로 출력하고 상기 콘트롤 모듈(430)로부터 출력된 위치정보신호를 안테나 모듈(410)로 출력하기 위해 신호처리하는 IEEE 802.11을 기반으로 하는 와이어레스 모듈(420)과;

상기 안테나(470)를 통해 수신된 신호를 콘트롤모듈(430)을 통해 수신되는 열차접근 신호를 인지하여 음향 경보신호를 발생함으로서 열차의 접근을 작업자에게 알리는 음향경보모듈(450)과;

본 위치표시 및 음향경보장치(400)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(440)로;

구성됨을 특징으로 하는 위험요소 예측 경보장치의 위치표시 및 경보장치

명세서

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

(발명이 속하는 기술분야)

본 발명은 선로 상의 위험 지역에 설치되어 돌발적으로 발생하는 위험 요소를 미리 식별한 후, 이를 열차를 운전하는 기관사 혹은 선로 상에서 작업을 수행하는 현장의 작업자에게 영상 혹은 음향 신호로 알려줌으로서 열차의 기관사 혹은 현장의 작업자가 위험 상황을 미리 예측하고 그에 적절히 대처할 수 있도록 함으로서 예기치 못한 불시적 상황에 의해 야기되는 사고를 미연에 방지하기 위한 위험요소 예측 경보장치에 관한 것이다.

(발명의 기술적 배경)

궤도 상을 운행하는 열차의 기관사 또는 선로 상에서 작업을 하는 현장의 작업자는 항상 위험한 환경에 노출되어 있다. 따라서 이들은 자신들이 가진 감각기관을 최대한 활용하여 자신의 안전을 확보하고 타인의 안전을 지키고자 노력한다. 이들이 직무 현장에서 위험 상황을 예측하기 위해 의존하는 가장 중요한 감각기관은 주로 시각과 청각이다.

한편 산악지형이 많은 국내의 철도는 그 지형적 특성상 불가피하게 대단히 많은 곡선구간과 터널구간을 가지게 되는 특징이 있다. 이와 같은 국내 철도의 지형적 특성은 철도 종사원들이 직무현장에서 활용할 수 있는 시각적 능력을 매우 제한하게 된다.

또 선로 상의 작업 현장이나 기관차의 내부는 소음이 매우 심하다. 따라서 이들이 직무현장에서 활용할 수 있는 청각 능력도 상황적 여건상 상당히 제한적으로 될 수밖에 없다.

철도에서 위와 같은 안전상의 제한적 요인이 매우 극명하게 나타나는 곳이 건널목 구간이다. 건널목 구간은 대체로 인구가 밀집된 지역에 설치되거나, 철도 종사원들에 비해 비교적 안전지식이나 관념이 희박한 일반 시민들이 자주 왕래하는 곳으로서 사고가 빈발하는 곳에 설치되는 것이 대부분이다. 따라서 철도 건널목 구간의 안전장치에 대해서는 오랜 기간 많은 연구 개발이 이루어져 왔다. 그 결과 비교적 정밀하고 세밀한 기술이 구현된 다종 다량의 안전장치가 건널목 구간에 설치되어 시민과 열차의 안전을 보호하고 있다. 이러한 건널목 경보장치는 선로상의 일정 지점에 고정 설치되는 장치로서 비록 높은 안전도를 확보할 수는 장점이 있기는 하나, 그 반면에 장비 전체의 구조가 복잡해지고 고가로 된다는 단점이 있다.

한편, 앞서 언급한 바와 같이 선로 상에는 안전을 위협하는 수많은 위험 구간(예를 들면, 곡선 구간, 터널, 낙석이나 산사태 발발 위험지역, 교량 등)이 존재한다. 그러나 선로 상에 위와 같은 안전을 위협하는 위험구간이 있다는 이유만으로 그와 같은 모든 위험 구간에 건널목 경보장치와 같은 규모의 안전장치를 설치하는 것은 신규시설에 대한 투자 측면에서나 시설된 장치의 관리 측면에서 생각할 때 효과 대비 투자가 지나치게 커서 비경제적이다.

바로 위와 같은 이유 때문에 선로 상에는 철도의 안전을 위협하는 많은 위험 우려 개소가 현실적으로 존재하고 있음에도 불구하고 그에 대한 안전 대책의 마련은 상대적으로 소홀히 취급되어 왔으며 그로 인하여 해마다 적지 않은 사고가 발생하여 많은 사상자를 내고 있다.

특히 근래 들어 열차의 운행횟수 및 운행 속도가 증가되면서 위와 같은 위험 개소에서 발생하는 사고는 더욱 증가되는 추세를 보이고 있고, 일단 발생된 사고는 대형화되는 형태를 띠고 있다. 따라서 위와 같은 위험 상황을 더 이상 방치거나 그에 대한 안전 대책을 더 이상 뒤로 미룰 수 없는 시점에 이르렀다.

또한 선로 상에서 항상 이동하면서 작업을 해야만 하는 수많은 현장 요원들에게 상기와 같이 안전을 위협하는 위험 구간은 갑자기 출현하는 열차와 불시에 직면하게 되는 대단히 위험한 상황을 조성하고 있다. 따라서 이 구간에서 작업을 할 경우 안전에 주위를 기울이다 보면 작업 능률과 속도가 현저히 저하될 뿐만 아니라 작업 시간의 지연으로 열차의 신속한 운행도 방해를 받게 된다.

또 열차를 운전하는 기관사 입장에서 볼 때에도 그와 같은 현장 요원들의 움직임이 전혀 예측할 수 없는 돌발적 상황이 되고 있으며 이는 항상 열차를 급제동시키는 원인이 되어 열차의 탈선의 우려를 높일 뿐만 아니라 쾌적하고 안전한 열차 여행에도 심대한 지장을 주고 있다.

(종래의 기술)

위와 같은 위험 개소에 대한 안전 조치로서 종래에는,

가시거리가 확보되지 아니하여 안전사고 발생의 우려가 있는 곡선구간에서는 하나의 폐색 구간 내에 또 중계신호기를 두어 전방의 열차의 유무를 열차를 운전하는 기관사가 확인할 수 있도록 하고 있다. 그러나 이러한 중계신호기는 전방의 열차의 유무를 확인 할 수는 있지만 자연재해로 인한 토사나 낙석 등과 같은 위험 요인은 발견할 수 없을 뿐만 아니라 현장의 작업자와 열차가 불시에 직면하는 문제를 해결할 수는 없다.

또 기 발표된 기술에 따르면 건널목 구간에서 2.4GHz 대역의 RF를 이용하여 건널목에 국한된 영상을 운전자가 볼 수 있게 하는 기술이 소개된 바 있다. 그러나 이는 운전자가 계속해서 모니터를 주시해야만 한다는 문제가 있으며, 또 건널목과 운전자간의 단방향 통신밖에 지원되지 않는다. 이는 운전자에게만 건널목의 상태정보가 전달이 되기 때문에 건널목에 추가적인 안전 시설물을 설치해야 한다. 예를 들자면 양방향 통신이 지원이 될 경우 철도 건널목에 설치되어야 할 건널목 제어기의 역할을 양방향 통신으로서 수행할 수 있지만 단방향 통신일 경우 이런 영상 장치 외에 추가로 건널목 제어기를 사용해야 한다. 이는 설비 면에서 살펴볼 때 이중 투자이며, 관리 포인트가 많아진다는 단점이 있다. 또한 철도 건널목에 제한하여 설치가 가능하기 때문에 선로 상에서 작업을 하는 작업자의 안전을 보장해 주지 못한다는 문제가 있다.

또한 기존의 위험 요소의 예측은 실시간으로 감지되는 것이 아니라 주기적인 유지보수를 통해 위험 요소를 확인하는 방식이다. 즉, 일정 기간마다 선로 유지보수자 들이 열차가 운행하지 않은 시간에 현장을 직접 순회하면서 레일의 절손이나 열차 운행에 대한 방해물을 정비하는 수준이다. 이렇기 때문에 위험 요소에 대해 즉각적인 대처가 불가능하다는 문제가 있다.

그리고 선로변 작업자에 대한 안전 대책은 현재까지는 특별한 수단이 없이 오직 열차의 운전자와 선로상에서 작업을 하는 작업자가 상호 주의를 기울여 작업자의 위치를 파악하거나 열차의 출현을 예측해야만 하는 가장 원시적인 수준에 머물고 있다.

발명이 이루고자 하는 기술적 과제

(발명의 목적)

본원발명은 상기와 같은 문제점을 해결하기 위해 안출된 것으로서,

본원발명은 동일한 무선 통신방식(2.4GHz 대역의 RF통신)을 이용하여 운전자가 열차 내의 모니터를 상시 주시하지 않더라도 실시간 영상분석 기법을 도입하여 위험요소가 있을 경우 경보를 통해 운전자에게 위험 상황을 알릴 수 있도록 함을 목적으로 한다.

또한 본원발명은 가시거리가 확보되지 않은 선로상의 위험 지역에서 현장과 열차 사이에 양방향 통신이 가능한 비교적 작은 크기의 위치표시 및 경보장치를 선로 작업자가 휴대하여 작업 현장에 비치해 두기만 하면, 동 장치가 선로 상의 작업자에게는 음향신호를 발하여 열차의 접근 여부를 알려주는 한편, 열차의 기관사에게는 전방에 작업구간이 있음을 알려 줌으로서 작업자에 의한 열차 안전사고를 최소화 할 수 있도록 함을 또 다른 목적으로 한다.

발명의 구성

상기와 같은 목적을 달성하기 위한 본원발명의 구성 및 작용관계를 도 1내지 7을 참조하여 설명한다.

우선 본원발명의 실시 예는 2가지 형태로 구분이 된다.

하나는 도1 및 도2에서와 같이 선로 상에 존재하는 위험 구간을 상시 감시하다 이상이 발생될 경우 이를 인지하여 선로의 상황에 대한 이상 유무를 경보함과 동시에 선로의 상황에 대한 영상정보를 기관사에게 전송하여 표시하도록 하는 것이고,

다른 하나는 도3에서와 같이 선로 작업자가 휴대하고 선로 상에서 작업을 할 경우, 열차가 접근하면 선로작업자에게는 열차의 접근을 음향신호로 경보하고 열차의 기관사에게는 선로 상에 작업구간이 있음을 알리도록 하는 것이다.

우선 본원발명의 제1의 구성은 우선 크게,

선로 상의 위험 개소에 설치되어 사고의 발생 여부를 상시 감시하고 그 감시 결과를 지상무선통신장치(100)로 전송하는 영상감시장치(200)와;

상기 영상감시장치(200)로부터 수신된 영상신호를 분석한 후, 이를 미리 입력되어 있는 정상적인 선로의 상태 정보와 비교하여 선로의 이상의 유무를 판단하는 한편, 열차의 진입 여부를 상시 감시하고 있다가 열차가 관할 구역 내로 진입하면 즉시 선로의 현재 상황에 대한 영상정보와 함께 현재의 선로상황의 이상 유무에 대한 판단 결과를 열차에 탑재된 차상무선통신장치로 전송하는 지상무선통신장치(100)와;

상기 지상무선통신장치(100)로부터 선로의 현재 상황에 관한 영상정보와 이상 유무에 대한 판단 결과가 수신되면 즉시 현재의 선로 상황에 대한 영상 정보를 LCD를 통해 디스플레이 함과 동시에, 선로의 상황에 대한 이상 유무 정보가 만일 선로에 이상이 있는 것을 알리는 신호이면 즉시 음향신호로 이 사실을 기관사에게 경보함으로서 기관사가 즉시 화면을 보고 적절히 대처할 수 있도록 하는 차상무선통신장치(300)로;

구성됨을 특징으로 한다.

다음 본원발명의 제2의 구성은 우선 크게,

가시거리가 확보되지 아니하는 심한 곡선구간에서 작업을 하기 위한 작업자가 선로 상에서 작업을 할 경우에 작업자가 직접 휴대하여 작업 현장에 비치할 수 있도록 휴대형으로 구성되며, 열차가 관할 구역 내로 진입을 하였음을 상시 감시하고 있다가 상기 지상무선통신장치(100)로부터 열차가 접근하고 있음을 알리는 신호가 수신되면 즉시 음향 신호를 발생하여 현장의 작업자에게 열차의 접근을 경보함으로서 작업자가 신속히 대피할 수 있도록 하는 한편, 현 위치에서 선로작업이 진행 중임을 알리는 신호를 상기 지상무선통신장치(100)를 통해 차상무선통신장치로 전송하는 위치표시 및 경보장치(400)와;

상기 위치표시 및 경보장치(400)로부터 송신된 위치표시 신호가 수신되면 수신된 신호를 미리 입력되어 있는 신호와 비교하여 선로상의 작업 여부 및 작업의 내용을 판단하는 한편, 열차의 진입 여부를 상시 감시하고 있다가 열차가 관할 구역 내로 진입하면 즉시 선로 상에 작업구간이 있음을 열차에 탑재된 차상무선통신장치(300)로 전송하는 지상무선통신장치(100)와;

상기 지상무선통신장치(100)로부터 선로 상에 현재 작업 구간이 있음과 그 작업의 내용을 알리는 정보가 수신되면 즉시 음향신호로 이 내용을 기관사에게 알려줌으로서 기관사가 속도를 줄이고 전방의 상황을 주시할 수 있도록 하는 차상무선통신장치(300)로;

구성됨을 특징으로 한다.

상기 제1구성과 제2구성에서 지상무선통신장치(100)와 차상무선통신장치(300)는 기본적으로 동일한 구성이며 다만 결합되는 구성이 영상감시장치(200)인지 아니면 위치표시 및 경보장치(400)인지에 따라 기능을 달리하고 있다는 차이가 있다. 또한 위험구간에서 위치표시 및 경보장치(400)를 사용하는 경우 대체로 영상감시장치(200)도 동시에 기능을 발휘하게 될 수 있으므로 제2구성에 영상감시장치만을 결합한 다면 제1구성의 역할도 동시에 수행할 수 있다.

상기 지상무선통신장치(100)는 다시,

안테나모듈(110)로부터 출력된 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하는 한편, 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로부터 전송되어 온 신호를 수신하는 안테나(150)와;

와이어레스 모듈(120)로부터 출력된 MPEG 영상신호 및 위치송수신 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하기 위해 안테나(150)로 브리지 출력하는 한편, 상기 안테나(150)를 거쳐서 수신된 영상신호 및 위치송수신신호를 와이어레스모듀(120)로 출력하는 안테나모듈(110)과;

IEEE 802.11을 기반으로 하는 무선통신 모듈로서 인접한 다른 지상무선통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 프로세스 모듈(130)에서 출력된 신호를 RF방식으로 차상무선통신장치(300)로 전송하기 위해 신호 처리하는 기능 및 수신된 신호를 입력받아 프로세스 모듈(130)로 출력기능을 수행하는 와이어레스 모듈(120)과;

영상감시장치(200)로부터 NTSC신호를 수신받아 상기 수신된 NTSC신호를 MPEG4신호로 변환하여 이미지프로세스모듈(140)로 출력하고 상기 이미지프로세스 모듈(140)의 영상분석 결과를 입력받아 이를 다시 차상무선통신장치(300)로 전

송하기 위해 와이어레스모듈(120)로 출력하는 한편, 와이어레스 모듈(120)로부터 수신된 위치표시 신호를 분석하여 작업의 위치와 작업의 내용을 파악한 후, 그 결과를 차상무선장치(300)로 전송하기 위해 와이어레스 모듈(120)로 출력하는 프로세스 모듈(130)과;

상기 프로세스 모듈(130)로부터 MPEG신호로 압축되어 수신된 신호를 패턴인식 알고리즘을 적용하여 미리 입력된 정상적인 선로의 신호와 분석 비교한 후, 선로상의 위험 요인을 실시간으로 판단한 다음 그 결과를 프로세스 모듈(130)로 다시 출력하는 이미지프로세스모듈(140)과;

본 지상무선통신장치(100)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(170)로;

구성됨을 특징으로 한다.

상기 안테나모듈(110)은 다이버시티 안테나의 구조로 하여, 하나의 지상무선통신장치에 두 개의 구조를 가지도록 함으로서, 지향성 안테나로서 무선 커버리지 각도는 무지향성 안테나보다 좁지만 전송거리가 높아지도록 한다. 이에 따라 두 개의 안테나의 전체 무선커버리지 각도는 240도 이상 커버할 수 있게 된다. 또 이러한 다이버시티 안테나의 불평형 전압에 대비하기 위하여 서지어레스터를 더 포함하여 구성되도록 한다.

상기 와이어레스 모듈(120)은 인접한 다른 지상무선통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 이중화된 안테나를 통해 수신되는 무선데이터는 대역통과필터를 통과하여 저잡음 증폭기를 통해 802.11의 표준으로 전송되도록 한다.

상기 영상감시장치(200)는 다시,

선로의 위험개소에 설치되어 선로의 상황을 상시 감시 촬영하되, 자동 모드 조정에 의해 주간에 발생되는 상황은 컬러영상으로 출력하고 야간이나 기타 조도가 현저히 낮은 상황(안개나 폭우 등과 같은 열악한 기상 조건)하에서는 CCD센서에 의해 적외선 영상으로 전환하여 NTSC신호의 형태로 출력하는 카메라모듈(230)과;

상기 카메라모듈(230)로부터 출력된 NTSC 영상신호를 지상무선통신장치(100)로 TCP/IP 방식으로 출력하는 네트워크 모듈(280)과;

본 영상감시장치에 필요한 전원을 정전압으로 변환하여 공급하는 파워서플라이모듈(270)로;

구성됨을 특징으로 한다.

상기 차상무선통신장치(300)는 다시,

안테나모듈(110)로부터 입력된 신호를 2.4GHz의 RF대역으로 지상무선통신장치로 출력하고, 지상무선통신장치로부터 전송되어 온 무선신호를 수신하여 안테나 모듈(310)로 출력하는 안테나(350)와;

상기 안테나(350)를 통해 수신된 지상무선통신장치(100)로부터 전송되어 온 MPEG 영상 송신 및 위치송수신 신호를 와이어레스 모듈(320)로 출력하기 위한 안테나모듈(310)과;

IEEE 802.11을 기반으로 하며, 상기 안테나 모듈(310)을 통해 수신된 상기 MPEG 영상신호 및 위치송수신신호를 메인콘트롤모듈(360)로 출력하는 한편, 상기 메인콘트롤 모듈(360)에서 출력되는 열차정보신호를 안테나(350)를 통해 RF방식으로 지상무선통신장치(100)로 전송하기 위해 신호 처리하는 와이어레스 모듈(320)과;

산업용 컴퓨터로 구성되어 실시간 영상처리 및 TCP/IP 이더넷 콘트롤러를 제공하되, 현장의 영상정보를 LCD 콘트롤모듈(340)로 출력하거나, 현장의 위치정보신호를 음향경보모듈(380)로 출력하는 메인콘트롤모듈(360)과;

메인콘트롤모듈(360)에서 출력된 영상신호를 열차를 운전하는 기관사가 편리하게 볼 수 있도록 LCD에 표시되어야 할 화상의 출력을 제어하기 위한 것으로서 여러 개의 화상을 동시에 볼 수 있도록 멀티케스팅이 지원되며 최소 24비트 컬러 기반의 1024*768 이상의 해상도를 지원하도록 된 LCD 콘트롤모듈(340)과;

상기 LCD 콘트롤모듈(340)을 통해 현장으로부터 전송되어 온 영상을 디스플레이하는 LCD(330)와;

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상기 메인콘트롤모듈(360)에서 출력된 위험 경보신호를 출력하여 열차를 운전하는 기관사에게 경보를 발하는 음향경보모듈(380)과;

본 차상무선통신장치(300)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(370)로;

구성됨을 특징으로 한다.

상기 위치표시 및 경보장치(400)는 다시,

지상무선통신장치(100)를 통해 열차의 접근신호를 수신하는 한편, 위치표시 및 경보장치에서 발생하는 위치표시신호를 지상무선통신장치(100)로 전송하는 안테나(470)와;

와이어레스 모듈(420)로 입력되는 위치표시신호를 안테나(47)로 출력하고, 지상무선통신장치(100)로부터 수신되는 열차의 접근신호를 와이어레스 모듈(420)로 출력하는 안테나모듈(410)과;

상기 안테나 모듈(410)로부터 수신된 열차접근신호를 콘트롤 모듈(430)로 출력하고 상기 콘트롤 모듈(430)로부터 출력된 위치정보신호를 안테나 모듈(410)로 출력하기 위해 신호처리하는 IEEE 802.11을 기반으로 하는 와이어레스 모듈(420)과;

상기 안테나(470)를 통해 수신된 신호를 콘트롤모듈(430)을 통해 수신되는 열차접근 신호를 인지하여 음향 경보신호를 발생함으로서 열차의 접근을 작업자에게 알리는 음향경보모듈(450)과;

본 위치표시 및 음향경보장치(400)의 동작에 필요한 정전압 전원을 안정적으로 공급하기 위한 파워서플라이 모듈(440)로;

구성됨을 특징으로 한다.

상기 안테나모듈(410)는 위치표시 신호를 차상무선통신장치(300) 혹은 인접한 지상무선통신장치로 출력하기 위해 다이버시티 방식의 안테나의 구조로 하여 하나의 지상무선통신장치에 두 개의 구조를 가지도록 한다. 이로서 무선 커버리지 각도는 무지향성 안테나보다 좁지만 전송거리가 높아지게 되며, 아울러 두 개의 안테나로서 커버할 수 있는 전체 무선커버리지 각도는 240도 이상이 된다. 또한 이러한 이중의 다이버시티 안테나에 의한 불평형 전압에 대비하여 서지어레스터를 포함하여 구성되도록 한다.

상기 와이어레스 모듈(420)은 인접한 다른 지상무선통신장치와도 통신이 가능하도록 이중 브리지 구조로 구성하되, 이중화된 안테나를 통해 수신되는 무선데이터는 대역통과필터를 통과하여 저잡음 증폭기를 통해 802.11의 표준으로 전송되도록 한다.

본원발명의 목적을 효과적으로 달성하기 위해서 상기와 같은 본원발명의 구성이 갖추어야 할 조건은 다음과 같다.

첫째, 2.4GHz대역의 무선통신방식을 채택하여야 한다.

이는 열차와 작업자 간의 정보 교류 및 열차의 자동 로밍을 위해서는 양방향 지상무선통신이 가능하도록 해야 하기 때문이다. 또한 2.4GHz는 특정 소출력 무선기기용으로 허용 중이며 ISM 밴드 대역이라 호환성 및 확장성이 용이하다.

둘째, 상기 무선전송방식은 IEEE 802.11 표준을 기반으로 하여야 한다.

이는 국제 표준 규격에서 정한 프로토콜을 사용함으로써 타 시스템과의 인터페이스가 용이하며 확장성이 뛰어나기 때문이다.

셋째, 통신상의 혼신을 예방하기 위한 조치를 취해야 한다.

이는 기존에 보급된 혼신 방지용 보안 알고리즘 중 어느 하나를 채택하여 적용하기만 하면 충분하다.

넷째, 위험 요소가 있는 곳에 설치되는 영상감시장치(CCD카메라)는 주간에는 칼라색상으로 작동되도록 하고, 야간이나 시계가 불량한 상황(안개 상황, 우천 등)하에서는 흑백 촬영이 가능한 것이어야 한다.

이는 어떠한 기상 상황 하에서도 기기의 동작이 중단되지 않도록 하여 충분한 동작 조건을 확보함으로서 안전을 확보하기 위한 것이다.

다섯째, 카메라에서 생성되는 NTSC신호는 MPEG 4방식으로 압축해서 실시간으로 디지털 영상으로 변환하여야 한다.

이는 통신량을 줄임으로서 무선 통신방식에 의한 신속한 데이터 통신이 가능하도록 하기 위해서이다.

여섯째, 상기 변환된 디지털 영상신호는 네트워크를 통해 전송하되 최소 초당 30프레임 이상의 영상을 전송할 수 있도록 하여야 한다.

이는 데이터의 전송량을 최소화하여 전송속도를 높임으로서 무선통신의 한계를 극복하고자 하되, 디스플레이되는 화상이 위험(사고)지역의 상황을 파악하는데 지장이 없도록 하기 위한 것이다. 본원발명에서는 화질을 26만 칼라그래픽으로 하고 전송속도를 30프레임/초로 할 경우, 기관사가 육안에 의해 끊어짐 없이 위험지역의 상황을 관찰함으로서 위험 지역의 상황을 파악하는데는 충분할 것으로 인식하고 있다.

일곱째, 또한 본원발명은 고속 로밍(120Km/h)이 가능한 양방향 통신기술 및 이중 브릿지 원리를 채택하여야 한다.

이는 구간이 긴 위험지역의 경우 움직이는 열차에서 변화되는 상황정보를 중단없이 지속해서 송수신할 수 있도록 하기 위한 것이다.

여덟째, 또 지상무선통신장치의 이미지프로세스모듈(140)에는 위험 구간의 정상적인 선로 상태의 영상이 저장되어 있어야 한다.

이는 실시간으로 관측되어 입력되는 영상이 위험 정보를 내포하고 있는 영상인지 여부를 비교하여 판단하기 위한 기준 자료로서의 데이터로 활용하기 위해서이다.

아홉째, 위치표시 및 경보장치(400)는 작업자가 상시 휴대하기 쉽도록 간편하고 견고하게 제작되어야 한다.

이는 위치표시 및 경보장치의 항상 작업자가 휴대하여 이동하는 단말기로서 이동성과 견고성이 중요하기 때문이다.

위 조건들은 본원발명이 구현되기 위해 부분적으로 혹은 전체적으로 반드시 갖추어져야 하는 것으로서 본원발명의 기술사상의 일부를 이룬다.

상기와 같이 구성된 본원발명의 동작 과정을 각 구성별로 나누어 설명한다.

먼저 본원발명에 의해 위험 구간에 대한 영상 감시 및 경보에 대해 설명한다.

우선 영상감시장치(300)의 동작과정을 설명하면,

위험 요소 구간의 현장에 설치되어 있는 카메라모듈(230)이 감시구간을 촬영한다. 이때 감시카메라의 모드는 야외의 경우에는 자동모드로 선택된다. 이에 따라 감시카메라의 촬영모드는 일정한 조도 이상이 되면 칼라 영상 모드로 되고 일정 조도 이하이면 적외선 영상에 의한 촬영 모드로 전환되어 감시 촬영을 하게 된다. 또한 터널 등과 같이 상시 어두운 장소에서는 야간 모드로 고정하여도 무방하다. 상기와 같이 촬영된 영상 신호는 NTSC신호로 네트워크 모듈(280)로 출력된다. 상기 카메라모듈(230)로부터 NTSC 영상신호를 수신한 네트워크 모듈(280)은 이를 TCP/IP 통신방식으로 지상무선통신장치(100)로 전송한다.

다음 지상무선통신장치(100)의 동작과정을 설명하면,

상기 영상감시장치(200)로부터 감시 촬영된 영상신호가 프로세스 모듈(130)로 수신되면 상기 프로세스 모듈(130)은 수신된 NTSC신호를 MPEG 4신호로 변환한 다음, 이를 이미지프로세스 모듈(140)로 출력한다. 상기 신호를 수신한 이미지프

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로세스 모듈(140)은 수신된 데이터를 미리 저장되어 있는 정상선로에 대한 데이터와 패턴인식 알고리즘을 적용하여 비교한 다음, 위험 요인의 유무를 판단하고 판단 결과를 프로세스 모듈(130)로 다시 전송한다. 상기 이미지프로세스 모듈(140)로부터 위험 요소 유무에 대한 판단 결과를 수신한 프로세스 모듈(130)은 그 결과를 와이어레스 모듈(120)로 출력하며, 이를 수신한 와이어레스 모듈(120)은 감시 촬영된 선로의 영상정보와 위험 요소의 유무에 대한 판단 정보를 안테나 모듈(110)과 안테나(150)를 거쳐 차상무선통신장치(300)로 2.4GHz RF 대역의 무선통신방식에 의해 전송한다.

이어서 차상무선통신장치(300)의 동작과정을 설명하면,

평상시 열차가 운행 중에 차상무선통신장치(300)는 모니터링 기능을 절전모드로 하여 운행을 하게 된다. 열차가 어느 한 지상무선통신장치(100)의 통신 영역으로 진입하게 되면 지상무선통신장치(100)로부터 2.4 GHz RF 대역의 무선신호가 수신되게 되며, 안테나(350)를 통해 동 신호를 수신한 차상무선통신장치는 즉시 이를 로밍구간에 진입한 것으로 인식하고 차상무선통신장치의 구동을 개시한다. 이때 안테나(350) 및 안테나 모듈(310)은 이중 브릿지 방식으로 인접한 다른 지상무선통신장치(100)로부터 전송된 신호도 동시에 수신하게 된다. 상기 지상무선통신장치로부터 수신된 신호는 안테나(350) 및 안테나 모듈(310)을 통해 와이어레스 모듈(320)로 수신된다. 상기 안테나모듈(310)로부터 출력된 MPEG 영상 수신 및 위치신호를 수신한 와이어레스모듈(320)은 수신된 신호를 메인콘트롤모듈(360)로 출력하며 이를 수신한 메인콘트롤 모듈(360)은 실시간으로 영상을 처리하거나 TCP/IP 이더넷 컨트롤러를 제공하여 LCD 콘트롤 모듈(340)로 출력하고 이를 수신한 LCD 콘트롤 모듈(340)은 사용자의 조작에 따라 화면을 분할하는 등 영상 변환을 한 후, 동 영상신호를 LCD(330)로 표시하게 된다.

한편 메인콘트롤러 모듈(360)은 수신된 신호를 분석하여 만일 수신된 신호가 이상 상황에 대한 정보를 내포한 것으로 판단되면 즉시 이를 LCD 콘트롤 모듈(340)과 음향 경보모듈(380)로 전송하여 LCD(330)에서는 영상으로, 음향경보모듈(380)에서는 음향으로 비상상황임을 알려 경보함으로서 열차를 운전하는 기관사가 즉시 비상의 상황임을 인지하고 즉각적으로 새로운 상황에 대처할 수 있도록 한다.

다음 본원발명에 의해 작업자의 위치 식별 및 경보장치(400)의 동작과정에 대해 설명한다.

우선 위치표시 및 경보장치(400)의 동작과정을 설명하면,

현장에서 작업을 수행하는 작업자는 항상 이 위치표시 및 경보장치(400)를 휴대하고 작업현장으로 출동한다.

작업자는 작업현장에 도착하면 즉시 위치표시 및 경보장치(400)의 전원을 켜서 장치를 동작시킨다. 이때 위치표시 및 경보장치의 전원은 이동하면서 사용이 가능하도록 배터리를 사용한다. 물론 작업 현장에서 직접 전원의 공급이 가능할 경우 동 전원을 활용할 수도 있다.

콘트롤모듈(430)에서는 지속적으로 현재의 위치에서 작업이 진행되고 있음을 알리는 신호를 발생시켜 와이어레스 모듈(420)로 출력한다. 이 신호를 수신한 와이어레스 모듈은 이를 안테나모듈(420)과 안테나(470)를 통하여 인접한 지상무선통신장치(100)로 무선으로 전송한다. 상기 신호에는 작업구간에 대한 정보와 작업의 내용에 대한 정보를 포함시킬 수 있다.

한편 열차의 접근정보가 지상무선통신장치(100)로부터 전송되어 오면 동 신호는 안테나(470) 및 안테나 모듈(410)과 와이어레스 모듈(420)을 통해 콘트롤 모듈(430)로 수신되며, 동 신호는 콘트롤 모듈(430)에서 분석되어 즉시 음향 모듈(450)을 통해 음향신호로 출력되어 작업자에게 열차가 접근하고 있음을 알린다. 상기 음향 경보신호를 들은 현장의 작업자는 열차의 접근을 직접 육안으로 확인하면서 즉시 대피 준비를 하게 된다.

다음 지상무선통신장치(100)의 동작과정을 설명하면,

상기 위치표시 및 경보장치(400)로부터 위치표시를 알리는 무선신호가 안테나(150)와 안테나 모듈(110)을 통해 와이어레스 모듈(120)로 수신되면 와이어레스 모듈(120)은 동 신호를 프로세스 모듈(130)로 출력하고 이를 수신한 프로세스 모듈(130)은 근접된 구간에서 작업이 진행되고 있음을 인지하고 수신된 신호를 분석하여 작업구간과 작업의 내용을 파악한다. 상기 작업구간과 작업의 내용이 확인되면 프로세스 모듈(130)은 동 정보를 다시 와이어레스 모듈(120)과 안테나 모듈(110) 그리고 안테나(150)를 통하여 차상무선통신장치(300)로 무선으로 전송한다.

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한편 지상무선통신장치(100)의 안테나(150)로 차상무선통신장치(300)로부터 접근을 알리는 신호가 수신되면 동신호는 안테나모듈(110)과 와이어레스 모듈(120)을 거쳐 프로세스 모듈(130)로 수신되며 이를 수신한 프로세스 모듈(130)은 동신호를 분석하여 열차의 번호와 위치를 파악한 후, 동 신호를 다시 와이어레스모듈(120) 및 안테나모듈(110) 그리고 안테나(150)를 통해 위치표시 및 경보장치(400)로 열차가 접근하고 있음을 무선으로 전송하여 알린다.

이어서 차상통신장치(300)의 동작과정을 설명하면,

평상시 열차가 운행 중에 차상무선통신장치(300)는 모니터링 기능을 절전모드로 하여 운행을 하게 된다. 이어서 지상무선통신장치(100)로부터 2.4 GHz RF 대역의 무선신호가 수신되면 차상무선통신장치는 즉시 이를 로밍구간에 진입한 것으로 인식하고 차상무선통신장치의 구동을 개시한다. 이때부터 차상무선통신장치(300)는 영상감시장치의 동작과정과 동일한 과정을 수행하게 된다.

한편 지상무선통신장치(100)로부터 영상감시신호와 함께 전방에 작업구간이 있음을 알리는 신호가 수신되면 동 신호는 안테나(350), 안테나모듈(310), 와이어레스 모듈(320)을 거쳐 메인콘트롤 모듈(360)로 수신되며, 동 신호를 수신한 메인콘트롤 모듈(360)은 실시간으로 수신된 영상정보를 LCD모듈(340)과 LCD(330)를 선로의 상황을 디스플레이 함과 동시에 전방에 작업구간이 있음을 영상으로 표시하여 알려주게 된다. 또한 메인콘트롤러 모듈(360) 이와 함께 음향경보모듈(380)을 통해 음향신호로 발하여 기관사에게 전방에 작업구간이 있음을 음향신호로 경보하여 알려주게 된다.

도8 및 도9는 본원발명에서 수행하는 이미지 프로시저와 열차의 로밍 프로시져를 도시한 것으로서 도8은 지상무선통신장치에서 수행하는 이미지 프로세싱에 대한 프로시저를 도시한 것이고, 도9는 차상무선통신장치에서 수행하는 열차 로밍의 프로시저를 도시한 것이다.

도8을 간단히 설명하면,

이미지 프로세싱의 원리는 패턴인식 알고리즘에 기반하여 실시간 영상을 감시한다. 현재 영상을 수신(P100)하면 기 설정된 사용자 영역을 추출(P110)하고 이산화 처리를 거쳐 선로 경계를 검출(P120)한다. 선로 경계 검출 이유는 선로의 왜곡률 판단 정밀도를 높이기 위한 것으로 이 프로시저를 통해 영상데이터는 디지털 데이터로 변환된다. 그 후 추출된 현재의 디지털 데이터와 정상상태의 과거 선로 경계(P140)을 실시간 비교(P130)한다. 이 프로시저는 고속 비교 분석이 가능하도록 손실압축을 통해 이루어진다. 비교 결과는 지상무선통신장치(100)를 통해 차상무선동신장치(300)로 전달된다.

이로서 선로의 이상 유무를 판단할 수 있게 된다.

도9를 간단히 설명하면,

차상무선통신장치(300)의 LCD 모듈(340)은 절전상태(P200)로 대기하다가 열차가 로밍구간에 진입여부를 확인(P210)하는 순간부터 영상 데이터 및 분석 데이터를 수신(P220)한다. 위험정보 여부 프로시저(P230)을 통하여 수신한 데이터에서 위험 정보가 검출되면 경보를 발생(P250) 후 영상을 디스플레이(P240)한다. 만약 위험정보가 검출되지 않으면 영상만을 디스플레이(P240)한다.

열차가 로밍 구간을 지나가면 다시 차상무선통신장치(300)의 LCD 모듈(340)은 절전상태(P200)로 대기한다.

이로서 열차는 위험 요소 구간에서만 당해 장치를 가동할 수 있게 되며 당해 구간 내에서는 지상무선통신장치(100)를 바꾸어 가며 연속적으로 동작할 수 있게 된다.

발명의 효과

이상에서 설명한 바와 같은 본 발명에 따른 위험요소 예측 경보장치는 다음과 같은 효과가 있다.

선로변의 위험요인을 이미지 분석 알고리즘을 통해 실시간 감시함에 따라 운전자가 상시 모니터를 감시하지 않더라도 위험요인을 경보를 통해 인지할 수 있고,

가시거리가 확보되지 않은 구간에서 작업이 이루어지고 있을 경우 기관사나 현장의 작업자가 모두 사전에 위험요인을 미리 인지할 수 있어 안전한 열차 운행과 효율적인 작업 수행의 효과를 얻을 수 있다.

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도면의 간단한 설명

도1은 본 발명에 따른 자연재해 위험요소 구간 실시 예의 구성도이다.

도2는 본 발명에 따른 철도 교량 위험요소 구간 실시 예의 구성도이다.

도3은 본 발명에 따른 작업자 보호 위험요소 구간 실시 예의 구성도이다.

도4는 본 발명에 따른 지상 무선통신장치의 구성도이다.

도5는 본 발명에 따른 영상감시장치의 구성도이다.

도6은 본 발명에 따른 위치표시 및 음성경보장치의 구성도이다.

도7은 본 발명에 따른 차상 무선통신장치의 구성도이다.

도8은 본 발명에 따른 이미지 처리부의 프로시저 구성도이다.

도9는 본 발명에 따른 무선통신 로밍 프로시저 구성도이다.

<도면의 주요부분에 대한 부호의 설명>

100 : 지상무선통신장치 110 : 안테나모듈

120 : 와이어레스 모듈 130 : 프로세스 모듈

140 : 이미지 프로세스 모듈 150 : 안테나

170 : 파워서플라이모듈

200 : 영상감시장치 230 : 카메라 모듈

270 : 파워서플라이모듈 280 : 네트워크 모듈

300 : 차상무선통신장치 310 : 안테나모듈

320 : 와이어레스모듈 330 : LCD

340 : LCD콘트롤모듈 350 : 안테나

360 : 메인콘트롤모듈 370 : 파워서플라이모듈

380 : 음향경보모듈

400 : 위치표시 및 경보장치 410 : 안테나 모듈

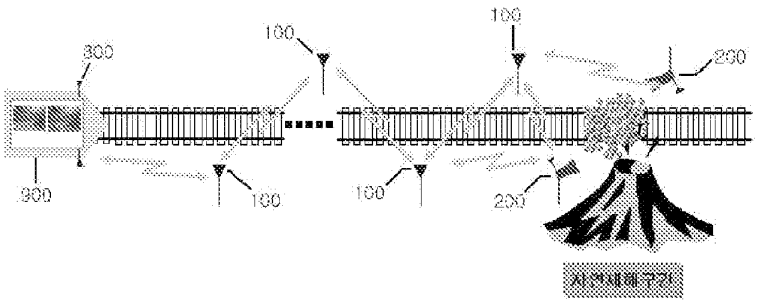
420 : 와이어레스모듈 430 : 메인콘트롤모듈

440 : 파워서플라이모듈 450 : 음향경보모듈

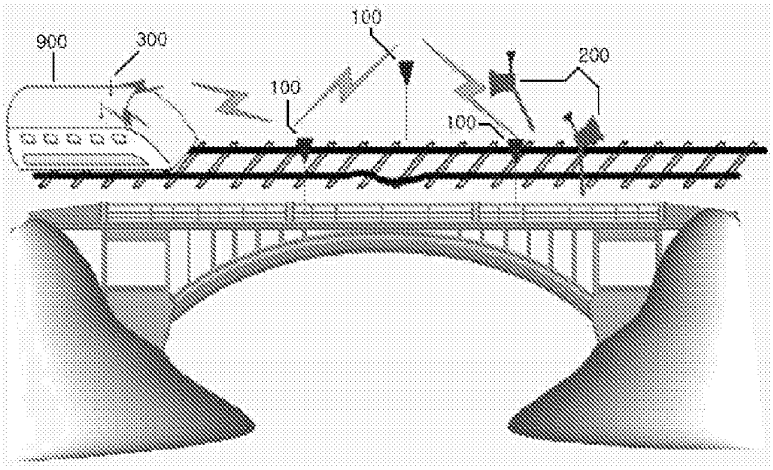
470 : 안테나

도면

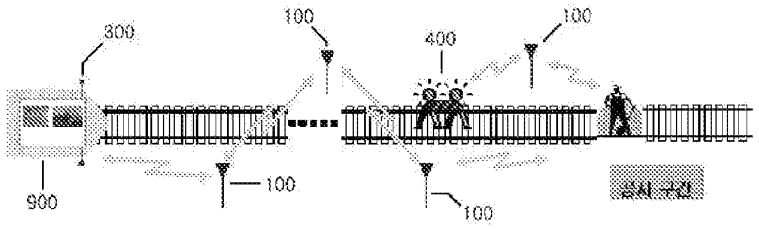
도면1



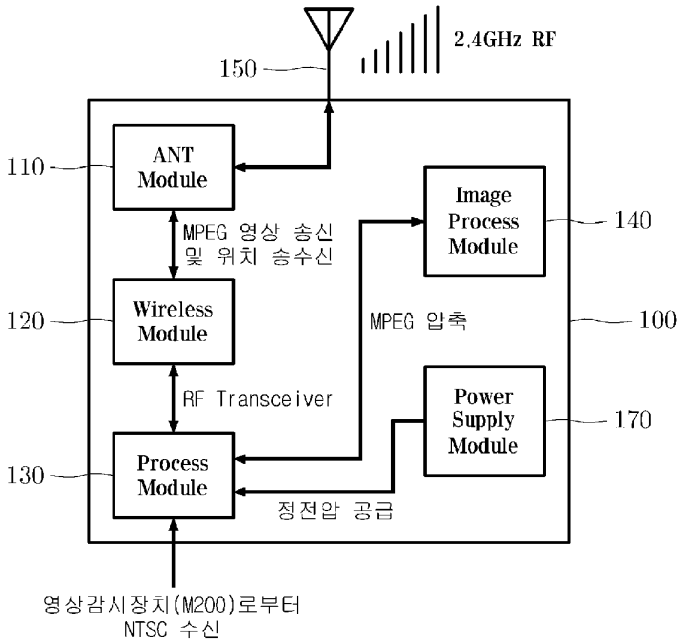
도면2



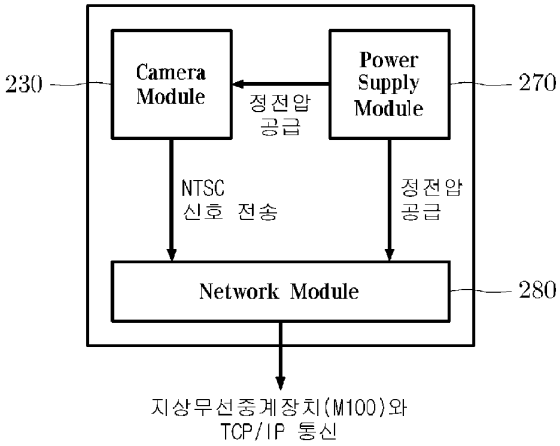
도면3



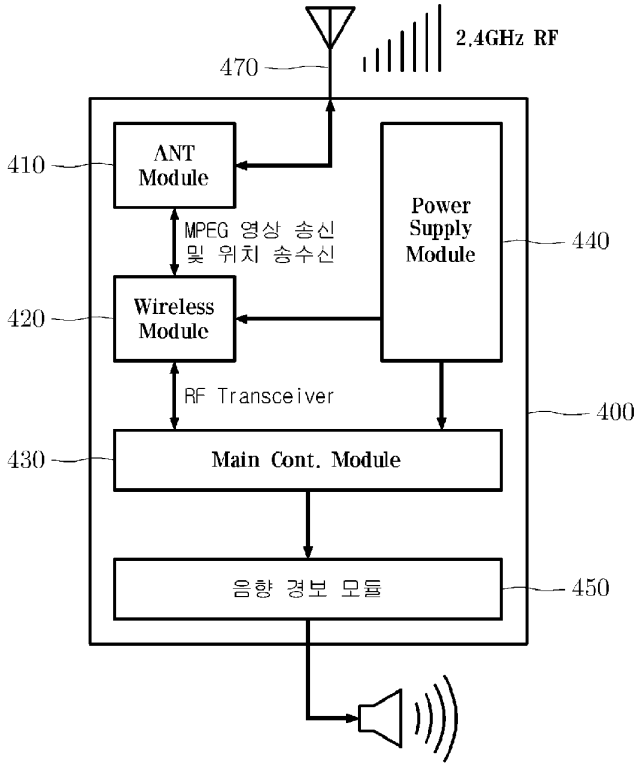
도면4


2.4GHz RF
150
ANT Module
110
MPEG 영상 송신 및 위치 승수신
Image Process Module
140
Wireless Module
120
MPEG 압축
100
RF Transceiver
Power Supply Module
170
Process Module
130
정전압 공급
영상감시장치(M200)로부터 NTSC 수신

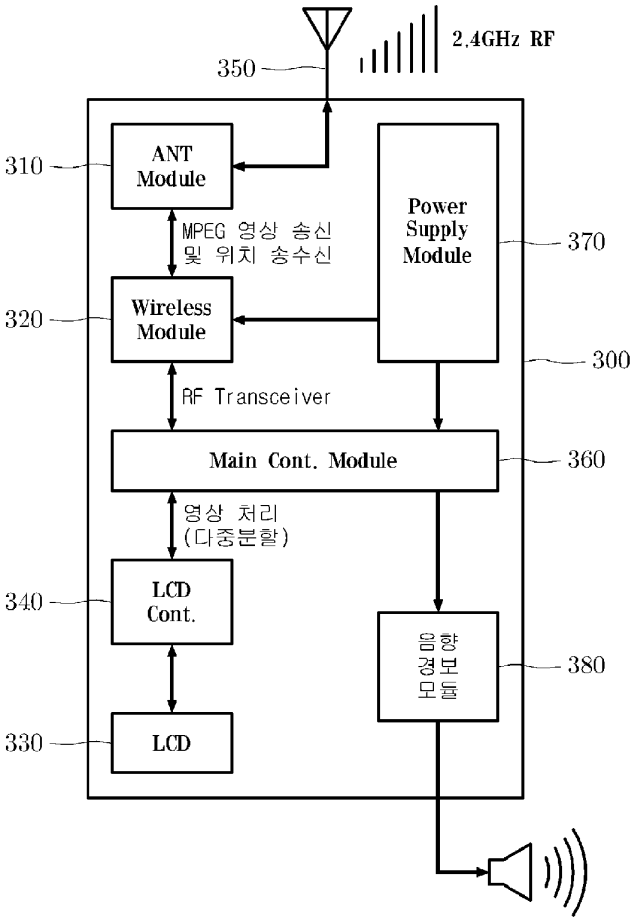
도면5


Camera Module
230
정전압 공급
Power Supply Module
270
NTSC 신호 전송
정전압 공급
Network Module
280
지상무선중계장치(M100)와 TCP/IP 통신

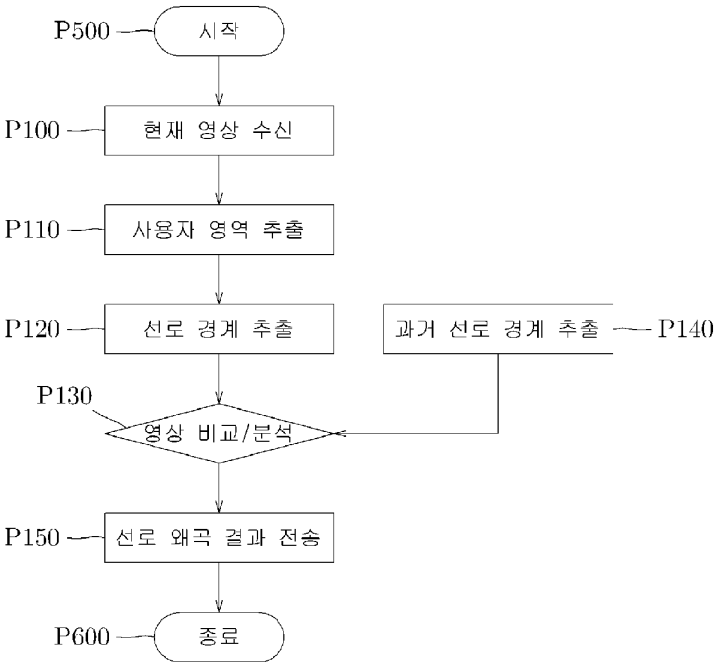
도면6


2.4GHz RF
470
ANT Module
410
MPEG 영상 송신 및 위치 송수신
Power Supply Module
440
Wireless Module
420
RF Transceiver
400
Main Cont. Module
430
음향 경보 모듈
450

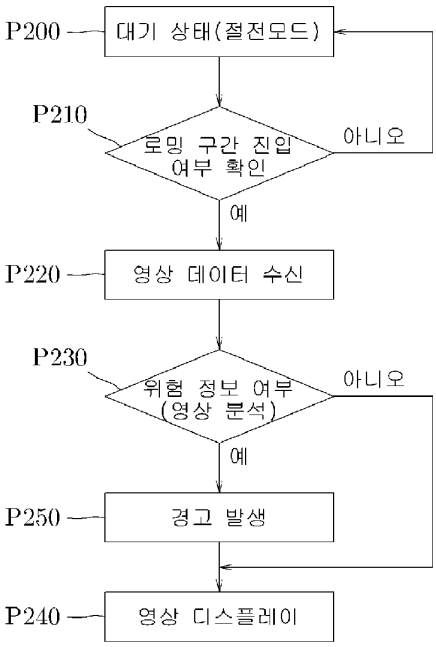
도면7


2.4GHz RF
350
ANT Module
310
MPEG 영상 송신 및 위치 송수신
Power Supply Module
370
Wireless Module
320
300
RF Transceiver
Main Cont. Module
360
영상 처리 (다중분할)
LCD Cont.
340
음향 경보 모듈
380
LCD
330

도면8


P500
시작
P100
현재 영상 수신
P110
사용자 영역 추출
P120
선로 경계 추출
과거 선로 경계 추출
P140
P130
영상 비교/분석
P150
선로 왜곡 결과 전송
P600
종료

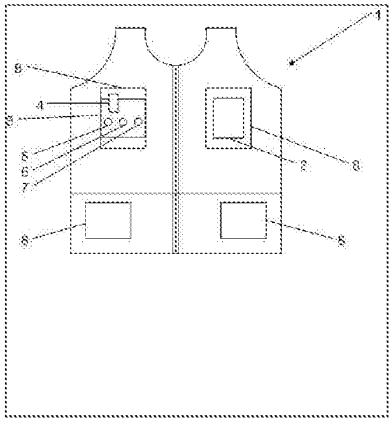
도면9


P200
대기 상태(절전모드)
P210
로밍 구간 진입 여부 확인
아니오
예
P220
영상 데이터 수신
P230
위험 정보 여부 (영상 분석)
아니오
예
P250
경고 발생
P240
영상 디스플레이

무선통신수단을 구비한 안전복

A SAFE CLOTH HAVING A WIRELESS COMMUNICATE MEANS

(51) Int. CL	A41D 13/00(2019.01.01) A41D 13/01(2006.01.01) A41D 1/00(2018.01.01)
(52) CPC	A41D 1/002(2013.01) A41D 13/0012(2013.01) A41D 13/01(2013.01) A41D 2600/20(2013.01)
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(71) Applicant	SHALOM ENGINEERING CO., LTD. KIM, Bong Taek
(11) Registration No.(Date)	
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(87) Int'l Unex. Pub. No.(Date)	
(30) Priority info. (Country / No. / Date)	
Legal Status	**Withdrawn**
Examination Status	Withdrawal (No request for examination)
Trial Info	
Kind	Domestic Application / New Application
Right of Org. Application No. (Date)	
Related Application No.	
Request for an examination(Date)	N
Number of examination claims	3



KPA (Korea Patent Abstract) PURPOSE: A safety clothing having a wireless communication unit is provided to warn the user when a train approaches by providing the information of the position of the user in real time.CONSTITUTION: The safety clothing having a wireless communication unit comprises a GPS(2), a wireless communication unit(3), a warning unit(7) and a receiving

portion(8). The GPS provides the information regarding the position of a user to the control room. When the train approaches the user at less than a predetermined distance, the signal notifying of the approach of the train is received by the warning unit from the control room. The warning unit produces warning sound when the wireless communication unit receives the signal notifying of the approach of the train.© KIPO 2006

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심사청구 : 없음

(54) 무선통신수단을 구비한 안전복

요약

본 발명은 무선통신수단을 이용한 안전복에 관한 것이다. 본 발명의 안전복은 작업자의 위치 신호를 실시간으로 통제실에 제공하는 GPS, 열차가 작업자와 소정 거리 이내로 접근 시에 상기 통제실로부터 열차의 접근 신호를 수신받는 무선통신수단, 상기 무선통신수단에 접근신호가 수신됨과 동시에 열차의 접근 경보가 자동으로 알려지는 경보수단, 및 상기 GPS 수신기, 무선통신수단, 및 경보수단 등을 장착시키기 위한 수납부를 포함한다.

또한 본 발명의 안전복에 있어서, 무선통신수단은 열차 접근 신호를 수신하기 위한 무선 안테나와, 열차 접근 여부를 알리는 신호가 수신되었음을 알려주는 LED 형태의 표시부와, 근접해 있는 다른 작업자 및 통제실과의 통화가 가능한 통화버튼으로 이루어진다.

본 발명의 안전복은 먼 거리에서 작업자의 위치 확인이 가능하도록 안전복 후면에 육안 식별용 LED와, 상기 LED의 전원 공급을 위해 하단부에 배터리 형태로 전원을 제공하는 배터리 팩, 및 상기 배터리 팩을 충전하기 위해 배터리 팩이 설치된 일측면에 부착된 충전케이블을 포함한다.

대표도

도 1

색인어

안전복, 안전신호, 열차접근, 경보, GPS

명세서

도면의 간단한 설명

도 1은 본 발명에 따른 무선통신수단을 구비한 안전복의 주요 구성도.

도 2는 본 발명에 따른 안전복의 일측면을 나타낸 구성도.

< 도면의 주요 부분에 대한 부호 설명 >

1: 안전복 2: GPS(Global Position System: 위치확인시스템)

3: 무선통신수단 4: 무선 안테나

5: LED 표시부 6: 무선 통화버튼

7: 경보수단 8: 수납부

9: 육안 식별용 LED 10: 배터리 팩 11: 배터리 충전케이블

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

본 발명은 무선통신수단을 구비한 안전복에 관한 것으로, 보다 상세하게는 열차 선로 상에 보수 작업 등을 하는 작업자의 위치 정보를 제공함으로써, 작업자의 위치와 근접하는 소정 거리 내로 열차가 접근하는 경우 이를 무선통신으로 작업자에 보내어 경보를 자동 알려주는 안전복에 관한 것이다.

종래에는 선로 상에 작업 중인 작업자의 안전을 위해서 소정 거리 밖에서 안전 담당자가 수신호나 기타 방법을 통해서 접근하는 열차를 통제하거나 열차가 접근하고 있음을 무전기와 같은 통신장비를 통해서 작업자에게 알려주는 방법을 사용하고 있다.

이와 같은 경우, 안전 담당자에게 의존도가 높기 때문에 잠시 위치를 벗어나거나 할 경우, 열차의 접근을 늦게 알려주거나 못 알려주는 문제점이 발생한다. 또한 무전기 통신의 에러로 작업자가 열차 접근 신호를 수신하지 못하는 경우 크나큰 안전에 문제점이 야기된다.

더 나아가, 작업자 이외의 안전 담당자 인력 등이 추가되므로, 작업의 효율성이 떨어지고 이에 대한 인력 비용이 추가 발생한다는 문제점이 있다.

발명이 이루고자 하는 기술적 과제

따라서, 본 발명은 상기한 종래의 문제점들을 해결하기 위하여 안출된 것으로, 본 발명은 작업자의 위치 신호를 통제실에 실시간을 제공함으로써, 통제실에서 작업자의 위치로 접근하는 열차접근신호가 작업자에게 수신되어 자동 경보음이 울리고 알람 표시등이 깜빡거리는 등 경보신호를 작업자에 신속히 알려줄 수 있는 안전복을 제공하는데 그 목적이 있다.

발명의 구성 및 작용

상기 목적을 달성하기 위한 본 발명의 무선통신수단을 구비한 안전복은, 그 청구범위 제 1항에 기재된 바와 같이, 열차 제어를 위한 중앙통제실에 작업자의 위치 신호를 실시간으로 통제실에 제공하는 GPS와;

열차가 작업자와 소정 거리 이내로 접근 시, 상기 통제실로부터 열차의 접근 신호를 수신하는 무선통신수단과;

상기 무선통신수단에 접근신호가 수신됨과 동시에 열차의 접근 상태를 알리는 경보가 자동으로 발생하는 경보수단; 및

상기 GPS, 무선통신수단, 및 경보수단 등을 장착시키기 위한 수납부로 이루지는 것을 특징으로 한다.

또한 본 발명의 안전복에 있어서, 무선통신수단은 열차 접근 신호를 수신하기 위한 무선 안테나와, 열차 접근 여부를 알리는 신호가 수신되었음을 알려주는 LED 형태의 표시부와, 근접해 있는 다른 작업자 및 통제실 또는 기지국과의 통화가 가능한 통화버튼으로 이루어지는 것을 특징한다.

더 나아가, 본 발명의 안전복은 먼 거리에서 작업자의 위치 확인이 가능하도록 안전복 후면에 육안 식별용 LED와, 상기 LED의 전원 공급을 위해 하단부에 배터리 형태로 전원을 제공하는 배터리 팩, 및 상기 배터리 팩을 충전하기 위해 배터리 팩이 설치된 일측면에 부착된 충전케이블을 포함한다.

이하 첨부된 도면을 참조하여 본 발명의 바람직한 실시예를 설명한다.

도 1은 본 발명의 무선통신수단을 구비한 안전복의 주요 구성도이다.

본 발명의 안전복(1)은, 도 1에 도시된 바와 같이, GPS(2), 무선통신수단(3), 경보수단(7), 및 수납부(8)로 이루어진다.

상기 GPS(2)는 열차 제어를 위한 통제실(또는 기지국)에서 작업자의 위치 신호를 실시간으로 제공한다. 이 신호를 수신한 통제실에서는 기존의 열차제어시스템을 통해 실시간으로 열차 위치를 관리하면서, 해당 작업자의 위치 신호와 작업자의 위치와 근접한 열차가 있을 경우, 이를 확인하여 경보 신호를 무선통신수(3)단에 송신한다.

상기 무선통신수단(3)은 열차가 작업자와 소정 거리 이내로 접근 시, 상기 통제실로부터 열차의 접근 신호를 수신한다. 이렇게 열차의 접근 신호가 수신되면, 동시에 경보수단(7)은 열차가 접근하고 있음을 작업자에 접근 경보를 자동으로 알리고 표시한다. 이 접근 경보는 경보음 및/또는 LED 형태의 적색 불빛 등으로 작업자에 알릴 수 있다.

상기 수납부(8)는 안전복의 일부에 상기 GPS(2), 무선통신수단(3), 및 경보수단(7) 등을 장착할 수 있도록 형성된다. 수납부는 안전복과 일체형이거나 착탈가능하게 형성될 수 있다.

상기 무선통신수단(3)은 열차 접근 신호를 수신하기 위한 무선 안테나(4)와, 열차 접근 여부를 알리는 신호가 수신되었음을 알려주는 LED 형태의 표시부(5), 및 근접해 있는 다른 작업자 및 통제실(또는 기지국)과의 통화가 가능한 통화버튼(6)으로 이루어진다. 또한 무선통신수단(3)은 일반적으로 사용되고 있는 무선통신장치로, 보다 상세한 설명은 생략하기로 한다.

도 2는 본 발명의 안전복에 관한 다른 구성을 나타낸다.

안전복(1)은 열차 운행 중 작업자에게 접근 중인 열차의 운전자가 먼 거리에서 작업자의 위치 확인이 가능하도록 안전복(1) 후면에 다수의 육안 식별용 LED(9)를 포함하고 있다. 또한, 상기 LED(9)의 전원 공급을 위해 하단부에 배터리 형태로 전원을 제공하는 배터리 팩(10)과, 상기 배터리 팩을 충전하기 위해 배터리 팩이 설치된 일측면에 충전케이블(11)이 부착되어 있다. 이 경우, 배터리는 충전용 또는 일회용으로도 대신할 수 있다.

이상에서는 본 발명의 바람직한 실시예에 대하여 도시하고 또한 설명하였으나, 본 발명은 상기한 실시예에 한정되지 않고, 본 발명의 취지에 크게 벗어나지 않는 범위 내에서 안전복이나 안전도구 등에 적용하는 것이 가능하다. 본 발명이 속하는 분야에 통상의 지식을 가진 자가 본 발명의 기술사상을 이용하여 설계 변경한 것은 본원 발명의 청구범위에 속하는 것으로 간주한다.

발명의 효과

이상에서 설명한 바와 같이, 본 발명에 따른 무선통신수단을 구비한 안전복은 선로 작업자의 위치에 접근하는 열차가 소정 거리에 근접하게 되면, 작업자에 열차가 접근 여부에 대한 경보 신호가 자동으로 발생함으로써, 작업자의 안전성을 크게 높이는 효과를 기대할 수 있다. 또한 작업자의 안전을 위해서 기존의 불필요한 무선통신기나 수신호로 열차통제를 하는 보조 인력 등에 대한 비용을 절감할 수 있는 효과가 있다.

(57) 청구의 범위

청구항 1.

작업자의 위치 정보를 실시간으로 통제실에 제공하는 GPS와;

열차가 작업자와 소정 거리 이내로 접근 시, 상기 통제실로부터 열차의 접근 신호를 수신하는 무선통신수단과;

상기 무선통신수단에 접근신호가 수신됨과 동시에 열차의 접근 상태를 알리는 경보가 자동으로 발생하는 경보수단; 및

상기 GPS 수신기, 무선통신수단, 및 경보수단 등을 장착시키기 위한 수납부로 이루지는 것을 특징으로 하는 무선통신수단을 구비한 안전복

청구항 2.

제 1항에 있어서,

상기 무선통신수단은 열차 접근 신호를 수신하기 위한 무선 안테나와, 열차 접근 여부를 알리는 신호가 수신되었음을 알려주는 LED 형태의 표시부와, 근접해 있는 다른 작업자 및 통제실과의 통화가 가능한 통화버튼으로 이루어지는 것을 특징으로 하는 안전복.

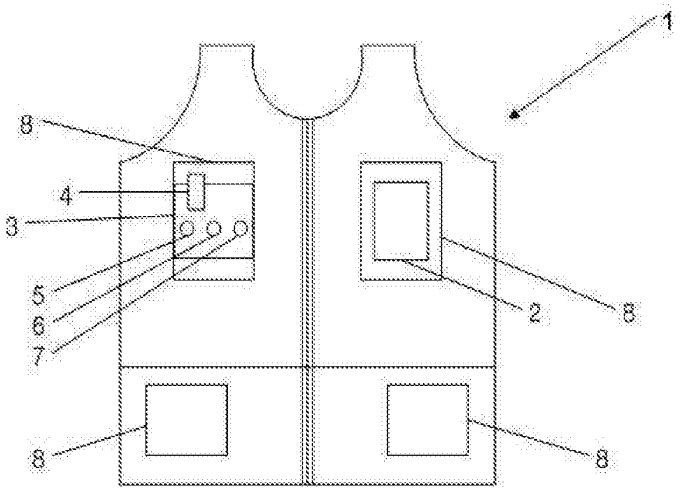
청구항 3.

제 1항에 있어서,

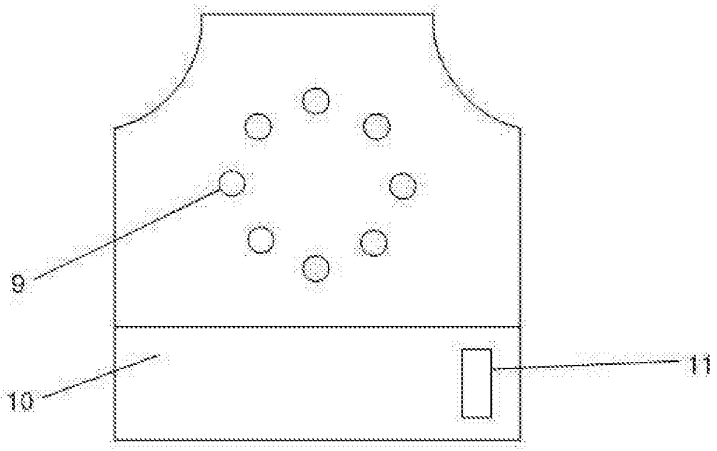
먼 거리에서 작업자의 위치 확인이 가능하도록 안전복 후면에 육안 식별용 LED와, 상기 LED의 전원 공급을 위해 하단부에 배터리 형태로 전원을 제공하는 배터리 팩, 및 상기 배터리 팩을 충전하기 위해 배터리 팩이 설치된 일측면에 부착된 충전케이블을 포함하는 것을 특징으로 하는 안전복.

도면

도면1



도면2



Espacenet

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Responder

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Classification: **- international:** ***B61L23/00; G06K19/07; H02J50/27; H04B1/59***
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Application number: CN200820123287U 20081231

Priority number (s): CN200820123287U 20081231

Abstract of CN201323574 (Y)

The utility model discloses a responder and belongs to the field of railway communication signal equipment. The responder comprises a responder vehicle-borne equipment communication interface unit and a responder wayside electronic equipment interface unit, wherein the responder wayside electronic equipment interface unit is provided with a responder signal loop back interface module; the responder vehicle-borne equipment communication interface module and the responder wayside electronic equipment interface unit are in communication connection, so as to send message data to vehicle-borne equipment; the responder wayside electronic equipment interface unit of the responder and the responder vehicle-borne equipment communication interface unit of the responder are in communication connection, so as to conduct connection and communication with wayside electronic equipment, receive the message data output by the wayside electronic equipment and send the data to the vehicle-borne equipment through the vehicle-borne equipment communication interface unit; and low-frequency signals, reflecting self working state of the responder and activate signals and generated by the responder signal loop back interface module, are output and transmitted to the wayside electronic equipment. The responder can accurately feed signals back, and the communication distance can reach more than 4km.

[19] 中华人民共和国国家知识产权局

[12] 实用新型专利说明书

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G06K 19/07 (2006.01)

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[11] 授权公告号 CN 201323574Y

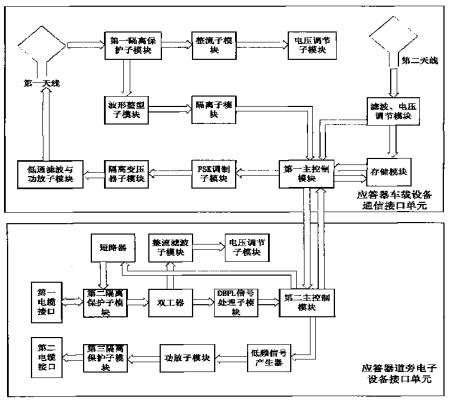
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权利要求书 4 页 说明书 17 页 附图 5 页

[54] 实用新型名称

应答器

[57] 摘要

本实用新型公开一种应答器。属于铁路通信信号设备领域。该应答器包括：应答器车载设备通信接口单元和应答器道旁电子设备接口单元，其中，应答器道旁电子设备接口单元中设有应答器信息回送接口模块；应答器车载设备通信接口模块与应答器道旁电子设备接口单元通信连接，向车载设备发送报文数据；应答器的应答器道旁电子设备接口单元与应答器的应答器车载设备通信接口单元通信连接，用于与道旁电子设备连接通信，接收道旁电子设备输出的报文数据并通过车载设备通信接口单元传送至车载设备，并将反应该应答器自身工作状态和激活信息通过应答器信息回送接口模块产生的低频信号输出传送至道旁电子设备。该应答器反馈信号准确，通信距离可达 4km 以上。



1、一种应答器，其特征在于，包括:

应答器车载设备通信接口单元和应答器道旁电子设备接口单元，其中，所述应答器道旁电子设备接口单元中设有应答器信息回送接口模块;

所述应答器车载设备通信接口单元，与所述应答器道旁电子设备接口单元通信连接，用于与车载设备无线通信，将道旁电子设备传送至该应答器中的报文数据，以无线方式向所述车载设备发送;

所述应答器道旁电子设备接口单元，与所述应答器车载设备通信接口单元通信连接，用于与道旁电子设备连接通信，接收道旁电子设备输出的报文数据并通过所述应答器车载设备通信接口单元以无线方式传送至车载设备;并将应答器产生的反应该应答器自身工作状态以及应答器激活信息，通过应答器信息回送接口模块产生的低频信号输出传送至道旁电子设备。

2、根据权利要求1所述的应答器，其特征在于，所述应答器车载设备通信接口单元具体包括:

第一主控制模块、存储模块、第一天线、上行链路接口模块和下行链路接口模块;

所述第一主控制模块，与所述存储模块连接，用于对接收的报文数据进行处理，并存储至所述存储模块中；并与所述应答器道旁电子设备接口单元连接通信，将该第一主控制模块自检获得的自检信息传送至所述应答器道旁电子设备接口单元;

上行链路接口模块，连接在第一天线和所述第一主控制模块的信号输出端之间，用于将所述第一主控制模块处理后的控制信号输出至第一天线，由第一天线传输至车载设备;

下行链路接口模块，连接在第一天线和第一主控制模块的信号输入端之

间，其供电输出端与所述应答器车载设备通信接口单元中各电路模块的供电端连接，用于将第一天线接收的车载设备的电磁信号整型后的报文信号输入所述第一主控制模块进行处理；并将电磁信号转换为电能为所述应答器车载设备通信接口单元供电。

3、根据权利要求2所述的应答器，其特征在于，所述上行链路接口模块具体由FSK调制子模块、隔离变压器子模块和滤波与功放子模块依次连接组成；

其中，所述FSK调制子模块，连接在所述第一主控制模块的信号输出端与隔离变压器子模块之间，用于对第一主控制模块输出的报文数据进行2FSK调制，确定编码对应的频率值；

所述隔离变压器子模块，用于信号耦合以及防雷保护；

所述滤波与功放子模块，与所述第一天线连接，用于将调制报文数据得到的FSK信号放大，并通过低通滤波处理后将FSK信号馈送至第一天线发送。

4、根据权利要求2所述的应答器，其特征在于，所述下行链路接口模块具体包括两部分，第一部分由第一隔离保护子模块、波形整型子模块和隔离子模块顺次连接而成；第二部分由第一隔离保护子模块的电压输出端与整流子模块和第一电压调节模块顺次连接而成；

其中，所述第一隔离保护模块，与所述第一天线连接，用于将第一天线与应答器的其他模块隔离，并以耦合的方式将第一天线接收的电磁信号输出至波形整型子模块和整流子模块。

5、根据权利要求1所述的应答器，其特征在于，所述应答器车载设备通信接口单元还包括：

第二天线和滤波及电压调节模块；

所述第二天线与所述滤波及电压调节模块连接，所述滤波及电压调节模块分别与第一主控制模块和存储模块连接，用于接收更新数据信号。

6、根据权利要求1所述的应答器，其特征在于，所述应答器道旁电子设备接口单元具体包括:

第二主控制模块、电缆接口、数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块;

所述第二主控制模块，与所述应答器车载设备通信接口单元连接通信，并分别与数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块连接，用于处理各模块发送或接收的报文数据；及对DBPL信号上承载的应答器报文进行CRC校验，将该第二主控制模块自检信息与接收的应答器车载设备通信接口单元的第一主控制模块反馈的自检信息综合成应答器的工作状态信息，并将该工作状态信息传送至应答器信息回送接口模块;

所述数据报文接口模块，连接在所述电缆接口1与所述第二主控制模块的信号输入端之间，用于将道旁电子设备传输的报文数据传送至所述第二主控制模块进行处理;

所述应答器信息回送接口模块，连接在所述第二主控制模块的信号输出端与所述电缆接口之间，用于产生表征了应答器自身工作状态以及应答器激活信息的低频信号，并通过电缆接口将产生的低频信号输出回送至道旁电子设备;

所述偏置电压接口模块，与所述数据报文接口模块连接，用于向所述数据报文接口模块提供偏置电压。

7、根据权利要求6所述的应答器，其特征在于，所述数据报文接口模块具体由第二隔离保护子模块、双工器、短路器和DBPL信号处理子模块顺次连接而成，第二隔离保护子模块的输入端与所述电缆接口连接，DBPL信号处理子模块的输出端与所述第二主控制器的信号输入端连接。

8、根据权利要求1或6所述的应答器，其特征在于，所述应答器信息回送接口模块具体由低频信号产生器、功放子模块和第三隔离保护子模块顺次连

接而成；其中，低频信号产生器的输入端与所述第二主控制模块的信号输出端连接，所述第三隔离保护子模块的输出端与电缆接口连接。

9、根据权利要求8所述的应答器，其特征在于，所述低频信号产生器的功率为1～10mW，产生的低频信号的频率范围为0.5～1.5KHz。

10、根据权利要求6所述的应答器，其特征在于，所述偏置电压接口模块具体由整流滤波子模块和第二电压调节子模块连接而成；其中，整流滤波子模块与数据报文接口模块中双工器的电流输出端连接。

应答器

技术领域

本实用新型涉及铁路通信信号设备领域，尤其涉及一种用于铁路信号中的有源应答器。

背景技术

随着我国国民经济对铁路运输要求的不断提高，对铁路列车运行管理和安全控制的要求也上升到一个新的等级。为确保对高速列车的运行控制和安全保障，势必要实现调度命令、列车控制信息、安全信息的实时传送和交换。因此，在列车与地面之间构建一个可靠、高效、双向、大数据量的无线传输与交换系统是列车的高速运行的必要条件。

欧洲标准应答器子系统在欧洲ETCS中的各个级别均有运用。中国列车控制系统（CTCS）是参照欧洲列车控制系统（ETCS）制定的应用于我国现代铁路的列车控制系统。在CTCS系统中，欧洲标准应答器子系统是信号基础设施，具有重要意义。应答器子系统如图1所示，该应答器系统中包括地面应答器、道旁电子设备（简称LEU）及车载设备。该应答器是基于电磁耦合原理而构成的高速点式数据传输设备，在特定地点实现车-地面间的数据交换，其中，地面应答器安装于两根钢轨中心枕木上的地面应答器不需要外加电源，平时应答器处于休眠状态，仅在列车通过并接收到车载查询器发送的功率载波时被激活，同时发送调制的数据编码信号。安装于列车底部的车载查询器不断发送功率载波信号，当列车通过地面应答器时，接收处理发自应答器的调制数字编码信号。车载主机（BTM）将处理后的信号传送给列车控制设备。

现有的应答器子系统中，要求有源应答器中要设有与车载设备和道旁电子设备LEU通信的接口，要求有源应答器要安全可靠地将道旁电子设备LEU传输过来的信息通过与车载设备通信的接口以无线方式传输到车载设备上，并且要求道旁电子设备LEU可以获得应答器的激活信息。实际中，现有的有源应答器与道旁电子设备LEU之间采用电缆方式连接，道旁电子设备LEU向有源应答器发送8.82KHz的信号为应答器提供能量，利用564KHz的双相差分电平编码（简称DBPL）信号传输应答器报文。当应答器被激活时，应答器将接收到的应答器报文通过FSK信号发送到车载设备。但现有有源应答器不具有向LEU回送自身激活状态信息的功能，确定有源应答器是否被激活是通过LEU检测有源应答器负载变化导致的电流幅度增大的方式来实现的，但这种检测方式，要求有源应答器与LEU之间的连接距离通常要小于500m，才能满足有源应答器与LEU正常通信要求，才可以保证LEU正常检测有源应答器的激活状态，保持与有源应答器正确通信，若连接距离超过500m，会导致LEU无法正确检测有源应答器是否激活，由于连接电缆本身具有电阻、电感和电容的效应，长距离的电缆传输后LEU的信号的幅度会衰减、DBPL信号的波形会变形，有源应答器与LEU的信号传输的可靠性不可避免的降低，并且由于目前有源应答器采用的是透明传输（对接收的报文不进行校验），有源应答器将从LEU传输来的DBPL信号解析得到的报文会透明传输到车载设备上，这样若报文出错也会影响行车安全，因此LEU与有源应答器长距离传输造成的可靠性降低也会对行车的安全造成影响。

另外，为保证行车安全，地面列控中心还需要及时监测有源应答器的工作状态，但现有的有源应答器也不具有向LEU回送自身工作状态的功能，因此现有技术常采用人工检测或安装在有源应答器上的专用检测设备定时检测的方式来检测有源应答器的工作状态，这样的检测方法会干扰有源应答器与LEU的正常工作，并大大提高了运行成本。因此，提供一种可将自身的工作状态

信息和激活状态信息以低功耗、无干扰的方式反馈至LEU，并可保证在连接距离大于500m的情况下正常与LEU通信工作的有源应答器是个迫切需要解决的问题。

实用新型内容

基于上述现有技术所存在的问题，本实用新型实施方式的目的是提供一种应答器，可以实现远距离、双向信号传输，可将应答器激活信息和应答器自身的工作状态准确的传输反馈至道旁电子设备LEU。

本实用新型的目的是通过以下技术方案实现的：

本实用新型实施例提供一种应答器，包括：

应答器车载设备通信接口单元和应答器道旁电子设备接口单元，其中，所述应答器道旁电子设备接口单元中设有应答器信息回送接口模块；

所述应答器车载设备通信接口单元，与所述应答器道旁电子设备接口单元通信连接，用于与车载设备无线通信，将道旁电子设备传送至该应答器中的报文数据，以无线方式向所述车载设备发送；

所述应答器道旁电子设备接口单元，与所述应答器车载设备通信接口单元通信连接，用于与道旁电子设备连接通信，接收道旁电子设备输出的报文数据并通过所述应答器车载设备通信接口单元以无线方式传送至车载设备；并将应答器产生的反应该应答器自身工作状态以及应答器激活信息，通过应答器信息回送接口模块产生的低频信号输出传送至道旁电子设备。

所述应答器车载设备通信接口单元具体包括：

第一主控制模块、存储模块、第一天线、上行链路接口模块和下行链路接口模块；

所述第一主控制模块，与所述存储模块连接，用于对接收的报文数据进行处理，并存储至所述存储模块中；并与所述应答器道旁电子设备接口单元

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连接通信，将该第一主控制模块自检获得的自检信息传送至所述应答器道旁电子设备接口单元；

上行链路接口模块，连接在第一天线和所述第一主控制模块的信号输出端之间，用于将所述第一主控制模块处理后的控制信号输出至第一天线，由第一天线传输至车载设备；

下行链路接口模块，连接在第一天线和第一主控制模块的信号输入端之间，其供电输出端与所述应答器车载设备通信接口单元中各电路模块的供电端连接，用于将第一天线接收的车载设备的电磁信号整型后的报文信号输入所述第一主控制模块进行处理；并将电磁信号转换为电能为所述应答器车载设备通信接口单元供电。

所述上行链路接口模块具体由FSK调制子模块、隔离变压器子模块和滤波与功放子模块依次连接组成；

其中，所述FSK调制子模块，连接在所述第一主控制模块的信号输出端与隔离变压器子模块之间，用于对第一主控制模块输出的报文数据进行2FSK调制，确定编码对应的频率值；

所述隔离变压器子模块，用于信号耦合以及防雷保护；

所述滤波与功放子模块，与所述第一天线连接，用于将调制报文数据得到的FSK信号放大，并通过低通滤波处理后将FSK信号馈送至第一天线发送。

所述下行链路接口模块具体包括两部分，第一部分由第一隔离保护子模块、波形整型子模块和隔离子模块顺次连接而成；第二部分由第一隔离保护子模块的电压输出端与整流子模块和第一电压调节模块顺次连接而成；

其中，所述第一隔离保护模块，与所述第一天线连接，用于将第一天线与应答器的其他模块隔离，并以耦合的方式将第一天线接收的电磁信号输出至波形整型子模块和整流子模块。

所述应答器车载设备通信接口单元还包括：

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第二天线和滤波及电压调节模块;

所述第二天线与所述滤波及电压调节模块连接，所述滤波及电压调节模块分别与第一主控制模块和存储模块连接，用于接收更新数据信号。

所述应答器道旁电子设备接口单元具体包括:

第二主控制模块、电缆接口、数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块;

所述第二主控制模块，与所述应答器车载设备通信接口单元连接通信，并分别与数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块连接，用于处理各模块发送或接收的报文数据；及对DBPL信号上承载的应答器报文进行CRC校验，将该第二主控制模块自检信息与接收的应答器车载设备通信接口单元的第一主控制模块反馈的自检信息综合成应答器的工作状态信息，并将该工作状态信息传送至应答器信息回送接口模块;

所述数据报文接口模块，连接在所述电缆接口1与所述第二主控制模块的信号输入端之间，用于将道旁电子设备传输的报文数据传送至所述第二主控制模块进行处理;

所述应答器信息回送接口模块，连接在所述第二主控制模块的信号输出端与所述电缆接口之间，用于产生表征了应答器自身工作状态以及应答器激活信息的低频信号，并通过电缆接口将产生的低频信号输出回送至道旁电子设备;

所述偏置电压接口模块，与所述数据报文接口模块连接，用于向所述数据报文接口模块提供偏置电压。

所述数据报文接口模块具体由第二隔离保护子模块、双工器、短路器和DBPL信号处理子模块顺次连接而成，第二隔离保护子模块的输入端与所述电缆接口连接，DBPL信号处理子模块的输出端与所述第二主控制器的信号输入端连接。

所述应答器信息回送接口模块具体由低频信号产生器、功放子模块和第三隔离保护子模块顺次连接而成；其中，低频信号产生器的输入端与所述第二主控制模块的信号输出端连接，所述第三隔离保护子模块的输出端与电缆接口连接。

所述低频信号产生器的功率为1～10mW，产生的低频信号的频率范围为0.5～1.5KHz。

所述偏置电压接口模块具体由整流滤波子模块和第二电压调节子模块连接而成；其中，整流滤波子模块与数据报文接口模块中双工器的电流输出端连接。

由上述本实用新型实施方式提供的技术方案可以看出，本实用新型实施方式中通过在应答器道旁电子设备接口单元中设置应答器信息回送接口模块，并通过应答器信息回送接口模块产生的低频信号，将反应该应答器自身工作状态以及应答器激活信息输出传送至道旁电子设备，使道旁电子设备可以准确监测应答器的工作状态和激活状态，解决了应答器工作状态实时监测的问题。由于低频信号的穿透力强，传输距离远，使采用低功耗电路实现的应答器在自身功耗很小的前提下，可以保证低功率状态下以较远的距离与道旁电子设备有效通信。使应答器与道旁电子设备之间的通信距离可以大大超过500m，可以达到1～4km以上，解决了应答器与道旁电子设备不能远距离通信或通信效果不好的问题。

附图说明

图1为现有技术提供的应答器系统各部分连接示意图；

图2为本实用新型实施例的应答器的结构框图；

图3为本实用新型实施例的应答器包括各具体模块的结构框图；

图4为本实用新型实施例的天线模块的结构示意图；

图5为本实用新型实施例的用双端齐纳二极管构成的保护电路图；

图6为本实用新型实施例的用压敏电阻构成的保护电路图；

图7为本实用新型实施例的倍压整流电路图；

图8为本实用新型实施例的稳压电路图；

图9为本实用新型实施例的双音频信号传输波型示意图。

具体实施方式

本实用新型实施方式提供一种应答器，用在铁路信号控制中的应答器系统中，该应答器具体包括：应答器车载设备通信接口单元和应答器道旁电子设备接口单元，其中，所述应答器道旁电子设备接口单元中设有应答器信息回送接口模块；应答器车载设备通信接口单元与所述应答器道旁电子设备接口单元通信连接，用于与车载设备通信，将地面列控中心经道旁电子设备传送至该应答器中的报文数据，向所述车载设备发送；应答器道旁电子设备接口单元与所述应答器车载设备通信接口单元通信连接，用于与道旁电子设备连接通信，接收道旁电子设备输出的报文数据并通过应答器车载设备通信接口单元以无线方式传送至车载设备，并将应答器激活信息和反应应答器自身工作状态的信息同时发送到电缆接口（包括第一电缆接口和第二电缆接口），承载在低频信号上通过电缆接口（一般为第二电缆接口）输出传送回道旁电子设备。

为便于理解，下面结合附图和具体实施例对本实用新型的实施方式作进一步说明。

实施例一

本实施例提供一种铁道应答器系统中使用的应答器，它可以与道旁电子设备通信，可以保证在4km以上的距离，使道旁电子设备准确监测该应答器的工作状态，如图2、图3所示，该应答器的具体包括：

应答器车载设备通信接口单元和应答器道旁电子设备接口单元两大部分，其中，应答器道旁电子设备接口单元中设有应答器信息回送接口模块；

所述应答器车载设备通信接口单元与所述应答器道旁电子设备接口单元通信连接，用于与车载设备通信，将道旁电子设备传送至该应答器中的报文数据，向所述车载设备发送；

所述应答器道旁电子设备接口单元与所述应答器车载设备通信接口单元通信连接，用于与道旁电子设备连接通信，接收道旁电子设备输出的报文数据并通过应答器的车载设备通信接口单元以无线方式传送至车载设备；并将应答器反应该应答器自身工作状态以及应答器激活信息通过应答器信息回送接口模块产生的低频信号输出传送回道旁电子设备。

上述应答器中，应答器车载设备通信接口单元具体包括：第一主控制模块、存储模块、第一天线、上行链路接口模块和下行链路接口模块，及第二天线和滤波及电压调节模块；其中，第一主控制模块与存储模块连接，用于对接收的报文数据进行处理，并存储至所述存储模块中；第一主控制模块还用于与所述应答器道旁电子设备接口单元连接通信；

上行链路接口模块连接在第一天线和所述第一主控制模块的信号输出端之间，用于将所述第一主控制模块处理后的报文数据经第一天线输出至车载设备；实际中，上行链路接口模块具体由FSK调制子模块、隔离变压器子模块和滤波与功放子模块依次连接而；

其中FSK调制子模块，连接在所述第一主控制模块的信号输出端与隔离变压器子模块之间，用于对报文数据进行2FSK调制，确定报文数据调制后编码对应的频率值；

隔离变压器子模块，用于将接收信号耦合以及防雷保护；

滤波与功放子模块与所述第一天线连接，用于将报文数据调制后的FSK信号放大，并通过低通滤波处理后将FSK信号馈送至第一天线发送。

下行链路接口模块连接在第一天线和第一主控制模块的信号输入端之间，其供电输出端与所述应答器车载设备通信接口单元中各电路模块，用于将接收的车载设备的27.095MHz电磁信号整型后的时钟信号输入所述第一主控制模块，并将电磁信号转换为电能为所述应答器车载设备通信接口单元中各电路模块供电；

实际中，下行链路接口模块具体包括两部分，第一部分由第一隔离保护子模块、波形整型子模块和隔离子模块顺次连接而成；第二部分由第一隔离保护子模块的电压输出端与整流子模块和第一电压调节子模块顺次连接而成；其中，第一隔离保护子模块与第一天线连接，用于将第二天线与应答器的其他各电路模块隔离，并以耦合的方式将第一天线接收的电磁信号输出至波形整型子模块和整流子模块。

上述应答器的应答器车载设备通信接口单元中，还包括第二天线和滤波及电压调节子模块，第二天线与滤波及电压调节子模块连接，滤波及电压调节子模块分别与第一主控制模块和存储模块连接。

上述应答器中的应答器道旁电子设备接口单元具体包括:

第二主控制模块、电缆接口、数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块；其中，电缆接口分为第一电缆接口和第二电缆接口，实际中可以使第一电缆接口与一对两芯电缆连接，第二电缆接口与另一对两芯电缆连接，两组两芯电缆作为连接LEU通信用的四芯电缆；

其中，第二主控制模块与应答器车载设备通信接口单元连接通信，并分别与数据报文接口模块、应答器信息回送接口模块和偏置电压接口模块连接，用于处理各模块发送或接收的报文数据；

数据报文接口模块连接在所述第一电缆接口与所述第二主控制模块的信号输入端之间，用于将道旁电子设备传输的报文数据传送至所述第二主控制模块进行处理；实际中，数据报文接口模块具体由第二隔离保护子模块、双

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工器、短路器和DBPL信号处理子模块顺次连接而成，第二隔离保护子模块的输入端与电缆接口连接，DBPL信号处理子模块的输出端与第二主控制器的信号输入端连接；

应答器信息回送接口模块连接在所述第二主控制模块的信号输出端与所述第二电缆接口之间，用于将该应答器的状态信息回送至道旁电子设备；实际中，应答器回送接口模块具体由低频信号产生器、功放子模块和第三隔离保护子模块顺次连接而成；其中，低频信号产生器的输入端与所述第二主控制模块的信号输出端连接，第三隔离保护子模块的输出端与第二电缆接口连接；实际中，组成应答器回送接口模块中的低频信号产生器的功率为1～10mW、可产生频率在0.5～1.5KHz的低频信号，这种低频信号产生器由于功率较小，在应答器本身电力供应很小的前提下，可以保证产生穿透力强、传输距离远的低频信号来将应答器的信息回送至LEU，保证了LEU可以准确监测应答器的工作状态。实际中，低频信号的频点应避开工频与轨道电路频率的谐波。具体使用中，可以采用双音频信号产生器作为低频信号发生器，双音频信号的不同组合后，可以更准确的向LEU反馈应答器的不同工作状态。并且为了使实用新型实施例中的应答器与现有的应答器系统兼容，功放子模块可以采用高效功放电路（一般采用效率高于70%的功放电路），以使应答器的总体负载为90Ω<|Z|<150Ω，以达到与现有应答器系统兼容的目的。

偏置电压接口模块与数据报文接口模块连接，用于向各电路模块提供偏置电压；偏置电压接口模块具体由整流滤波模块和第二电压调节模块连接而成；其中，整流滤波模块与数据报文接口模块的双工器的电流输出端连接。

上述本实用新型实施例的应答器在应答器道旁电子设备接口单元中可以通过报文数据接口模块对LEU传输过来的DBPL信号上承载的应答器报文进行校验，以及在应答器车载设备通信接口单元中通过第一主控制模块和应答器道旁电子设备接口单元中通过第二主控制模块进行自检获得应答器的工作状态

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信息，使应答器可以将校验后的信息、应答器激活信息和应答器自身工作状态信息通过应答器信息回送接口模块承载在低频信号上发送至LEU，使道旁电子设备可以准确监测应答器的各种工作状态和激活状态，解决了应答器工作状态实时监测的问题。

在欧洲应答器标准中规定，实际中使用的应答器要具备（部分为可选）下述相应的接口：

A接口，应答器与车载设备之间的通信接口，A接口可以分为A1、A2、A4和A5等子接口。

A1接口：从上行应答器到天线传输上行应答器报文的接口。

A2接口：从天线到下行应答器传输下行应答器报文的接口。目前的应答器系统没有采用。

A4接口：车载设备的车载天线将建立电磁场为应答器提供能量（车→地传输），A4接口是通过车载设备的车载天线形成的无线电磁场中为应答器获取所需能量的接口，当与A4接口连接的应答器的第一天线位于接触区（contact Zone）内时，应答器接收车载设备的车载天线形成的无线电磁场能量，建立工作电源，并向车载设备发送报文数据（地→车传输），一般车载设备的车载天线的功率载频为：27.095MHz±5KHz;

A5接口：是可选的接口，通过无线的方式给固定的上行应答器写入报文的接口。

C接口，用于连接道旁电子设备LEU，为应答器供电和控制信息传输接口，有4个子接口：

C1接口：上传数据;

C4接口：输出闭塞信号（Blocking）;

C5接口：应答器编程接口，是可选接口，目前的应答器系统没有采用。

C6接口：辅助能量输入。

C1、C4和C6必须共享同一对电缆。

下面结合上述标准中的要求，对本实用新型实施例中的应答器的各接口作进一步说明：

图2和图3所示为该应答器的结构框图，整个系统分为两个部分，应答器车载设备通信接口单元和应答器道旁电子设备接口单元，也就是应答器标准中规定的A接口部分和C接口部分。

A接口部分主要由第一天线、第一隔离保护子模块、整流子模块、第一电压调节子模块、波形整形子模块、隔离子模块、FSK调制子模块、存储模块、第一主控制模块、功放与滤波子模块等组成，其中，各电路模块连接形成下行链路接口模块作为A1接口和A4接口，及上行链路接口模块作为A2接口。

C接口部分由第二隔离保护子模块、低频信号接收子模块、双工器、整流滤波子模块、第二电压调节子模块、第三隔离保护子模块、低频信号产生器、第二主控制模块、功放子模块等组成；其中，各电路模块连接形成数据报文接口模块作为接收C1接口和C6接口信号，第一电缆接口与所述第二隔离保护子模块、双工器、短路器相连接产生并传输C4接口信号。与此同时第二电缆接口与反馈信号产生模块共同产生并传输应答器工作状态和激活信息的低频信号。应答器激活是通过短路器将应答器负载下降到15欧姆，在应答器被激活后5us时间内将激活信息回送至第一电缆接口。

作为A接口部分的应答器车载设备通信接口单元中的第一主控制模块与作为C接口部分的应答器道旁电子设备接口单元中的第二主控制模块通信连接，实际中也可以将两个控制模块采用一个控制芯片来实现。第一主控制模块和第二主控制模块的芯片可以采用CPLD、FPGA、MCU、DSP等，但不因采用特定的芯片类型对本实用新型实施例的应答器造成任何限制，只要用在应答器中可起到相应的控制作用即可。

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上述应答器在使用中C接口部分通过一对四芯电缆中的两对电缆与LEU连接，一对电缆中的信号是完成C接口与LEU通信，包括C1、C4和C6各接口信号的传输；另外一对电缆传输应答器的反馈信号。

下面对应答器中作为A接口部分的车载设备通信接口模块的各部分的作用进行说明：

在上述应答器中，第一主控制模块主要在应答器被激活时发送FSK信号，同时通过第二天线接收和滤波电压调节模块接收A5接口信号对应答器存储的默认报文进行改写。

实际中，第一天线可以是27.095M和4.234M的双频天线，同时从车载设备接收27.095MHz的无线信号和向车载设备发送中心频率为4.234MHz的FSK信号并由双工器将两路信号分离；第一天线也可以由工作频率分别为27.095MHz和4.234M的两个单频天线组成，分别完成接收27.095MHz信号和发送FSK信号的功能。天线材料可以采用PCB或铜板制造，两个频率可以由一副天线实现，并用双工器来区分两个频率；也可以分别用两副天线来组成。

第二天线是9.032MHz天线，天线材料可以采用PCB或铜板制造，为了将第一天线1和第二天线2隔离，第二天线2采用与第一天线1不同的结构，两天线的具体结构参见图4。

第一隔离保护模块，可以采用隔离保护电路，主要作用是将第一天线与应答器的其他模块隔离开，并且具有防雷的作用，实际中，隔离保护电路可以采用变压器构成的隔离电路，而防雷部分可以采用如图4中所示的由并联双端齐纳二极管防雷电路，或如图5中所示的在变压器前串联压敏电阻构成的防雷电路。

整流模块是将交流变直流，可以采用如图6所示的利用全波整流、整流桥或倍压整流电路等，也可以采用其它形式的整流电路。

第一电压调节模块，使整流后的脉动电压获得稳定的电压，为其它电路

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模块提供电源。A接口部分中其它电路模块所需电压可以采用如图8所示的稳压电路进行稳压，实际中，可以使用不同稳压值的齐纳二极管D1，R1可以取50～100欧姆电阻。

波形整形模块的作用将经第一天线接收的正弦波整形为27.095M方波信号，为第一主控制模块提供时钟信号，波形整形模块可以由比较器或施密特电路组成。

隔离子模块用来保护第一主控制模块，可以使用但不仅限于使用光耦。

FSK调制子模块对1023比特的报文数据进行2FSK调制，编码0对应3.9MHZ，编码1对应4.5MHZ。

隔离变压器子模块，主要起到信号耦合以及防雷保护的作用。

功放与滤波子模块可以采用低通滤波和功放电路，FSK调制模块调制后的FSK信号经隔离变压器子模块耦合到功放与滤波子模块，由功放与滤波子模块的功放电路将FSK信号放大，并通过低通滤波器电路将FSK信号馈传到第一天线上向车载设备发送。

存储模块是用来存放默认报文以及由应答器道旁电子设备接口单元接收的报文，可以使用EEPROM，FRAM等存储芯片，但并不限于所述的存储器。

第二天线与滤波、电压调节模块连接，形成向应答器写入报文用的接收电路，主要用于利用手持设备向应答器写入报文时，接收报文数据用。滤波、电压调节模块完成对第二天线的匹配滤波，整流后通过电压调节模块输出电源，供A接口部分的第一主控制模块和存储模块，并提供中断信号，使第一主控制模块加入写报文状态。

下面对本发明实施例的应答器中作为C接口部分的应答器道旁电子设备接口单元的各电路模块的作用及组成进行说明:

第二隔离变压器子模块主要起到信号耦合以及防雷保护的作用。

第二主控制模块是根据LEU获取的数据进行相应的操作，第二主控制模块

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对量化后的DBPL信号进行解码，并进行CRC校验，从而产生应答器道旁电子设备接口单元的状态信息。另外C接口部分的第二主控制模块也接收A接口部分的第一主控制模块反馈的应答器激活信息以及A接口部分的状态信息，并将总体应答器的工作状态信息反馈回LEU。第二主控制模块的控制芯片可以采用但不限于CPLD、FPGA、MCU、DSP等。

双工器将LEU输出的8.82K正弦信号和DBPL信号分离，并分别输出到后继电路模块。

整流模块将8.82K的正弦信号整流，可以使用但不限于全波整流、整流桥电路或者倍压整流电路等。

第二电压调节子模块使用电源芯片输出各种幅度电压以供C接口部分的其它电路模块使用。

DBPL信号处理子模块主要进行三种处理：滤波消除8.82K信号及其高次谐波干扰；对DBPL信号进行限幅以防止大幅度的输入对模数转换器ADC（图中未示出）造成损伤；用模数转换器ADC将DBPL模拟信号转换为数字信号，其中模数转换器ADC也可以使用比较器实现1比特量化。

功放子模块是对低频信号产生器产生的低频信号进行放大，实际中可以使用运放或分立器件电路作为功放子模块，对低频信号进行放大。功放子模块的效率应高于70％。功放子模块输出的低频信号的幅度见图8，其中，V_1要符合：$8V_{pp} \le v_1 \le 15V_{pp}$。

低频信号产生器可以采用双音频信号产生器，具体可以按应答器状态产生双音频信号，分别由一个低频（共四个）、一个高频信号（共四个）组合构成，存在16个状态，用来传递应答器工作状态的反馈信号到LEU。一种可行的具体信号表示的应答器状态与频率组定义如下：

表1 频率与信息对应表

数字	低频组	高频组	比特	信息

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	（Hz）	（Hz）		
1	697	1209	0001	应答器工作正常
2	697	1336	0010	A接口主控模块错误
3	697	1477	0011	A接口FSK功放错误
4	770	1209	0100	A接口与C接口连接错误
5	770	1336	0101	C接口无DBPL信号达0.6ms
6	770	1477	0110	C接口接收DBPL信号不稳定
7	852	1209	0111	C接口接收到DBPL信号，但报文错误
8	852	1336	1000	火车通过
9	852	1477	1001	待定
10	941	1336	1010	待定
11	941	1209	1011	待定
12	941	1477	1100	待定
13	697	1633	1101	待定
14	770	1633	1110	待定
15	852	1633	1111	待定
0	941	1633	0000	待定

表1中的空余状态，可以根据实际的需要对应答器可反馈的功能进行完善和丰富。

本实用新型应答器的C接口部分的功放子模块输出端输出的双音频信号的传输波形（如图8所示）的要求如下：

幅度（1K欧姆负载）：$8V_{pp} \le v_1 \le 15V_{pp}$；

频率精度：表1中频率的误差$\le 2\%$；

时间参数：$18ms \le t_1 \le 22ms$，$t_2 = 100ms - t_1$。

下面通过对在实际中的使用情况，对本实用新型实施例中的应答器作进一步说明：

(1)应答器与LEU正常

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此时工作正常，应答器发送双音频的0001比特信息，即697Hz和1209Hz信号；

(2)应答器与LEU正常通信，火车通过：

此时工作正常，应答器发出对8.82KHz的C6接口信号短路200us<t<350us，并发射双音频的1000比特信息，即852Hz和1336Hz信号；

(3)应答器与LEU无连接：

此时应答器的有源部分不工作，无双音频信号向LEU反馈；

(4)应答器与LEU有连接，A接口部分工作不正常：

此时应答器的作为C接口部分的应答器道旁电子设备接口单元工作正常，作为应答器车载设备通信接口单元的A接口部分没有产生FSK信号，即没有反馈信号给作为有源单元的C接口部分，应答器反馈比特0011，即697Hz和1477Hz信号；若A接口部分的第一主控制模块错误，与C接口部分的第二主控制模块的通信信号失常，应答器反馈比特0010，即697Hz和1336Hz信号。

(5)应答器与LEU有连接，C接口接分没有接收到DBPL信号达0.6ms：

此时应答器的无源部分工作（A接口部分），若没有产生FSK信号，应答器反馈比特0101，即770Hz和1336Hz信号。

综上所述，本实用新型实施例中通过在作为C接口部分的应答器道旁电子设备接口单元中增设应答器信息回送接口模块，并且该应答器信息回送接口单元采用双音频信号经功放放大后作为向LEU反馈应答器各种状态的反馈信号，这样利用不同频率信号组合的方式，不但保证了反馈信息的准确性，并且由于双音频信号的低频特性也保证了应答器可以用较小的功率（≤10mW）达到反馈至较远距离（反馈信号的传输距离一般可超过4km）的LEU的效果。

以上所述，仅为本实用新型较佳的具体实施方式，但本实用新型的保护范围并不局限于此，任何熟悉本技术领域的技术人员在本实用新型揭露的技术范围内，可轻易想到的变化或替换，都应涵盖在本实用新型的保护范围之内。因此，本实用新型的保护范围应该以权利要求的保护范围为准。

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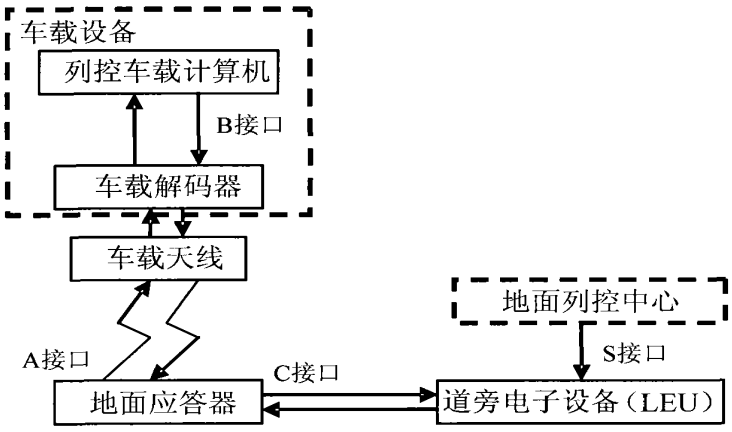


图1

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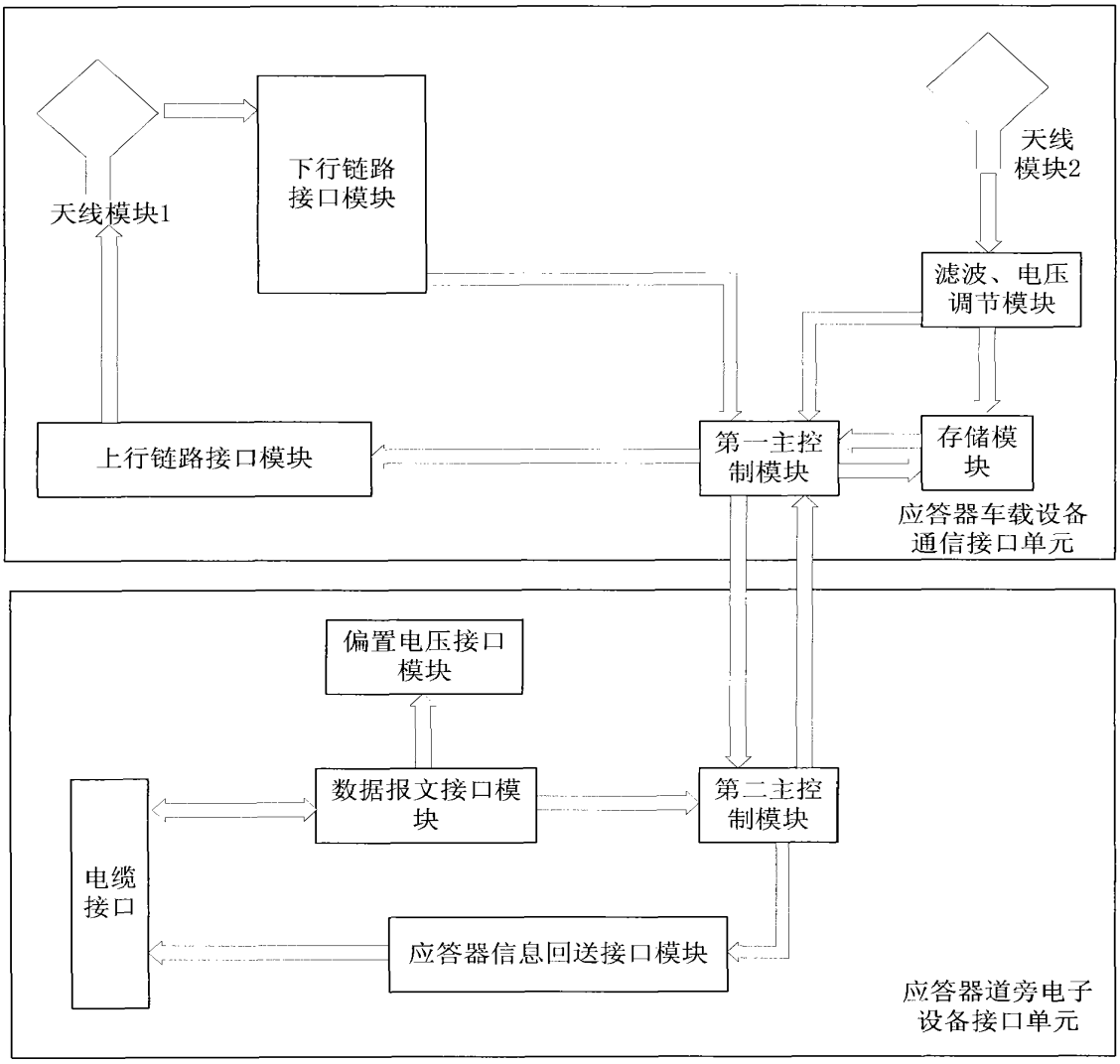


图2

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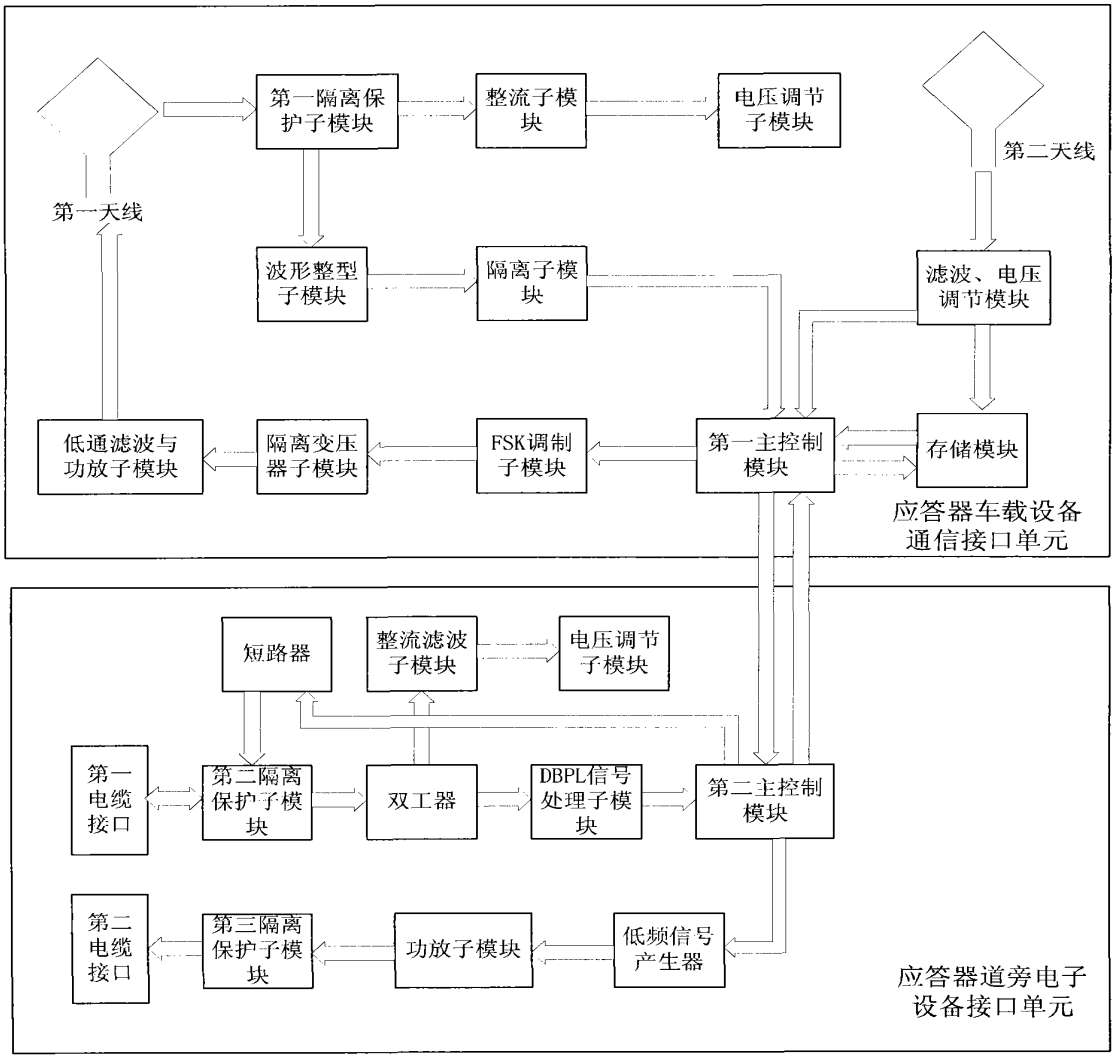

第一隔离保护子模块
整流子模块
电压调节子模块
第二天线
第一天线
波形整型子模块
隔离子模块
滤波、电压调节模块
低通滤波与功放子模块
隔离变压器子模块
FSK调制子模块
第一主控制模块
存储模块
应答器车载设备通信接口单元
短路器
整流滤波子模块
电压调节子模块
第一电缆接口
第二隔离保护子模块
双工器
DBPL信号处理子模块
第二主控制模块
第二电缆接口
第三隔离保护子模块
功放子模块
低频信号产生器
应答器道旁电子设备接口单元

图3

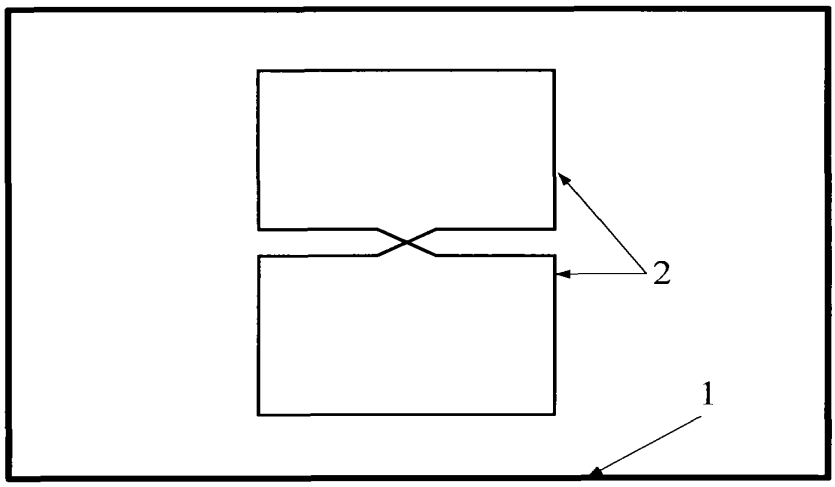


图4

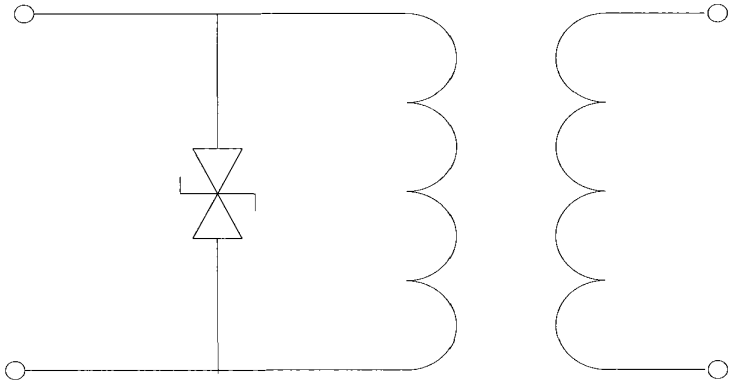


图5

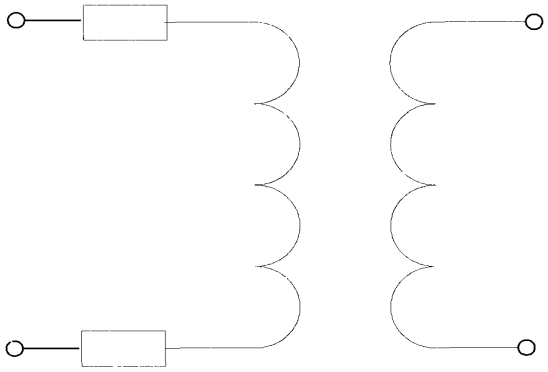


图6

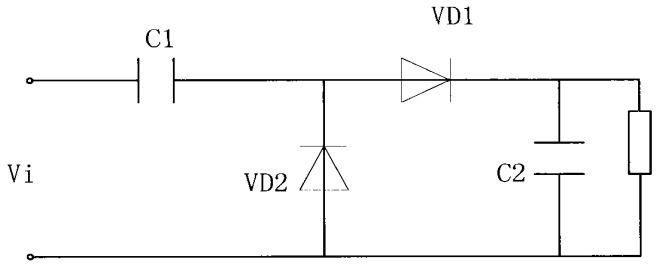


图7

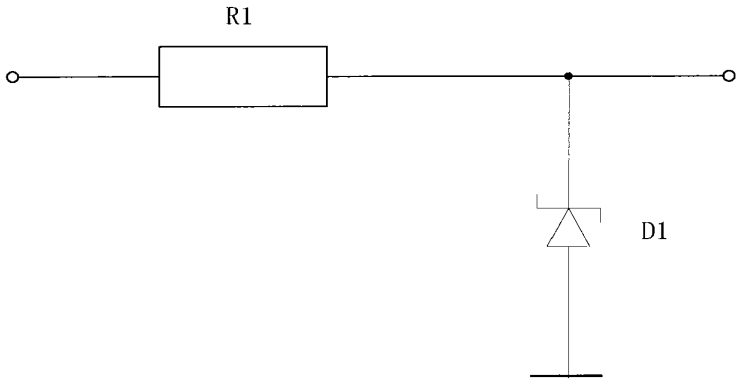


图8

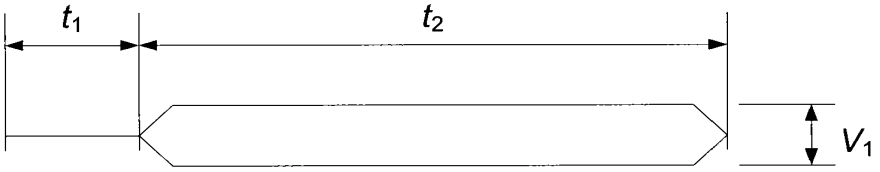


图9

Ex. 1002 - Page 452

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(54) SYSTEME ET METHODE SERVANT A ETABLIR UNE COMMUNICATION ENTRE UN DETECTEUR INSTALLE LE LONG D'UNE VOIE FERREE ET LA CABINE D'UNE LOCOMOTIVE

(54) SYSTEM AND METHOD FOR COMMUNICATING BETWEEN A RAILWAY WAYSIDE SYSTEM AND A LOCOMOTIVE CAB

(57)

A system and method of communicating via digital radio between a train and a device positioned at the wayside of a railway system, wherein the device detects defects at the wayside and information related to the defects is transmitted from the wayside to the train for display in the locomotive cab. A communications unit having a microprocessor control circuit and a transceiver is electrically coupled, preferably by serial connection, to the defect detector along the wayside. The transceiver of the communications unit is in radio communication with an existing transceiver in the head-of-train (HOT) unit located in the locomotive cab at the head-end of the train. The head-of-train unit has a microprocessor control circuit that drives a display which is preferably alphanumeric, for the purpose of displaying messages related to the defects detected by the defect detector at the wayside, and subsequently transmitted between the transceiver of the communications unit and the transceiver of the HOT unit. In a preferred embodiment, the HOT unit includes recording means for recording the messages displayed and an alarm for notifying an operator that a message is being displayed.

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(12) (19) (CA) **Brevet-Patent**

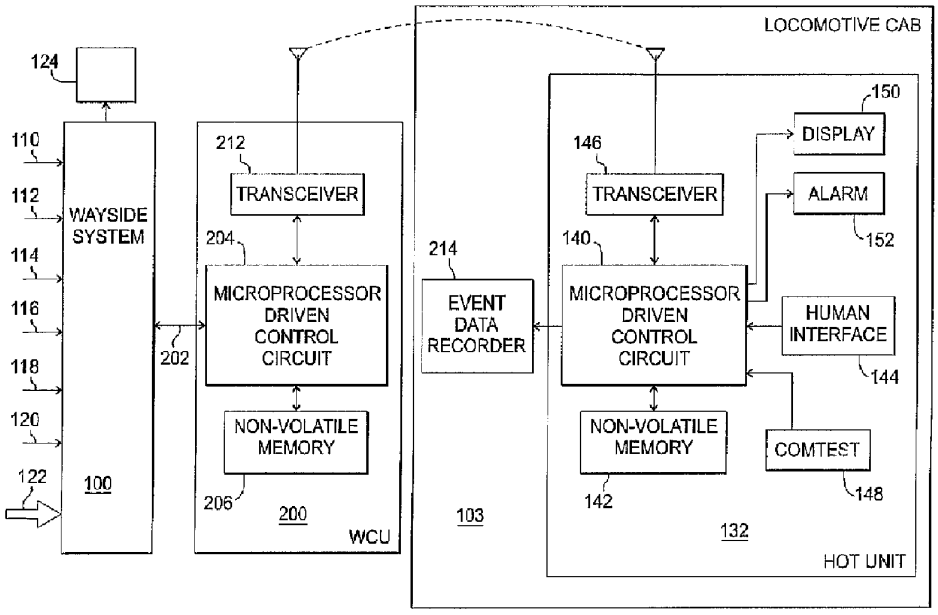
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(30) 1996/11/25 (756,322) US

(54) **SYSTEME ET METHODE SERVANT A ETABLIR UNE COMMUNICATION ENTRE UN DETECTEUR INSTALLE LE LONG D'UNE VOIE FERREE ET LA CABINE D'UNE LOCOMOTIVE**

(54) **SYSTEM AND METHOD FOR COMMUNICATING BETWEEN A RAILWAY WAYSIDE SYSTEM AND A LOCOMOTIVE CAB**



(57) L'invention est constituée par un système et une méthode de communication entre un train et un dispositif placé le long de la voie ferrée, ce dispositif servant à détecter les anomalies le long de la voie et à transmettre

(57) A system and method of communicating via digital radio between a train and a device positioned at the wayside of a railway system, wherein the device detects defects at the wayside and information related to the

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(45) 2000/01/11

au train une information connexe qui est affichée dans la cabine de la locomotive. Une unité de communication comportant un circuit de commande à microprocesseur et un émetteur-récepteur est couplée électriquement, de préférence par une connexion série, au détecteur d'anomalies le long de la voie. L'émetteur-récepteur de l'unité de communication est en communication radio avec un émetteur-récepteur faisant partie de l'unité de tête de train installée dans la cabine de la locomotive. Cette unité de tête de train comporte un circuit de commande à microprocesseur qui attaque un afficheur de préférence alphanumérique pour afficher des messages en rapport avec les anomalies détectées qui sont transmis à l'émetteur-récepteur de l'unité de tête de train par l'émetteur-récepteur de l'unité de communication. Dans la concrétisation privilégiée de l'invention, l'unité de tête de train comporte un dispositif d'enregistrement des messages affichés et un dispositif d'alerte servant à avertir l'opérateur qu'un message est affiché.

defects is transmitted from the wayside to the train for display in the locomotive cab. A communications unit having a microprocessor control circuit and a transceiver is electrically coupled, preferably by serial connection, to the defect detector along the wayside. The transceiver of the communications unit is in radio communication with an existing transceiver in the head-of-train (HOT) unit located in the locomotive cab at the head-end of the train. The head-of-train unit has a microprocessor control circuit that drives a display which is preferably alphanumeric, for the purpose of displaying messages related to the defects detected by the defect detector at the wayside, and subsequently transmitted between the transceiver of the communications unit and the transceiver of the HOT unit. In a preferred embodiment, the HOT unit includes recording means for recording the messages displayed and an alarm for notifying an operator that a message is being displayed.

Industrie Canada Industry Canada

ABSTRACT OF THE DISCLOSURE

A system and method of communicating via digital radio between a train and a device positioned at the wayside of a railway system, wherein the device detects defects at the wayside and information related to the defects is transmitted from the wayside to the train for display in the locomotive cab. A communications unit having a microprocessor control circuit and a transceiver is electrically coupled, preferably by serial connection, to the defect detector along the wayside. The transceiver of the communications unit is in radio communication with an existing transceiver in the head-of-train (HOT) unit located in the locomotive cab at the head-end of the train. The head-of-train unit has a microprocessor control circuit that drives a display which is preferably alphanumeric, for the purpose of displaying messages related to the defects detected by the defect detector at the wayside, and subsequently transmitted between the transceiver of the communications unit and the transceiver of the HOT unit. In a preferred embodiment, the HOT unit includes recording means for recording the messages displayed and an alarm for notifying an operator that a message is being displayed.

SYSTEM AND METHOD FOR COMMUNICATING BETWEEN A RAILWAY WAYSIDE SYSTEM AND A LOCOMOTIVE CAB

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to communications systems in the railway industry, and more particularly, to a system and method for communicating operational status information, such as a defect sensed by a wayside device, for display in the locomotive cab.

2. Description of the Related Art

In the related art, wayside systems are located along the track through the North American rail system. A wayside system may be defined as, for instance, a hot box detector, a hot wheel detector, a dragging equipment detector, a high water detector, a high/wide load detector, an automatic equipment identification system, a highway crossing system, an interlocking controller system, or any other equipment located adjacent the track and used to monitor the status of the track, environment and railway vehicles. These wayside systems are typically placed at approximately twenty mile intervals throughout the entire North American rail system. These wayside systems typically communicate

operational status information relating to the condition of the train or the track to control centers through various types of modems. In addition, these wayside systems typically communicate similar operational status information in the form of synthesized voice to the train crew in the locomotive cab via voice channel Very-High Frequency (VHF) radio. In the related art, the information has been communicated via voice channel VHF radio because adequate display systems in the locomotive cab have been unavailable. Since the wayside systems "talk" to train crews using VHF radios (typically 5 watts) on the road channel, a great deal of radio congestion is created. This radio congestion can result in a message being transmitted well after a train has passed the detector location, or the message being "walked on", thereby causing the train crew to not hear the message. In either case, the train crew may claim that a message to stop a train was not transmitted or received. This problem is very serious, especially when a train derails after the wayside system determines that a defect exists at the wayside or the train and then sends a stop message that the train does not respond to in a timely manner.

Not all messages transmitted from the wayside system to the train crew via voice channel VHF radio contain information concerning defective equipment. In fact, the majority of messages typically indicate that all systems are working correctly. However, the messages that indicate everything is working correctly contributes more to the problem of radio congestion than the minority of messages that contain defects. With more information being made available at the wayside locations, more information is required either in the cab, or at the control center. As additional information is transmitted, the problem of radio congestion increases. Further, messages from one wayside system may be received by a second train that is different than a first train for which the message was intended, thereby further increasing radio congestion.

Referring now to FIG. 1, there is shown a block diagram of a wayside system 100 in voice radio communication with a locomotive cab 103 in accordance with the prior art.

The wayside system 100 receives inputs relating to operational status information associated with the train and track wayside. For instance, the wayside system 100 typically receives a track circuit input 110, a hot box detector (HBD) input 112, a hot wheel detector (HWD) input 114, a dragging equipment detector (DED) input 116, a high wide load detector (HWLD) input 118 and an automatic equipment identification (AEI) input 120.

In addition, as is known in the art, the wayside system 100 may also receive wayside specific information 122 which comprises various inputs related to environmental and other conditions found at the specific wayside of the wayside system 100. For instance, the wayside specific information 122 may include inputs related to wind speed, temperature, slipped earth, or flood conditions.

The wayside system 100 communicates operational status information related to the inputs 110, 112, 114, 116, 118, 120, and 122 to a control center (not shown) through a data modem 124. In addition, a voice radio 126 typically is used as is known in the art to transmit synthesized voice messages relating to the inputs 110, 112, 114, 116, 118, 120, and 122 to be received by a voice radio 130 located in the locomotive cab 103.

As is known in the art, the locomotive cab 103 typically also includes a head-of-train (HOT) unit 132 that communicates with an end-of-train (EOT) unit (not shown), typically using Ultra-High Frequency (UHF) radio, as part of an end-of-train monitoring system (not shown) that is used as a means of eliminating the need for a caboose (not shown). The HOT unit 132 typically includes a microprocessor control circuit 140, a non-volatile memory 142 which stores the control program for the microprocessor control circuit, and a human interface 144 through which an operator stationed at the HOT unit 132 can manually enter the unique code number of the end of train (EOT) unit (not shown) with which the HOT unit 132 communicates via transceiver 146, typically using UHF radio. In addition to inputs from the non-volatile memory 142 and the human

interface 144, the microprocessor control circuit 140 typically also has a communication test (COMTEST) switch input 148 and provides outputs to the transceiver 146, a display 150, and an audible alarm 152. In a preferred embodiment, the HOT unit 132 records events displayed with an event data recorder 154 positioned at the locomotive cab 103, as is known in the art.

One solution to decreasing voice channel VHF radio congestion includes transmitting information obtained at the wayside detector to the dispatch center using a communication radio system such as ARES. This radio system was developed by Rockwell International, Inc. for controlling wayside devices from the dispatch center and for tracking the locomotive. After the dispatch center receives the information transmitted from the wayside system, the dispatch center would then transmit the message to the train crew. However, this solution adds an additional step between wayside and the locomotive cab, whereby additional time is used and additional errors could occur. In addition, this solution does not address the problem of the train crew not being able to hear a synthesized voice transmission of the message.

It is known from "Monitoring Cabooseless Trains" in *Railway Age*, March 1987, pp. 47-48, that the ATS&F (Santa Fe) Railroad worked with Colt Technology Corp. to develop a system specifically for displaying and printing train defect information in the locomotive. However, this system has been abandoned.

Consequently, a need exists for a system and method of communicating operational status information, including defects sensed by a wayside system, for display in the locomotive cab, wherein communication of the information using voice channel VHF radio may be eliminated, and wherein the communicated information may be acknowledged at the locomotive cab and recorded for subsequent review and analysis.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a system and method for communicating operational status information, including defects sensed by a wayside system, for display in the locomotive cab, that eliminates the use of voice channel VHF radio.

It is a feature of the present invention to provide a wayside communications unit that receives electronic input from the wayside system and then transmits digital information from a first transceiver located at the wayside communications unit, to be received by a second transceiver that is typically used for UHF communication between the HOT unit located at the locomotive cab and the EOT unit located at the end of the train.

It is a feature of the present invention to display a message related to status information received from the first transceiver located at the wayside system by the second transceiver for the HOT unit located at the locomotive cab, using an alphanumeric display for the HOT unit.

It is a feature of the present invention to retain the message related to status information for alphanumeric display at the locomotive cab for convenient reference.

It is a further feature of the present invention to transmit an acknowledgment message from the locomotive cab to the wayside communications unit after the operator's acknowledgment at the locomotive cab.

A preferred embodiment of the present invention is a wayside communications unit having a first microprocessor control circuit and a transceiver with related circuitry for transmitting and receiving digital information. The wayside communications unit is electrically coupled to the wayside defect detector, preferably with a serial connection, thereby to receive information relating to defects detected by the wayside defect detector. The information is processed and formatted according to a preferred protocol for

transmission by the transceiver in order to be received by a second transceiver located in the head of train (HOT) unit.

Briefly described according to another embodiment of the present invention, a communication system is provided for communicating between a first railway apparatus positioned at a railway wayside location and a second railway apparatus positioned at a second location which is different than the railway wayside location, wherein the communication system comprises: a wayside system positioned at the railway wayside location for sensing a wayside condition and determining an operational status output signal that characterizes the wayside condition; a first communications unit positioned at the wayside system and electrically coupled to the wayside system for generating a digital transmission signal that is responsive to the operational status output signal, the first communications unit comprising first microprocessor means for controlling the first communications unit, and transmitting means for transmitting the digital transmission signal; and a second communications unit positioned at the second location, the second communications unit comprising first microprocessor means for controlling the second communications unit, receiving means in communication with the transmitting means, for receiving the digital transmission signal from the transmitting means, and display means for displaying a message that is responsive to the digital transmission signal.

An advantage of the present invention is that radio congestion on the voice channel VHF radio is avoided.

An additional advantage of the present invention is that communication via voice channel VHF radio is avoided, thereby decreasing potential interference to other wayside systems that use the same voice channel.

Another advantage of the present invention is that the message is continuously displayed or available for display until acknowledged, thereby minimizing the possibility of an operator not receiving the message.

Another advantage of the present invention is that the message may be re-transmitted from the wayside until acknowledged at the appropriate train for which the message was intended, thereby minimizing loss of the message due to radio interference.

Another advantage of the present invention is that the message may be transmitted economically to an already existing locomotive transceiver.

An additional advantage of the present invention is that the digital information relating to the operational status input and the operator's knowledge thereof may be recorded for later review.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and features of the present invention will become better understood with reference to the following more detailed description and claims taken in conjunction with the accompanying drawings, in which like elements are identified with like symbols, and in which:

FIG. 1 is a block diagram showing the major component parts of a wayside defect detector and associated head of train unit that uses voice radio communication in accordance with the prior art;

FIG. 2 is a block diagram showing the major component parts of the communications system in accordance with a preferred embodiment of the present invention;

FIG. 3 is a flow diagram showing the logic of the software run by the wayside communications unit microprocessor to provide a method of communication between the wayside communications unit and the locomotive cab, in accordance with a preferred embodiment of the present invention; and

FIG. 4 is a flow diagram showing the logic of the software run by the head-of-train unit microprocessor to provide a method of communication between the wayside communications unit and the locomotive cab, in accordance with a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

1. Detailed Description of the Figures

Referring to FIG. 2, a wayside communications unit (WCU) 200 is shown electrically coupled to the wayside system 100 and in digital radio communication with the HOT unit 132 in accordance with a preferred embodiment of the present invention. The WCU 200 is shown electrically coupled to the wayside system 100 of the prior art, preferably with a bi-directional serial cable 202, such as an RS-232 connector, for instance, thereby to relay data therethrough in the manner known in the art. In a preferred embodiment, port settings for the serial port cable 202 are 9600 baud, 8 bits per character, no parity. In another preferred embodiment, port settings of the serial port cable 202 are 1200 baud, 8 bits per character, even parity. One skilled in the art will recognize the port settings and hardware that are required for the WCU 200 to be compatible with varying embodiments of the wayside system 100.

The WCU 200 includes a microprocessor control circuit 204, and a non-volatile memory 206 which stores the control program for the microprocessor control circuit 204. The microprocessor control circuit 204 provides outputs to and receives inputs from a transceiver 212. The transceiver 212 transmits digital information to the transceiver 146 which is also used by the HOT unit for communication with the EOT unit. The transceiver 146 provides inputs to the microprocessor control circuit 140 which formats the inputs for display on the display 150. In accordance with a preferred embodiment of the present invention, the display 150 may be an alphanumeric display, for example. In

addition, input to the alarm 152 from the microprocessor control circuit at the time of activating the display 150 with the message processed from the transceiver 146 may be provided by the microprocessor control circuit 140, thereby to alert the operator that a message is being displayed. In a preferred embodiment input to an event data recorder 214 is provided by the microprocessor control circuit at the time of activating the display 150, thereby to record the message displayed at the display 150 for subsequent review and analysis, and to record the interaction of the operator due to the message displayed.

FIG. 3 is a flow diagram showing the logic of the software implemented on the WCU microprocessor control circuit 204 to provide a method of communication between the WCU 200 and the locomotive cab 103 in accordance with a preferred embodiment of the present invention. Starting with decision block 305, when a status input is detected by the wayside system 100 and conveyed to the microprocessor control circuit 204, the status input is processed in function block 310 by the microprocessor control circuit 204 for subsequent transmission as a wayside digital radio signal. In function block 315, the processed wayside digital radio signal is transmitted by the transceiver 212, and a software timer is started in function block 320. While the software timer is running, a check is made in decision block 325 to determine if an acknowledgment message has been received by the transceiver 212, thereby to determine if a status message related to the transmitted wayside digital radio signal was displayed by the operator (not shown) in the locomotive cab 103. If the acknowledgment message was received, the process is complete. If the acknowledgment message was not received, a further check is made in decision block 330 to determine if the timer has timed out. If so, the process loops back to function block 315 to re-transmit the processed wayside digital radio signal by the transceiver 212, in the event that the wayside digital radio signal was not previously received by the transceiver 146 at the HOT unit 132. In a preferred embodiment, a software counter may be implemented as known in the art, thereby to return the process

to the function block 315 from the decision block 330 only a predetermined number of times. In decision block 330, if the timer has not timed out, then the process loops back to decision block 325.

FIG. 4 is a flow diagram showing the logic of the software implemented on the HOT microprocessor control circuit 140 to provide a method of communication between the WCU 200 and the locomotive cab 103 in accordance with a preferred embodiment of the present invention. Starting with decision block 405, when the wayside digital radio signal that was transmitted by the transceiver 212 is received by the transceiver 146 at the HOT unit 132, the wayside digital radio signal is processed in function block 410 by the microprocessor control circuit 140 for subsequent display as a status message. In function block 412, the status message is recorded, preferably at the event data recorder 214. In decision block 414, a check is made to determine whether the alarm 152, typically audible or visual, for instance, should be actuated to alert the operator at the locomotive cab 103 that a status message is available for display. If so, in function block 416, the alarm 152 is actuated to notify the operator to view the status message, and then the process proceeds to decision block 420. However, if no alarm is necessary, typically due to lack of relative importance of the status message, the process proceeds directly to decision block 420 from decision block 414.

In decision block 420, a check is made to determine if a status message acknowledgment from the operator was detected, preferably by the operator activating a switch (not shown) at the human interface 142. If not, the process loops back to decision block 420, thereby holding the status message ready for display. In function block 425, when the operator acknowledges the status message, the message is displayed at the display 150. A check is then made in decision block 430 to determine whether the alarm 152 was actuated for the status message. If so, a check is made in decision block 435 to determine whether the operator acknowledges, preferably by the operator activating a

switch (not shown) at the human interface 142, that the status message displayed at the display 150 was intended for the locomotive cab 103 that is occupied by the operator. If so, in function block 440, the transceiver 146 transmits the acknowledgment message, preferably as a digital radio signal, that is being anticipated by the WCU 200 in decision block 325 of FIG. 3, and the process ends. In a preferred embodiment, the acknowledgment message is also recorded at the event data recorder 214 in a manner similar to function block 412 wherein the status message was recorded. If the determination in decision block 430 is that the alarm 152 was not actuated for the status message, the process ends with no transmission by the transceiver 146. Similarly, if the determination in decision block 435 is that the operator does not acknowledge that the status message was intended for the operator's locomotive cab 103, the process ends with no transmission by the transceiver 146

Thus there has been described a system and method of communicating operational status information such as defects sensed by a wayside sensor from a wayside system to a locomotive cab, for display in the head-of-train unit of the locomotive cab, wherein the operational status information is transmitted and acknowledged via digital radio from the wayside system to the HOT unit positioned at the locomotive cab, thereby eliminating the need for synthesized voice transmission of the message via the voice channel VHF radio presently used in the prior art. One skilled in the art will recognize that this system and method of communicating operational status information such as defects sensed by a wayside sensor may also be used for communicating the status of a highway crossing analyzer, which status may then be communicated to a train in advance of the train approaching a highway crossing system that is malfunctioning.

The foregoing description of the preferred embodiment of the present invention has been presented for purposes of illustration and description. It is not intended to be

exhaustive or to limit the present invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teachings.

The preferred embodiment was chosen and described in order to best explain the principles of the present invention and its practical application to those persons skilled in the art, and thereby to enable those persons skilled in the art to best utilize the present invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the present invention be broadly defined by the claims which follow.

CLAIMS

What is claimed is:

1. A communication system for communicating between a railway wayside system and a railway locomotive cab positioned at the head-end of a train, wherein the communication system comprises:

a wayside system for sensing a wayside condition and determining an operational status output signal that characterizes said wayside condition;

a wayside communications unit positioned at said wayside system and electrically coupled to said wayside system for generating a digital transmission signal that is responsive to said operational status output signal, said wayside communications unit comprising first microprocessor means for controlling said wayside communications unit, and transmitting means for transmitting said digital transmission signal;

a head of train (HOT) unit positioned at the railway locomotive cab, said head of train (HOT) unit comprising first microprocessor means for controlling said HOT unit, receiving means in radio communication with said transmitting means, for receiving said digital transmission signal from said transmitting means, and display means for displaying a message that is responsive to said digital transmission signal.

2. The communication system in accordance with claim 1, further comprising:

recording means positioned at the railway locomotive cab, for recording said digital transmission signal.

3. The communication system in accordance with claim 1, wherein said transmission means is a radio transmitter.

4. The communication system in accordance with claim 1, wherein said transmission means is a first radio transceiver.

5. The communication system in accordance with claim 3, wherein said receiving means is a radio receiver.

6. The communication system in accordance with claim 4, wherein said receiving means is a second radio transceiver.

7. The communication system in accordance with claim 6, wherein said second radio transceiver transmits an acknowledgment signal after said message is displayed, and said first radio transceiver receives said acknowledgment signal.

8. The communication system in accordance with claim 1, further comprising:

alarm means for actuating an alarm at the locomotive cab to notify an operator to view said message.

9. The communication system in accordance with claim 2, further comprising:

alarm means for actuating an alarm at the locomotive cab to notify an operator to view said message.

10. The communication system in accordance with claim 1, further comprising:

interface means for receiving a control input from an operator.

11. A communication system for communicating between a railway wayside system and a railway vehicle, wherein the communication system comprises:

a wayside system for sensing a wayside condition and determining an operational status output signal that characterizes said wayside condition;

a first communications unit positioned at said wayside system and electrically coupled to said wayside system for generating a digital transmission signal that is responsive to said operational status output signal, said first communications unit comprising first microprocessor means for controlling said first communications unit, and transmitting means for transmitting said digital transmission signal; and

a second communications unit positioned at the railway vehicle, said second communications unit comprising first microprocessor means for controlling said second communications unit, receiving means in communication with said transmitting means, for receiving said digital transmission signal from said transmitting means, and display means for displaying a message that is responsive to said digital transmission signal.

12. The communication system in accordance with claim 11, further comprising:

recording means positioned at the railway vehicle, for recording said digital transmission signal.

13. The communication system in accordance with claim 11, wherein said transmission means is a radio transmitter.

14. The communication system in accordance with claim 11, wherein said transmission means is a first radio transceiver.

15. The communication system in accordance with claim 13, wherein said receiving means is a radio receiver.

16. The communication system in accordance with claim 14, wherein said receiving means is a second radio transceiver.

17. The communication system in accordance with claim 16, wherein said second radio transceiver transmits an acknowledgment signal after said message is displayed, and said first radio transceiver receives said acknowledgment signal.

18. The communication system in accordance with claim 11, further comprising:

alarm means for actuating an alarm at the railway vehicle to notify an operator to view said message.

19. The communication system in accordance with claim 12, further comprising:

alarm means for actuating an alarm at the railway vehicle to notify an operator to view said message.

20. The communication system in accordance with claim 11, further comprising:

interface means for receiving a control input from an operator.

21. A communication system for communicating between a first railway apparatus positioned at a railway wayside location and a second railway apparatus positioned at a second location which is different than the railway wayside location, wherein the communication system comprises:

a wayside system positioned at the railway wayside location for sensing a wayside condition and determining an operational status output signal that characterizes said wayside condition;

a first communications unit positioned at said wayside system and electrically coupled to said wayside system for generating a digital transmission signal that is responsive to said operational status output signal, said first communications unit comprising first microprocessor means for controlling said first communications unit, and transmitting means for transmitting said digital transmission signal; and

a second communications unit positioned at the second location, said second communications unit comprising first microprocessor means for controlling said second communications unit, receiving means in communication with said transmitting means, for receiving said digital transmission signal from said transmitting means, and display means for displaying a message that is responsive to said digital transmission signal.

22. The communication system in accordance with claim 21, further comprising:

recording means positioned at the second location, for recording said digital transmission signal.

23. The communication system in accordance with claim 21, wherein said transmission means is a radio transmitter.

24. The communication system in accordance with claim 21, wherein said transmission means is a first radio transceiver.

25. The communication system in accordance with claim 23, wherein said receiving means is a radio receiver.

26. The communication system in accordance with claim 24, wherein said receiving means is a second radio transceiver.

27. The communication system in accordance with claim 26, wherein said second radio transceiver transmits an acknowledgment signal after said message is displayed, and said first radio transceiver receives said acknowledgment signal.

28. The communication system in accordance with claim 21, further comprising:

alarm means for actuating an alarm at the second location to notify an operator to view said message.

29. The communication system in accordance with claim 22, further comprising:

alarm means for actuating an alarm at the second location to notify an operator to view said message.

30. The communication system in accordance with claim 21, further comprising:

interface means for receiving a control input from an operator.

31. A system for communicating between a railway wayside system and a railway locomotive cab positioned at the head-end of a train, wherein the system comprises:

wayside receiving means for receiving at a wayside system an operational status input signal;

wayside transmission means for transmitting a first digital radio signal from the wayside system, whereby said first digital radio signal characterizes said operational status input signal;

cab receiving means receiving said first digital radio signal at the locomotive cab;

cab processing means for providing a status message that characterizes said first digital radio signal received at the locomotive cab, to be viewed by an operator at the locomotive cab; and

display means for displaying said status message at the locomotive cab when an acknowledgment of said status message by said operator is detected.

32. The system in accordance with claim 31, further comprising:

alarm means for actuating an alarm to notify said operator to view said status message.

33. The system in accordance with claim 31, further comprising:

recording means for recording at the locomotive cab said status message provided at the locomotive cab.

34. The system in accordance with claim 33, wherein said recording means further records at the locomotive cab said status message provided at the locomotive cab after said operator acknowledges said status message.

35. The system in accordance with claim 31, further comprising:

alarm means for actuating an alarm at the locomotive cab to notify said operator to view said status message;

recording means for recording at the locomotive cab an alarm message characterizing said alarm actuated at the locomotive cab, and for recording said status message provided at the locomotive cab.

36. The system in accordance with claim 35, wherein said recording means further records said status message displayed after said operator acknowledges said status message.

37. The system in accordance with claim 31, further comprising:

cab transmission means for transmitting a second digital radio signal from the locomotive cab, whereby said second digital radio signal characterizes said acknowledgment by said operator of said status message; and

wayside receiving means for receiving said second digital radio signal at the wayside system.

38. The communication system in accordance with claim 31, further comprising:

interface means for receiving a control input from an operator.

39. The communication system in accordance with claim 1, wherein said display means is an alphanumeric display.

40. The communication system in accordance with claim 1, wherein said display means is a computer display.

41. A communication system for communicating between a railway wayside system and a railway locomotive cab positioned at the head-end of a train, wherein the system comprises:

a head of train unit positioned at the locomotive cab, said head of train unit comprising a first transceiver and a display unit, said head of train unit being controlled by a first microprocessor;

a wayside system for receiving status inputs sensed at the wayside;

a wayside communications unit positioned at said wayside system and electrically coupled to said wayside system for generating a digital signal that characterizes said status input, said wayside communications unit comprising a second transceiver in radio communication with said first transceiver and a second microprocessor which controls said second transceiver, wherein said second microprocessor receives data from said wayside defect detector to be transmitted by said second transceiver to said first transceiver for display as a message at said display unit.

42. The communication system in accordance with claim 41, further comprising:

recording means driven by said first microprocessor for recording said message displayed at said display unit.

43. The communication system in accordance with claim 41, further comprising:

interface means at the locomotive cab for receiving a control input from an operator.

44. The communication system in accordance with claim 7, wherein said display means is an alphanumeric display.

45. The communication system in accordance with claim 7, wherein said display means is a computer display.

46. The communication system in accordance with claim 2, wherein said recording means is a railway event data recorder.

47. The communication system in accordance with claim 8, wherein said alarm is audible.

48. The communication system in accordance with claim 9, wherein said alarm is audible.

49. The communication system in accordance with claim 8, wherein said alarm is visible.

50. The communication system in accordance with claim 9, wherein said alarm is visible.

51. A method of communicating between a railway wayside system and a railway locomotive cab positioned at the head-end of a train, wherein the method comprises the steps of:

(a) receiving at a wayside system an operational status input signal;

(b) transmitting a first digital radio signal from the wayside system, whereby said first digital radio signal characterizes said operational status input signal;

(c) receiving said first digital radio signal at the locomotive cab;

(d) providing a status message that characterizes said first digital radio signal received at the locomotive cab, to be viewed by an operator at the locomotive cab; and

(e) displaying said status message at the locomotive cab when an acknowledgment of said status message by said operator is detected.

52. The method in accordance with claim 51, further comprising the step between steps (d) and (e) of:

(f) actuating an alarm to notify said operator to view said status message.

53. The method in accordance with claim 51, further comprising the step between steps (d) and (e) of:

(f) recording at the locomotive cab said status message provided at the locomotive cab.

54. The method in accordance with claim 53, further comprising the step of:

(g) receiving at the locomotive cab an acknowledgment message from said operator acknowledging said status message.

55. The method in accordance with claim 54, further comprising the step of:

(h) transmitting a second digital radio signal from the locomotive cab, whereby said second digital radio signal characterizes said acknowledgment message.

56. The method in accordance with claim 55, further comprising the step of:

(h) recording at the locomotive cab said operator acknowledging said status message.

57. The method in accordance with claim 51, further comprising the step between steps (d) and (e) of:

(f) actuating an alarm at the locomotive cab to notify said operator to view said status message;

(g) recording at the locomotive cab said alarm actuated at the locomotive cab; and

(h) recording at the locomotive cab said status message provided at the locomotive cab.

58. The method in accordance with claim 57, further comprising the step of:

(i) recording said status message displayed after said operator acknowledges said status message.

59. The method in accordance with claim 51, further comprising the steps of:

(f) transmitting a second digital radio signal from the locomotive cab, whereby said second digital radio signal characterizes said acknowledgment by said operator of said status message; and

(g) receiving said second digital radio signal at the wayside system.

60. The communication system in accordance with claim 17, wherein said display means is an alphanumeric display.

61. The communication system in accordance with claim 11, wherein said display means is an alphanumeric display.

62. The communication system in accordance with claim 17, wherein said display means is a computer display.

63. The communication system in accordance with claim 11, wherein said display means is a computer display.

64. The communication system in accordance with claim 12, wherein said recording means is a railway event data recorder.

65. The communication system in accordance with claim 18, wherein said alarm is audible.

66. The communication system in accordance with claim 19, wherein said alarm is audible.

67. The communication system in accordance with claim 18, wherein said alarm is visible.

68. The communication system in accordance with claim 19, wherein said alarm is visible.

69. The communication system in accordance with claim 27, wherein said display means is an alphanumeric display.

70. The communication system in accordance with claim 21, wherein said display means is an alphanumeric display.

71. The communication system in accordance with claim 27, wherein said display means is a computer display.

72. The communication system in accordance with claim 21, wherein said display means is a computer display.

73. The communication system in accordance with claim 22, wherein said recording means is a railway event data recorder.

74. The communication system in accordance with claim 28, wherein said alarm is audible.

75. The communication system in accordance with claim 29, wherein said alarm is audible.

76. The communication system in accordance with claim 28, wherein said alarm is visible.

77. The communication system in accordance with claim 29, wherein said alarm is visible.

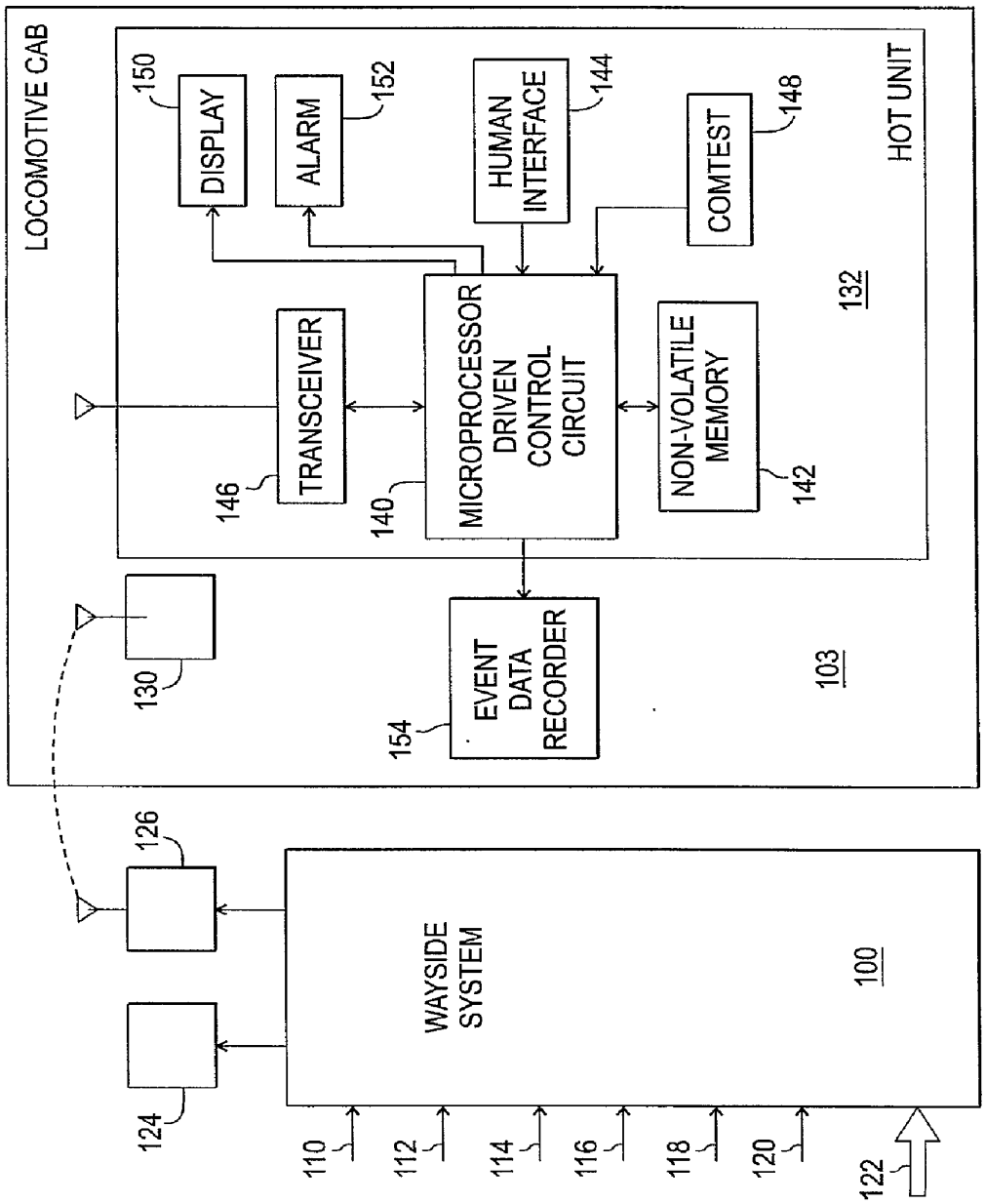


Fig. 1
(Prior Art)

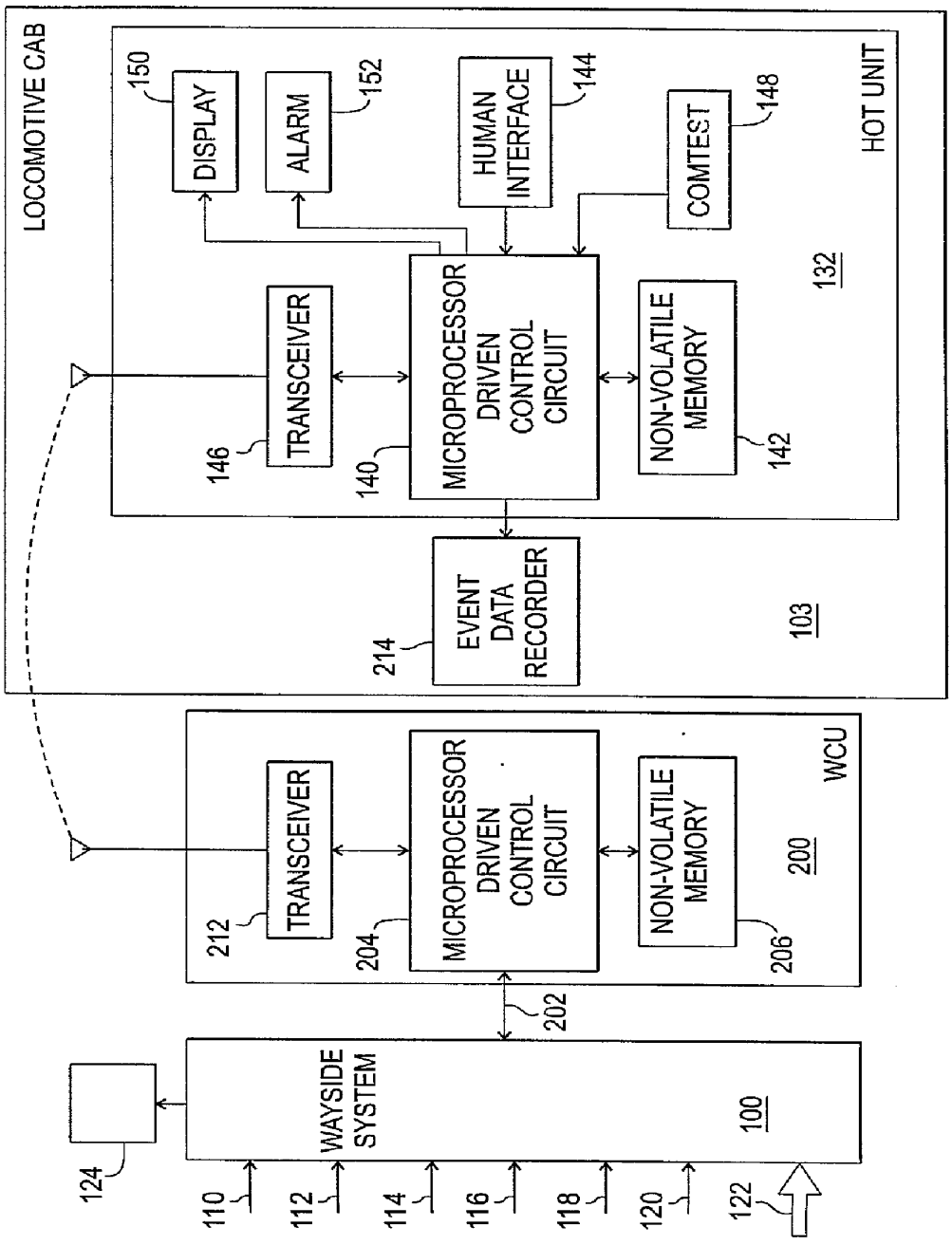

LOCOMOTIVE CAB
HOT UNIT
DISPLAY
150
ALARM
152
HUMAN INTERFACE
144
COMTEST
148
TRANSCEIVER
146
MICROPROCESSOR DRIVEN CONTROL CIRCUIT
140
NON-VOLATILE MEMORY
142
132
EVENT DATA RECORDER
214
103
WCU
TRANSCEIVER
212
MICROPROCESSOR DRIVEN CONTROL CIRCUIT
204
NON-VOLATILE MEMORY
206
200
202
WAYSIDE SYSTEM
100
124
110
112
114
116
118
120
122

Fig. 2

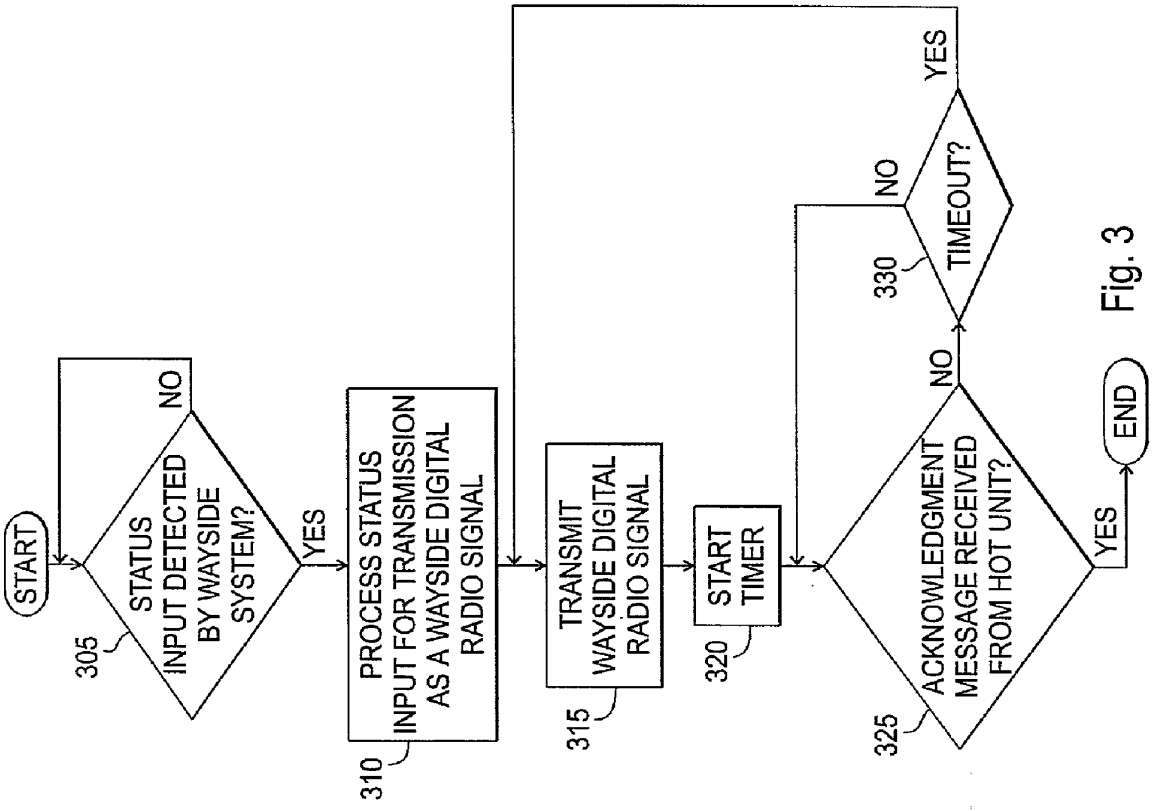

START
STATUS INPUT DETECTED BY WAYSIDE SYSTEM?
NO
YES
305
PROCESS STATUS INPUT FOR TRANSMISSION AS A WAYSIDE DIGITAL RADIO SIGNAL
310
TRANSMIT WAYSIDE DIGITAL RADIO SIGNAL
315
START TIMER
320
ACKNOWLEDGMENT MESSAGE RECEIVED FROM HOT UNIT?
NO
YES
325
TIMEOUT?
NO
YES
330
END

Fig. 3

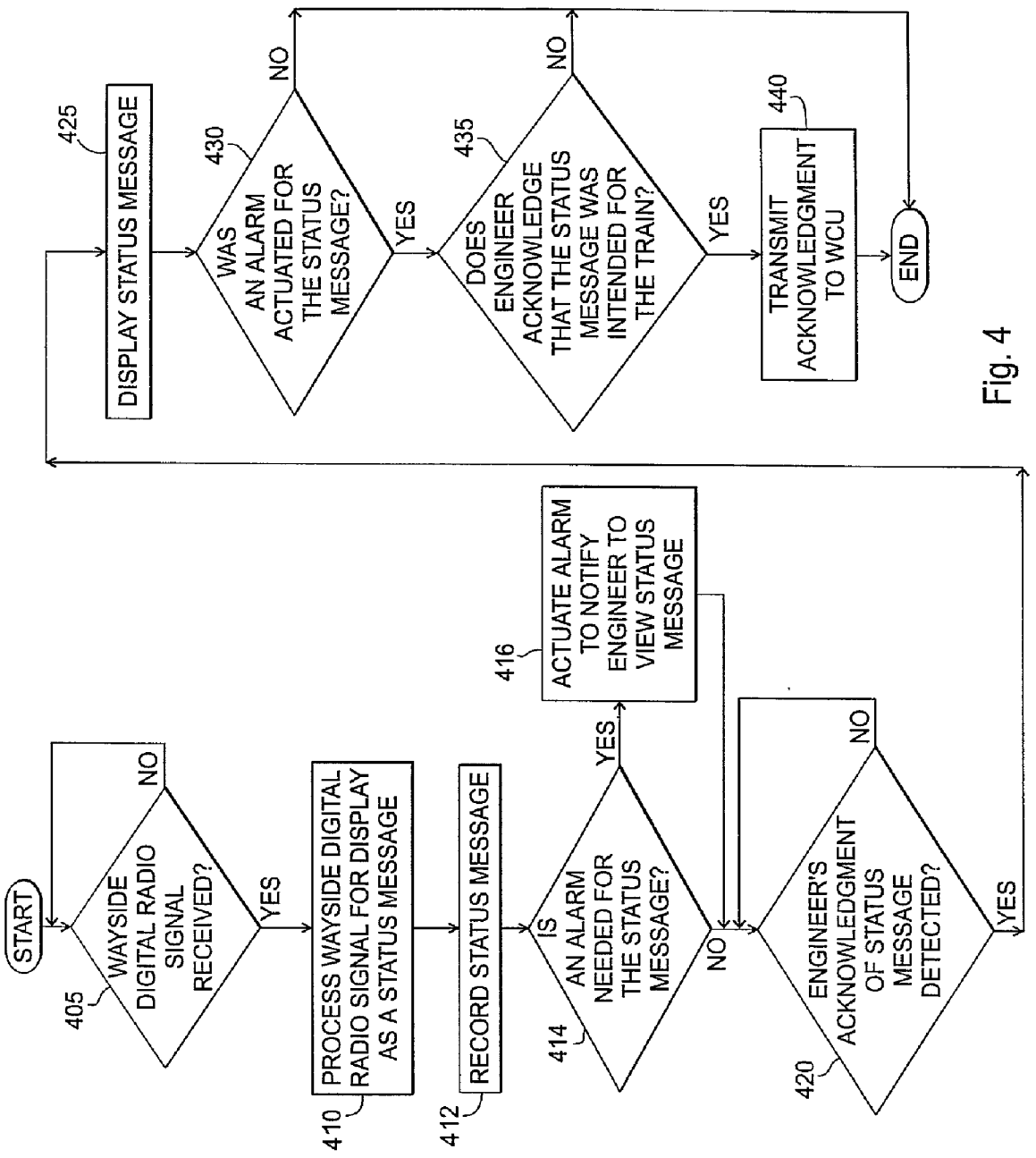

START
WAYSIDE DIGITAL RADIO SIGNAL RECEIVED?
405
NO
YES
PROCESS WAYSIDE DIGITAL RADIO SIGNAL FOR DISPLAY AS A STATUS MESSAGE
410
RECORD STATUS MESSAGE
412
IS AN ALARM NEEDED FOR THE STATUS MESSAGE?
414
YES
NO
ACTUATE ALARM TO NOTIFY ENGINEER TO VIEW STATUS MESSAGE
416
ENGINEER'S ACKNOWLEDGMENT OF STATUS MESSAGE DETECTED?
420
NO
YES
DISPLAY STATUS MESSAGE
425
WAS AN ALARM ACTUATED FOR THE STATUS MESSAGE?
430
NO
YES
DOES ENGINEER ACKNOWLEDGE THAT THE STATUS MESSAGE WAS INTENDED FOR THE TRAIN?
435
NO
YES
TRANSMIT ACKNOWLEDGMENT TO WCU
440
END

Fig. 4

Espacenet

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RAILROAD WAYSIDE INFORMATION TRANSMISSION SYSTEM

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Applicant(s): RAILWAY TECHNICAL RES INST

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- cooperative:

Application number: JP20060099260 20060331 Global Dossier

Priority number(s): JP20060099260 20060331

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Abstract of JP2007269245 (A)

PROBLEM TO BE SOLVED: To provide a system for transmitting railroad wayside information on a pin-point basis and a real time basis by grasping the traveling position of a train when transmitting railroad wayside information such as degradation of the meteorological state and occurrence of a disaster. ;SOLUTION: The system comprises an on-vehicle equipment mounted on a train, and a railroad wayside monitoring equipment for transmitting railroad wayside information obtained by monitoring the state of a railroad wayside. The on-vehicle equipment includes an on-vehicle storage unit for storing train position information or the like, an on-vehicle transmission-reception unit for performing the radio communication to/from the railroad wayside monitoring equipment, and an on-vehicle control unit for instructing the communication to the on-vehicle transmission-reception unit,; and performs the control that the on-vehicle control unit and the railroad wayside monitoring control unit establish the communication between the on-vehicle transmission-reception unit and the railroad wayside monitoring transmission-reception unit when the on-vehicle equipment and the railroad wayside monitor equipment are brought close to each other within a predetermined distance based on the train position information stored in the on-vehicle storage unit and the monitoring equipment position information stored in the railroad wayside monitoring storage unit. ;COPYRIGHT: (C)2008,JPO&INPIT

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最終頁に続く

(54)【発明の名称】鉄道沿線情報伝送システム

(57)【特許請求の範囲】

【請求項1】

列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器とからなる鉄道沿線情報伝送システムであって、

前記車上機器には、

前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、

前記沿線監視機器と無線通信を行う車上送受信部と、

前記車上記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、

前記沿線監視機器には、

前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、

前記車上機器と無線通信を行う沿線監視送受信部と、

前記沿線監視記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、

前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記沿線監視記憶部に記憶された前記沿線監視機器の監視機器位置情報とに基づいて、前記車上機器と前記沿線監視機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記沿線監視制御部とが前記車上送受信部と前記沿線監視送受信部との間の通信を確立する制御を行い、

前記沿線監視機器と前記車上機器との通信が確立されている列車同士が、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、車上機器同士での通信に切り替える制御を行う、
鉄道沿線情報伝送システム。
【請求項2】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、
前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記車上記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記沿線監視記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記沿線監視記憶部に記憶された前記沿線監視機器の監視機器位置情報とに基づいて、前記車上機器と前記沿線監視機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記沿線監視制御部とが前記車上送受信部と前記沿線監視送受信部との間の通信を確立する制御を行い、
前記沿線監視機器と前記車上機器との通信が確立されている列車と前記沿線監視機器と前記車上機器との通信が確立されていない列車とが、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、通信が確立されて前記沿線情報を受信した車上機器から通信が確立されていない車上機器に前記沿線情報を送信する制御を行う、
鉄道沿線情報伝送システム。
【請求項3】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、
前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記車上記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記沿線監視記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記沿線監視記憶部に記憶された前記沿線監視機器の監視機器位置情報とに基づいて、前記車上機器と前記沿線監視機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記沿線監視制御部とが前記車上送受信部と前記沿線監視送受信部との間の通信を確立する制御を行い、
前記沿線監視機器と前記車上機器との通信が確立されていない列車同士が、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の

車上機器の車上制御部が、前記車上記憶部に格納した前記沿線情報をすれ違う相手側列車の車上機器に送信する制御を行う、
鉄道沿線情報伝送システム。
【請求項4】
前記沿線監視機器は、前記沿線監視送受信部を通じて定期的に前記沿線監視機器の監視機器位置情報を送信し、
前記車上機器は前記車上送受信部を通じて前記沿線監視機器の監視機器位置情報を受信した場合に、前記車上制御部が、前記車上送受信部が受信した前記沿線監視機器の監視機器位置情報と前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と比較して予め定められた所定の距離以内に接近したと判断した場合に、前記車上機器が前記沿線情報を受信する、請求項１から請求項３のいずれかに記載の鉄道沿線情報伝送システム。
【請求項5】
前記車上機器と通信回線を介して接続され、所定領域内を走行する列車を監視する中央監視装置を含み、
列車ダイヤ情報が変動を生じた場合に、前記車上機器に現時点での最新の列車ダイヤ情報を送信する、請求項１から請求項４のいずれかに記載の鉄道沿線情報伝送システム。
【請求項6】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器と、前記沿線監視機器からの送信情報を中継する中継機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、
前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記中継機器には、
前記中継機器の中継機器位置情報を記憶する中継記憶部と、
前記車上機器及び前記沿線監視機器と無線通信を行う中継送受信部と、
前記中継記憶部に記憶された情報に基づいて、前記中継送受信部に通信を指示する中継制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記中継記憶部に記憶された前記中継機器の中継機器位置情報とに基づいて、前記車上機器と前記中継機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記中継機器とが前記車上送受信部と前記中継送受信部との間の通信を確立する制御を行い、前記中継送受信部は前記沿線監視機器から得られた沿線情報を中継し、
前記車上送受信部が受信した前記中継機器の中継機器位置情報と、前記車上記憶部に記憶された列車の現在位置の列車位置情報とに基づいて、前記車上制御部が前記中継機器を通り過ぎたと判断した場合には前記沿線監視機器との通信に切り替える制御を行う、
鉄道沿線情報伝送システム。
【請求項7】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器と、前記沿線監視機器からの送信情報を中継する中継機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、

前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記中継機器には、
前記中継機器の中継機器位置情報を記憶する中継記憶部と、
前記車上機器及び前記沿線監視機器と無線通信を行う中継送受信部と、
前記中継記憶部に記憶された情報に基づいて、前記中継送受信部に通信を指示する中継制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記中継記憶部に記憶された前記中継機器の中継機器位置情報とに基づいて、前記車上機器と前記中継機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記中継機器とが前記車上送受信部と前記中継送受信部との間の通信を確立する制御を行い、前記中継送受信部は前記沿線監視機器から得られた沿線情報を中継し、
前記中継機器と前記車上機器との通信が確立されている列車同士が、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、車上機器同士での通信に切り替える制御を行う、
鉄道沿線情報伝送システム。
【請求項8】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器と、前記沿線監視機器からの送信情報を中継する中継機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、
前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記中継機器には、
前記中継機器の中継機器位置情報を記憶する中継記憶部と、
前記車上機器及び前記沿線監視機器と無線通信を行う中継送受信部と、
前記中継記憶部に記憶された情報に基づいて、前記中継送受信部に通信を指示する中継制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記中継記憶部に記憶された前記中継機器の中継機器位置情報とに基づいて、前記車上機器と前記中継機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記中継機器とが前記車上送受信部と前記中継送受信部との間の通信を確立する制御を行い、前記中継送受信部は前記沿線監視機器から得られた沿線情報を中継し、
前記中継機器と前記車上機器との通信が確立されている列車と前記中継機器と前記車上

機器との通信が確立されていない列車とが、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、通信が確立されて前記沿線情報を受信した車上機器から通信が確立されていない車上機器に前記沿線情報を送信する制御を行う、
鉄道沿線情報伝送システム。
【請求項9】
列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器と、前記沿線監視機器からの送信情報を中継する中継機器とからなる鉄道沿線情報伝送システムであって、
前記車上機器には、
前記車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び前記沿線監視機器の監視機器位置情報を記憶する車上記憶部と、
前記沿線監視機器と無線通信を行う車上送受信部と、
前記記憶部に記憶された情報に基づいて、前記車上送受信部に通信を指示する車上制御部とを含み、
前記沿線監視機器には、
前記沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、
前記車上機器と無線通信を行う沿線監視送受信部と、
前記記憶部に記憶された情報に基づいて、前記沿線監視送受信部に通信を指示する沿線監視制御部とを含み、
前記中継機器には、
前記中継機器の中継機器位置情報を記憶する中継記憶部と、
前記車上機器及び前記沿線監視機器と無線通信を行う中継送受信部と、
前記中継記憶部に記憶された情報に基づいて、前記中継送受信部に通信を指示する中継制御部とを含み、
前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と、前記中継記憶部に記憶された前記中継機器の中継機器位置情報とに基づいて、前記車上機器と前記中継機器とが予め定められた所定の距離以内に接近した場合に、前記車上制御部と前記中継機器とが前記車上送受信部と前記中継送受信部との間の通信を確立する制御を行い、前記中継送受信部は前記沿線監視機器から得られた沿線情報を中継し、
前記中継機器と前記車上機器との通信が確立されていない列車同士が、前記車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、前記車上記憶部に格納した前記沿線情報をすれ違う相手側列車の車上機器に送信する制御を行う、
鉄道沿線情報伝送システム。
【請求項10】
前記中継機器は、前記中継送受信部を通じて定期的に前記中継機器の中継機器位置情報を送信し、
前記車上機器は前記車上送受信部を通じて前記中継機器の中継機器位置情報を受信した場合に、前記車上制御部が、前記車上送受信部が受信した前記中継機器の中継機器位置情報と前記車上記憶部に記憶された列車の現在位置を示す列車位置情報と比較して予め定められた所定の距離以内に接近したと判断した場合に、前記車上機器が前記沿線監視機器からの中継を受信して沿線情報を受信する、請求項６から請求項９のいずれかに記載の鉄道沿線情報伝送システム。
【請求項11】
前記車上機器と通信回線を介して接続され、所定領域内を走行する列車を監視する中央監視装置を含み、
列車ダイヤ情報が変動を生じた場合に、前記車上機器に現時点での最新の列車ダイヤ情報を送信する、請求項６から請求項１０のいずれかに記載の鉄道沿線情報伝送システム。

【発明の詳細な説明】

【技術分野】
【0001】
本発明は、鉄道沿線情報伝送システムに係り、特に鉄道沿線の気象状況や災害発生等の沿線情報をリアルタイムで走行中の列車に知らせることを可能とする鉄道沿線情報伝送システムに関する。
【背景技術】
【0002】
鉄道沿線の鉄道用電気設備の現状の情報を収集する場合には、鉄道用電気設備の現状の情報を沿線に設けた子機において収集し、移動中の電車内に設置した親機に対して送信し、電車内において受信することで、大規模なネットワークシステムを組むことなく、かつ、作業員の手を介すことなく自動的に、鉄道用電気設備の現状の情報を収集することは可能になっている。（例えば特許文献１参照）。
【0003】
一方で、鉄道用電気設備の情報ではなく、雨量、風速、落石、雪崩等を監視するための監視機器が鉄道沿線に設置され沿線情報を収集している。これらの監視機器は自然災害による鉄道事故防止のためには不可欠なものである。これら沿線に設置された監視機器により得られた情報は適宜走行中の列車乗務員に通報することが肝要である。このため、これら監視機器は有線ケーブルで接続され、一旦、沿線情報集約端末を経由して中央指令所へ伝送され、その情報が指令所の人間を介して列車乗務員に伝えられるか、又は近くを走行する列車の前の信号を制御するようにして事故になるのを未然に防いでいる。
【0004】
この沿線情報集約端末は多段に接続され、下位の集約端末にて沿線情報が一定時間蓄積され、数分間の平均値や最大値の値を抽出し、さらに上位の沿線情報集約端末に伝送している。
【特許文献1】特開平１１－７８８８４号公報
【発明の開示】
【発明が解決しようとする課題】
【0005】
しかし、従来の方法では、沿線情報の伝送の際に、列車の走行位置を把握してピンポイントで、かつ、リアルタイムに沿線情報を伝送することはできず、また、沿線状況監視機器を常設している地点における沿線情報しか収集することができず、さらに、監視地点を追加する際には、伝送ケーブル等の配線が必要なため複雑な工事が必要となっていた。
【課題を解決するための手段】
【0006】
そこで、本発明に係る鉄道沿線情報伝送システムは、列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器とからなる鉄道沿線情報伝送システムであって、車上機器には、車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び沿線監視機器の監視機器位置情報を記憶する車上記憶部と、沿線監視機器と無線通信を行う車上送受信部と、車上記憶部に記憶された情報に基づいて、車上送受信部に通信を指示する車上制御部とを含み、沿線監視機器には、沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、車上機器と無線通信を行う沿線監視送受信部と、沿線監視記憶部に記憶された情報に基づいて、沿線監視送受信部に通信を指示する沿線監視制御部とを含み、車上記憶部に記憶された列車の現在位置を示す列車位置情報と、沿線監視記憶部に記憶された沿線監視機器の監視機器位置情報とに基づいて、車上機器と沿線監視機器とが予め定められた所定の距離以内に接近した場合に、車上制御部と沿線監視制御部とが車上送受信部と沿線監視送受信部との間の通信を確立する制御を行う。
【0007】
また、本発明に係る鉄道沿線情報伝送システムは、沿線監視機器は、沿線監視送受信部を通じて定期的に沿線監視機器の監視機器位置情報を送信し、車上機器は車上送受信部を

通じて沿線監視機器の監視機器位置情報を受信した場合に、車上制御部が、車上送受信部が受信した沿線監視機器の監視機器位置情報と車上記憶部に記憶された列車の現在位置を示す列車位置情報と比較して予め定められた所定の距離以内に接近したと判断した場合に、車上機器が沿線情報を受信するようにしてもよい。

【0008】

また、車上機器と通信回線を介して接続され、所定領域内を走行する列車を監視する中央監視装置を含み、列車ダイヤ情報が変動を生じた場合に、車上機器に現時点での最新の列車ダイヤ情報を送信するようにしてもよい。

【0009】

また、本発明に係る鉄道沿線情報伝送システムは、列車に搭載される車上機器と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器と、沿線監視機器からの送信情報を中継する中継機器とからなる鉄道沿線情報伝送システムであって、車上機器には、

車上機器が搭載される列車の現在位置を示す列車位置情報、列車番号情報、列車ダイヤ情報及び沿線監視機器の監視機器位置情報を記憶する車上記憶部と、沿線監視機器と無線通信を行う車上送受信部と、記憶部に記憶された情報に基づいて、車上送受信部に通信を指示する車上制御部とを含み、沿線監視機器には、沿線監視機器の監視機器位置情報を記憶する沿線監視記憶部と、車上機器と無線通信を行う沿線監視送受信部と、記憶部に記憶された情報に基づいて、沿線監視送受信部に通信を指示する沿線監視制御部とを含み、中継機器には、中継機器の中継機器位置情報を記憶する中継記憶部と、車上機器及び沿線監視機器と無線通信を行う中継送受信部と、中継記憶部に記憶された情報に基づいて、中継送受信部に通信を指示する中継制御部とを含み、車上記憶部に記憶された列車の現在位置を示す列車位置情報と、中継記憶部に記憶された中継機器の中継機器位置情報とに基づいて、車上機器と中継機器とが予め定められた所定の距離以内に接近した場合に、車上制御部と中継機器とが車上送受信部と中継送受信部との間の通信を確立する制御を行い、中継送受信部は沿線監視機器から得られた沿線情報を中継する。

【0010】

また、中継機器は、中継送受信部を通じて定期的に中継機器の中継機器位置情報を送信し、車上機器は車上送受信部を通じて中継機器の中継機器位置情報を受信した場合に、車上制御部が、車上送受信部が受信した中継機器の中継機器位置情報と車上記憶部に記憶された列車の現在位置を示す列車位置情報と比較して予め定められた所定の距離以内に接近したと判断した場合に、車上機器が沿線監視機器からの中継を受信して沿線情報を受信するようにしてもよい。

【0011】

また、車上機器と通信回線を介して接続され、所定領域内を走行する列車を監視する中央監視装置を含み、列車ダイヤ情報が変動を生じた場合に、車上機器に現時点での最新の列車ダイヤ情報を送信するようにしてもよい。

【0012】

また、車上送受信部が受信した中継機器の中継機器位置情報と、車上記憶部に記憶された列車の現在位置の列車位置情報とに基づいて、車上制御部が中継機器を通り過ぎたと判断した場合には沿線監視機器との通信に切り替える制御を行うようにしてもよい。

【0013】

また、沿線監視機器又は中継機器と車上機器との通信が確立されている列車同士が、車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、車上機器同士での通信に切り替える制御を行うようにしてもよい。

【0014】

また、沿線監視機器又は中継機器と車上機器との通信が確立されている列車と沿線監視機器又は中継機器と車上機器との通信が確立されていない列車とが、車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車

上制御部が、通信が確立されて沿線情報を受信した車上機器から通信が確立されていない車上機器に沿線情報を送信する制御を行うようにしてもよい。

【0015】

また、沿線監視機器又は中継機器と車上機器との通信が確立されていない列車同士が、車上記憶部に記憶された列車ダイヤ情報に基づいて列車がすれ違うと判断される場合、両列車の車上機器の車上制御部が、車上記憶部に格納した沿線情報をすれ違う相手側列車の車上機器に送信する制御を行うようにしてもよい。

【0016】

また、車上機器の車上受信部が沿線情報を受信した場合に沿線情報が所定の危険度以上であると判断される場合には、列車乗務員に警報を発する手段をさらに備えてもよい。

【発明の効果】

【0017】

沿線状況監視機器から列車に直接、沿線情報を伝送することで、指令所を介さずにリアルタイムかつピンポイントな沿線情報の伝送が可能になる。

【発明を実施するための最良の形態】

【0018】

図１は、本発明に係る鉄道沿線情報伝送システム１０の全体図である。図１には、沿線監視機器２０、車上機器３０，中央監視装置４０、線路５０が示されている。

【0019】

沿線監視機器２０は、雨量、風速、落石、雪崩等を監視するために鉄道沿線に設置された監視機器である。この沿線監視機器２０は、例えば、雨量計、風速計、地震計等が該当する。また、落石や雪崩の有無を判断する装置も含まれる。ただし、気象状況や自然現象のみを監視する機器には限定されず、鉄道沿線で生じた出来事を監視する機器すべてが含まれる。

【0020】

車上機器３０は、線路５０を走る列車に搭載されて列車の進行に伴って移動する。車上機器３０の位置が図示されている場合には当該場所には列車が位置していることになる。今、車上機器３０は図面右側に向かって移動している。この車上機器３０は、沿線監視機器２０に接近すると沿線監視機器２０と通信を行って沿線監視機器２０が得た雨量、風速、地震の震度、落石や雪崩の有無等の情報を受信する。

【0021】

中央監視装置４０は、管轄する区域内のすべての列車の運行を監視する。例えば線路の一区間を通過するときに電流回路が形成されることで列車の通過を検知するようにし、その場合に列車の通過情報を中央監視装置４０に通知するように構成すると列車の現在位置及びある地点の通過時刻が分かる。管轄する区域内のすべての列車の運行を監視してダイヤの乱れを検知することもできる。

【0022】

図２は、本発明に係る鉄道沿線情報伝送システム１０の内部構成図である。図２には、列車に搭載されて線路５０上を移動する車上機器３０と、鉄道沿線の状態を監視して得られた沿線情報を送信する沿線監視機器２０とからなる鉄道沿線情報伝送システム１０が図示されている。

【0023】

車上機器３０は、車上機器３０が搭載される列車の現在位置を示す列車位置情報６８、列車番号情報７２、列車ダイヤ情報７４及び沿線監視機器２０の監視機器位置情報７６を記憶する車上記憶部６２と、沿線監視機器２０と無線通信を行う車上送受信部６６と、車上記憶部６２に記憶された情報に基づいて、車上送受信部６６に通信を指示する車上制御部６７とを含む。

【0024】

車上記憶部６２は、車上機器３０が搭載される列車の現在位置を示す列車位置情報６８、列車番号情報７２、列車ダイヤ情報７４及び沿線監視機器２０の監視機器位置情報７６

を記憶する。列車の現在位置を示す列車位置情報６８は、中央監視装置４０からの情報に基づくものであってもよいし、ＧＰＳを用いて算出された位置に基づくものであってもよい。列車が走行中に自車の位置を認識できる情報であればその取得方法については任意である。例えば、鉄道に沿線に敷設されている距離標（キロポスト）を読み取って列車位置情報と認識する装置を用いることも任意である。

【0025】

列車番号情報７２は、中央監視装置４０が管轄する全列車に一意に割り振られた固有の番号である。列車ダイヤ情報７４は各列車のダイヤグラムである。この列車ダイヤ情報７４は、通常取り運行されていれば毎日同じものとなるのが原則であるが、臨時列車があったり、何らかの原因で遅延が生じたりすると刻々と変動するものである。従って、この列車ダイヤ情報７４は、列車の運行状況を監視する中央監視装置４０との通信によって更新されるのが望ましい。

【0026】

沿線監視機器２０の監視機器位置情報７６については、沿線監視機器２０は固定されているので、例えば、近くのキロポストからどの程度の距離離れているかという観点から監視機器位置情報７６を定めることができる。ここで、車上機器３０の車上記憶部６２に記憶されている監視機器位置情報７６は、列車が走行する路線に位置するすべての監視機器位置情報が記憶されていることが望ましい。

【0027】

車上送受信部６６は、沿線監視機器２０と無線通信を行う。従って、車上送受信部６６は無線通信機を用いて実現することができる。また、車上制御部６７は、車上記憶部６２に記憶された情報に基づいて、車上送受信部６６に通信を指示する。

【0028】

沿線監視機器２０は、沿線監視機器２０の監視機器位置情報８４を記憶する沿線監視記憶部８２と、車上機器３０と無線通信を行う沿線監視送受信部８６と、沿線監視記憶部８２に記憶された情報に基づいて、沿線監視送受信部８６に通信を指示する沿線監視制御部８８とを含む。

【0029】

沿線監視記憶部８２は、沿線監視機器２０の監視機器位置情報８４を記憶する。沿線監視送受信部８６は、車上機器３０と無線通信を行う。沿線監視制御部８８は、沿線監視記憶部８２に記憶された情報に基づいて、沿線監視送受信部８６に通信を指示する。ここで、沿線監視機器２０の監視機器位置情報８４は、その沿線監視機器２０の位置情報であり、例えば上述したように、近くのキロポストからどの程度の距離離れているかという観点から監視機器位置情報８４を定めることができる。

【0030】

この鉄道沿線情報伝送システム１０は、車上記憶部６２に記憶された列車の現在位置を示す列車位置情報６８と、沿線監視記憶部８２に記憶された沿線監視機器２０の監視機器位置情報８４とに基づいて、車上機器３０と沿線監視機器２０とが予め定められた所定の距離以内に接近した場合に、車上制御部６７と沿線監視制御部８８とが車上送受信部６６と沿線監視送受信部８６との間の通信を確立する制御を行う。例えば、沿線監視機器２０が、列車位置情報６８と監視機器位置情報８４とが３キロメートル以内に近づいたとときには、沿線監視機器２０が収集した風量、降雪量等の情報を沿線監視送受信部８６が送信するように沿線監視制御部８８は指示を発するようにすることもできるし、車上機器制御部６７が、沿線監視機器２０に対して通信が可能である旨の信号を送信するようにしてもよい。

【0031】

なお、車上機器３０の車上記憶部６２には、上述したように車上機器３０の車上記憶部６２に記憶されている監視機器位置情報７６は、列車が走行するすべて路線に位置する沿線監視機器２０の位置情報が記憶されている場合には、車上記憶部６２に記憶されている列車位置情報６８と監視機器位置情報７６との対比により沿線監視機器２０と車上機器３

０との接近を検地するようにすることも可能である。

【0032】

表示部６４は、車上機器３０の車上受信部６６が沿線情報を受信した場合に沿線情報が所定の危険度以上であると判断される場合には、列車乗務員に警報を発するものである。前方の沿線機器の種類に応じて、例えば、「風速２５メートル危険」「降雨量５０ミリメートル以上危険」などのような表示をすることが可能であるし、「前方落石あり」のような表示でもよい。なお、図２には表示部６４のみ示したが、警報を鳴らす装置によって乗務員に警報を発するものであってもよい。

【0033】

また、沿線監視機器２０は、沿線監視送受信部８６を通じて定期的に沿線監視機器２０の監視機器位置情報８４を送信し、車上機器３０は車上送受信部６６を通じて沿線監視機器の監視機器位置情報８４を受信した場合に、車上制御部６７が、車上送受信部６６が受信した沿線監視機器２０の監視機器位置情報８４と車上記憶部６２に記憶された列車の現在位置を示す列車位置情報６８と比較して予め定められた所定の距離以内に接近したと判断した場合に、車上機器３０が沿線情報を受信するようにしてもよい。

【0034】

図３は、本発明の他の実施形態に係る鉄道沿線情報伝送システム１０の構成図である。図１及び図２と同一の符号は同一の内容であるためその説明は省略する。図３には、車上機器３０と沿線監視機器２０と、車上機器３０と中央監視装置４０の他に中継機器３００が図示されている。

【0035】

中継機器３００は、中継機器３００の中継機器位置情報３８０を記憶する中継記憶部３６０と、車上機器３０及び沿線監視機器２０と無線通信を行う中継送受信部３２０と、中継記憶部３６０に記憶された情報に基づいて、中継送受信部３２０に通信を指示する中継制御部３４０とを含む。

【0036】

そして、車上記憶部６２に記憶された列車の現在位置を示す列車位置情報６８と、中継記憶部３６０に記憶された中継機器３００の中継機器位置情報３８０とに基づいて、車上機器３０と中継機器３００とが予め定められた所定の距離以内に接近した場合に、車上制御部６７と中継機器３００とが車上送受信部６６と中継送受信部３２０との間の通信を確立する制御を行い、中継送受信部３２０は沿線監視機器２０から得られた沿線情報を中継する。

【0037】

これにより、車上機器３０が、今、図面左側から右側に走行している場合に、沿線監視機器２０との間で通信が確保できない場合でも途中の中継器３００が沿線監視機器２０が送信する情報を中継することでより遠くの車上機器３０と通信が行える。

【0038】

また、中継機器３００は、中継送受信部３２０を通じて定期的に中継機器３００の中継機器位置情報３８０を送信し、車上機器３０は車上送受信部６６を通じて中継機器３００の中継機器位置情報３８０を受信した場合に、車上制御部６７が、車上送受信部６６が受信した中継機器３００の中継機器位置情報３８０と車上記憶部６２に記憶された列車の現在位置を示す列車位置情報６８と比較して予め定められた所定の距離以内に接近したと判断した場合に、車上機器３０が沿線監視機器２０からの中継を受信して沿線情報を受信するようにしてもよい。

【0039】

図４は、本発明の他の実施形態に係る鉄道沿線情報伝送システム１０の構成図である。図１から図３と同一符号は同一の意味である。図４には、車上送受信部６６が受信した中継機器３００の中継機器位置情報３８０と、車上記憶部６２に記憶された列車の現在位置の列車位置情報６８とに基づいて、車上制御部６７が中継機器３００を通り過ぎたと判断した場合には沿線監視機器２０との通信に切り替える制御を行う鉄道沿線情報伝送システ

ムが示されている。これにより、より通信性能のよい状態で沿線情報を取得することができる。

【0040】

図５は、本発明の他の実施形態に係る鉄道沿線情報伝送システム１０の構成図である。図１から図４と同一符号は同一の意味である。図５には、沿線監視機器２０又は中継機器３００と車上機器３０、３２との通信が確立されている列車同士が、車上記憶部６２に記憶された列車ダイヤ情報７４に基づいて列車がすれ違うと判断される場合、両列車の車上機器３０、３２の車上制御部６７が、車上機器同士での通信に切り替える制御を行う様子が図示されている。

【0041】

また、沿線監視機器２０又は中継機器３００と車上機器３２との通信が確立されている列車と沿線監視機器２０又は中継機器３００と車上機器３０との通信が確立されていない列車とが、車上記憶部６２に記憶された列車ダイヤ情報７４に基づいて列車がすれ違うと判断される場合、両列車の車上機器３０、３２の車上制御部６７が、通信が確立されて沿線情報を受信した車上機器３２から通信が確立されていない車上機器３０に沿線情報を送信する制御を行う様子が図示されている。

【0042】

図５は走行している列車に搭載されている車上機器３０を中継器として使用しようとするものである。これにより、沿線監視機器２０と車上機器３０との通信状態が悪い場合であっても安定した通信を行うことができる。

【0043】

図６は、本発明に係る第二の実施形態である通信回線構成装置の具体的な構成を示したブロック図である。図６は車上機器３２が沿線監視機器２０を通り過ぎて進行した状態が図示されている。この車上機器３２は沿線監視機器２０に近傍にいた場合には沿線監視機器２０から沿線情報を取得したはずであるので、その際に、車上記憶部６２にその情報を保持する。

【0044】

そして、図６には、車上機器３２と沿線監視機器２０との通信が確立されなくなった後に対向列車に搭載された車上機器３０とすれ違う様子が図示されている。

【0045】

この場合、車上機器３２は車上機器３０に対して、車上機器３２の車上記憶部６２に格納している保持された沿線情報を車上機器３２に対して送信する。

【0046】

これにより、車上機器３０は、まだ沿線監視機器２０との通信が不可能な状態であっても、前方の沿線監視機器２０が得た情報を事前に知ることができる。

【産業上の利用可能性】

【0047】

沿線状況監視機器から列車に直接、沿線情報を伝送することで、指令所を介さずにリアルタイムかつピンポイントな沿線情報の伝送が可能になり、また、列車も沿線情報の伝送の中継端末となることが可能にすることで、有線ケーブルではなく無線を採用したことにより、沿線状況監視機器と列車との間の対向車両により無線が伝送されにくくなった場合においても、列車が中継端末となることで、沿線情報の伝送が可能にし、さらに、監視地点及び中継地点を増設や一時的に仮設したい場合において、有線ケーブルではなく無線により情報伝達を行うことにより、工事の負担が軽減したので、鉄道による輸送業界での利用が見込まれる。

【図面の簡単な説明】

【0048】

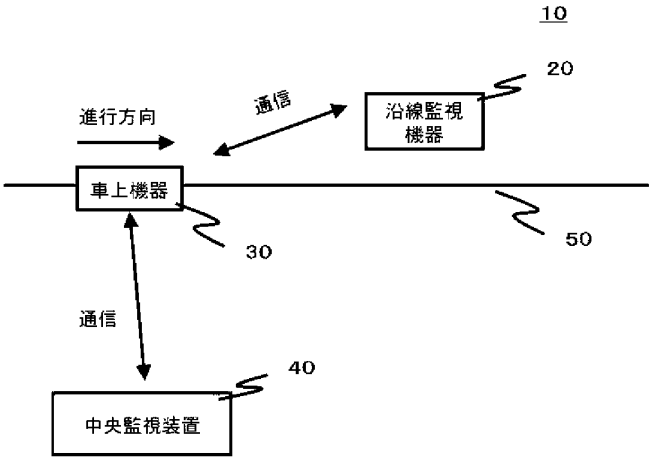
【図1】本発明に係る鉄道沿線情報伝送システムの全体図である。

【図2】本発明に係る鉄道沿線情報伝送システムの内部構成図である。

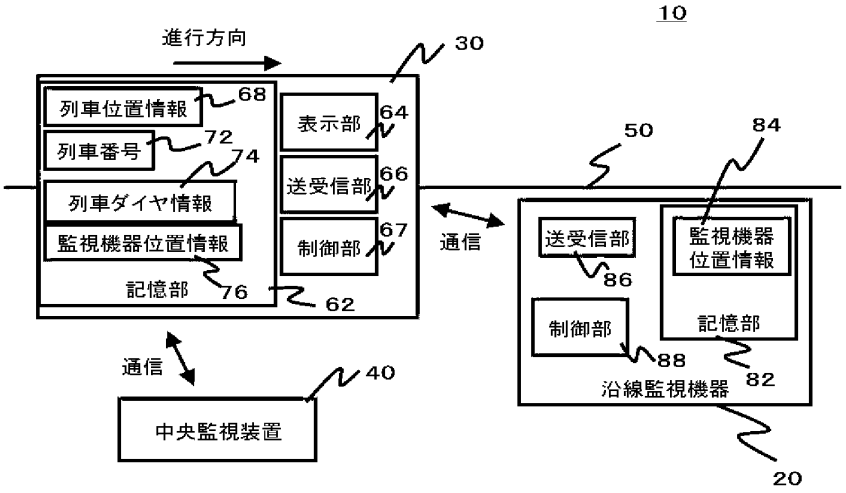
【図3】本発明の他の実施形態に係る鉄道沿線情報伝送システムの構成図である。

【図4】本発明の他の実施形態に係る鉄道沿線情報伝送システムの構成図である。
【図5】本発明の他の実施形態に係る鉄道沿線情報伝送システムの構成図である。
【図6】本発明に係る第二の実施形態である通信回線構成装置の具体的な構成を示したブロック図である。
【符号の説明】
【0049】
１０　鉄道沿線情報伝送システム
２０　沿線監視機器
３０　車上機器
４０　中央監視装置
５０　線路
６２　車上記憶部
６４　表示部
６６　車上送受信部
６７　車上制御部
６８　列車位置情報
７２　列車番号
７４　列車ダイヤ情報
７６　監視機器位置情報
８２　沿線監視記憶部
８４　監視機器位置情報
８６　沿線監視送受信部
８８　沿線監視制御部
３００　中継機器
３２０　中継送受信部
３４０　中継制御部
３６０　中継記憶部
３８０　中継機器位置情報

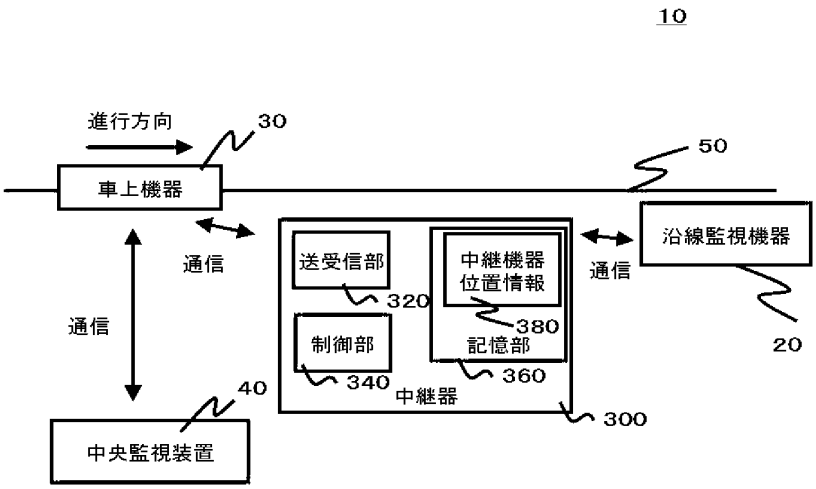
【図1】


10
20
進行方向
通信
沿線監視機器
車上機器
30
50
通信
40
中央監視装置

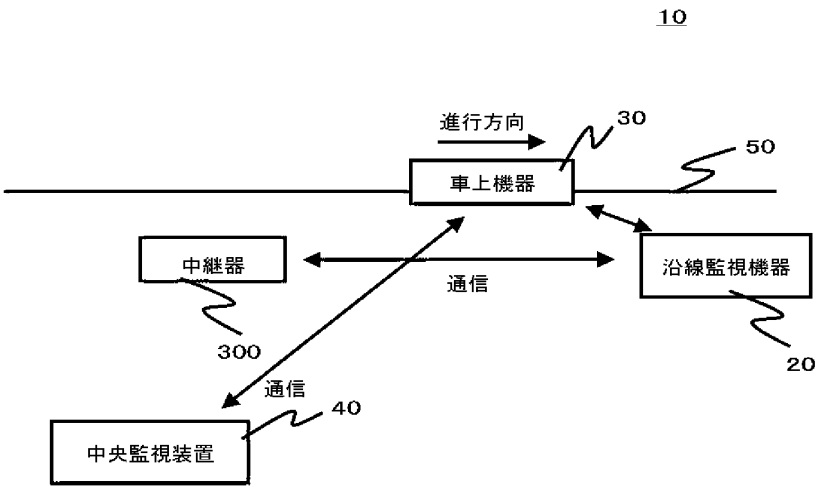
【図2】


10
進行方向
30
列車位置情報
68
表示部
64
列車番号
72
74
送受信部
66
50
84
列車ダイヤ情報
監視機器位置情報
制御部
67
通信
送受信部
86
監視機器位置情報
記憶部
76
62
制御部
88
記憶部
82
通信
40
沿線監視機器
中央監視装置
20

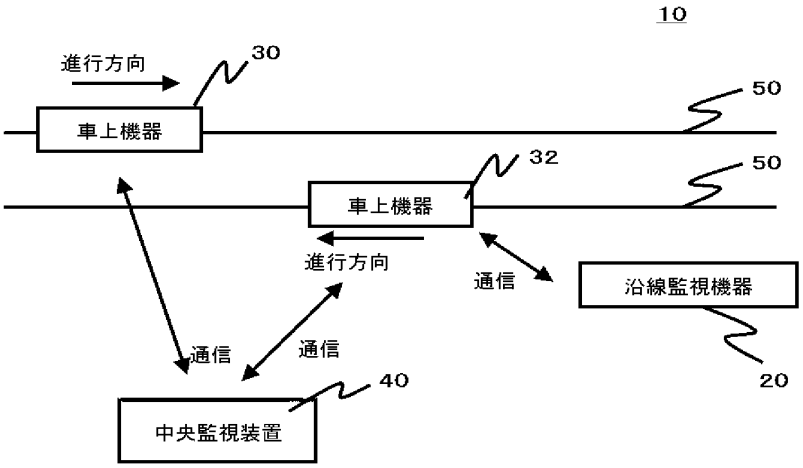
【図3】


10
進行方向
30
50
車上機器
通信
送受信部
320
中継機器
位置情報
380
沿線監視機器
通信
20
通信
制御部
340
記憶部
360
40
中継器
300
中央監視装置

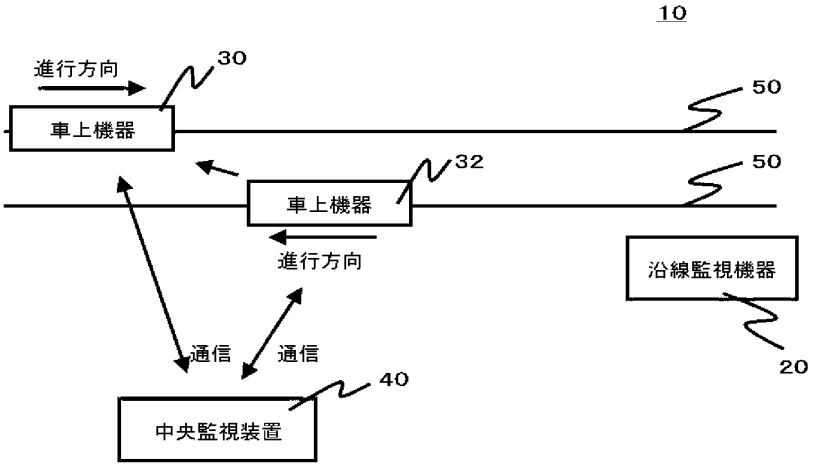
【図4】


10
進行方向
30
50
車上機器
中継器
通信
沿線監視機器
300
20
通信
40
中央監視装置

【図5】


10
進行方向
30
車上機器
50
32
車上機器
50
進行方向
通信
沿線監視機器
20
通信
通信
40
中央監視装置

【図6】


10
進行方向
30
車上機器
50
32
車上機器
50
進行方向
沿線監視機器
20
通信
通信
40
中央監視装置

(56)参考文献　特開平１１－２４５８１８（ＪＰ，Ａ）
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特開２００４－１８９０４３（ＪＰ，Ａ）
特開２００３－２２４５０７（ＪＰ，Ａ）

(58)調査した分野(Int.Cl.，ＤＢ名)
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TRAIN COMMUNICATION SYSTEM

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Classification: **- international:** ***B60L15/40; B61L3/12; H04B7/26;***
(IPC1-7): B60L15/40; B61L3/12; H04B7/26
- cooperative: Y02T90/16

Application number: JP19990286355 19991007

Priority number(s): JP19990286355 19991007

Abstract of JP2001106074 (A)

PROBLEM TO BE SOLVED: To perform the transmission and receiving of information between a train and the ground or among a train, ground and a base point reliably. SOLUTION: This system is provided with an on-vehicle communication device 10 that is mounted on the train 1 and transmits a train information signal to the outside and a ground-based communication device 12 that is established on the ground side. The ground-based communication device 12 receives the train information signal transmitted from the on-vehicle communication device 10 when the train enters into the communication area and alarms and displays at least approaching of the train. In addition, fixed communication systems are established at bases or the base points of stations and the like to establish a communication network between the on-vehicle communication device and external devices such as a central control room and the like installed on the base point sides.

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（P2001－106074A）
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(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
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Ｂ６０Ｌ　15/40		Ｂ６０Ｌ　15/40	Ｊ	５Ｈ１６１
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(21)出願番号　特願平11－286355

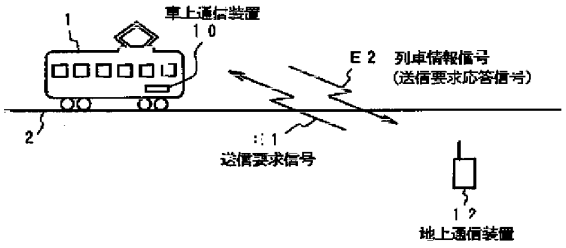
(22)出願日　平成11年10月７日(1999.10.7)

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最終頁に続く

(54)【発明の名称】　列車通信システム

(57)【要約】
【課題】列車・地上間もしくは列車・地上・拠点間での情報の送受を確実に行う。
【解決手段】列車１に設置され外部に対し列車情報信号を送信する車上通信装置と、地上側に設置され列車が通信エリアに入った際に車上通信装置１０から送信された列車情報信号を受信して少なくとも列車の接近を警報表示する地上通信装置１２によりシステムを構成する。更に固定通信装置を基地や駅等の拠点に固定設置し、車上通信装置と拠点側に設置した中央指令室等の外部装置との間で通信回線を確立する。



【特許請求の範囲】
【請求項１】列車に設置され、外部に対し列車情報信号を送信する車上通信装置と、
地上側に設置され、前記列車が通信エリアに入った際に前記車上通信装置から送信された列車情報信号を受信して前記列車の接近を含む列車情報を表示する地上通信装置とを備えた列車通信システムに於いて、
前記車上通信装置は、送受信を行う無線部と、車上通信装置の制御を行う制御部と、データを蓄えておくメモリと、送信情報の設定を行う情報設定部又は外部装置との通信を行うインターフェース部を備え、
前記地上通信装置は、データの送受信を行う無線部と、地上通信装置の制御を行う制御部と、データを蓄えておくメモリとを備えたことを特徴とする列車通信システム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、鉄道交通システムにおける列車・地上間もしくは列車・地上・基地や駅等の拠点間で情報を送受する列車通信システムに関する。
【０００２】
【従来の技術】従来、この種の鉄道における列車・地上間もしくは列車・地上・拠点間の通信システムとしては、以下に挙げるような人為監視システム、軌道回路による列車検知システム、音声無線による通信システム等がある。
【０００３】人為監視システムは、保守作業の作業区間に見張り員を配置し、目視によって列車の通過を確認している。また列車番号などの情報は運行ダイヤを調べることで確認している。列車の接近をなるべく遠い位置から検知する通信手段としては、トランシーバーを用いたシステムや軌道回路を伝送線路として用いるシステム等が提案されている。地上の保守作業員から列車への信号伝達は、主に手旗や標識の設置によっている。
【０００４】また軌道回路による列車検知システムは、列車と指令室との間の信号伝送について、軌道をある距離で区切って閉塞区間とし、この閉塞区間に軌道回路を構成することで列車の接近を検知し、列車の接近情報を中央指令室に送信して列車がダイヤ通りに運行されているかの確認を行う。また軌道回路に特定周波数の信号を流し、列車側で信号を受信して制限速度等を知る自動列車制御システム（ＡＴＣ）が行われている。
【０００５】更に、音声無線による通信システムは、事故や故障などが発生した際の列車と基地との通信は音声無線によって行われている。これによって基地から列車運転士に対して事故や運行状況などの連絡を行う。また列車から中央指令室への連絡も主に音声無線で行っている。
【０００６】
【発明が解決しようとする課題】しかしながら、このような従来の鉄道における列車・地上もしくは列車・地上・拠点間の通信システムにおいては、以下に示すような問題点があった。
【０００７】まず人為監視システムは、基本的に運転士もしくは保守作業員が情報の確認を行っているため、見落としなどによる情報伝達ミスが生じやすい。また運行ダイヤが乱れた場合には状況の確認が難しく、保守作業における安全確保や効率的な作業を行うことが難しくなる。更に、軌道回路を伝送線路として用いるシステムにおいては、列車・地上側とも装置の設置費用が掛かってしまう。
【０００８】また軌道回路による列車検知システムは、列車の有無しか確認できないため、列車番号や走行速度などを基地側で確認することができない。また基地側から列車を制御するＡＴＣにおいても、制限速度情報しか送ることができない。これらのことは、運行ダイヤが乱れている場合に特に問題となる。
【０００９】更に、音声無線による通信システムは、運転士に負担をかけてしまう。また特定の列車運転士や特定の区間を走行する列車に対してしか通信を行うことができない。更に音声無線は聞き取りにくく、人が通信を行うため間違える可能性がある。
【００１０】本発明は、このような従来の問題点に着目してなされたもので、列車・地上間もしくは列車・地上・拠点間での情報の送受を確実に行う列車運行や保守作業の安全性を確保するようにした列車通信システムを提供することを目的とする。
【００１１】
【課題を解決するための手段】この目的を達成すめため本発明は次のように構成する。
（車上・地上間の基本通信システム）まず本発明は、列車に設置され外部に対し列車情報信号を送信する車上通信装置と、地上側に設置され列車が通信エリアに入った際に車上通信装置から送信された列車情報信号を受信して少くとも列車の接近警報を含む列車情報を表示する地上通信装置とを備えた列車通信システムを対象とする。
【００１２】このような車両通信システムにつき本発明は、車上通信装置には、送受信を行う無線部と、車上通信装置の制御を行う制御部と、データを蓄えておくメモリと、送信情報の設定を行う情報設定部又は外部装置との通信を行うインターフェース部を設け、また地上通信装置は、データの送受信を行う無線部と、地上通信装置の制御を行う制御部と、データを蓄えておくメモリとを備え、更に必要に応じて情報を表示する表示部と、警報を発する警報発生部等とを備えことを特徴とする。
【００１３】このようなシステム構成により、列車からの情報を例えば保守作業等を行っている地上側で確実に知ることができ、特に列車が接近していることを知らせるための接近警報を、地上通信装置の通信エリアの設定で確実に行うことができ、保守作業の安全性が確保でき

る。
【００１４】(車上側の常時受信)車上通信装置は常時受信状態にあり、地上通信装置は送信要求信号を送信しており、車上通信装置は列車が地上通信装置との通信エリアに入って地上通信装置からの送信要求信号を受信した際に前記列車情報信号を送信する。これにより車上通信装置の消費電力を減らすことができ、不要な信号を車上通信装置から送信しなくて済む。
【００１５】この場合、地上通信装置は一定周期毎に送信要求信号を送信してもよいし、地上通信装置に外部接点入力部を追加し、外部接点入力部から信号が入力された場合に車上通信装置に対して送信要求信号を送信するようにしてもよい。
【００１６】例えば地上通信装置の外部接点入力部に軌道閉塞区間に設置した軌道回路を接続し、軌道回路から閉塞区間に進入した列車の検出信号に基づいて車上通信装置に対して送信要求信号を送信する。このように列車が接近してきたときのみ送信要求信号を送信することができるため、地上通信装置の更なる低消費電力化を図ることができる。また車上通信装置からの信号に関わらず接近警報を行うことができるため、通信路の状況が悪く通信エリアが狭い場合でも、軌道回路などを用いれば接近警報を早く確実に出力することができる。
【００１７】また人為的に信号を入力することで、人が必要時にのみ車上通信装置に対して送信要求信号を送信することで、地上通信装置の更なる低消費電力化が図れる。
【００１８】(地上側の常時受信)一方、地上通信装置を常時受信状態とし、車上通信装置が列車情報信号を送信しており、地上通信装置は列車が自己の通信エリアに入った際に車上通信装置からの列車情報信号を受信する形態をとることもできる。これにより地上通信装置の消費電力を減らすことができ、不要な信号を地上通信装置から送信しなくて済む。
【００１９】(車上設定情報と地上設定情報)車上通信装置は列車情報信号として列車番号、最終列車かどうかの情報、保守列車の場合は保守作業予定時間等の情報を送信する。このため地上通信装置は、列車情報信号を受信して列車番号、最終列車か否か、保守車両の場合は保守作業予定時間等の受信情報を表示する。
【００２０】このため列車からの情報として列車番号・最終電車であるかの情報等を地上側で確実に知ることができ、地上側の保守作業員は、これらの情報と運行ダイヤなどを比較することにより、次の列車までの時間や通過した列車が最終列車であるかの確認を行え、運行ダイヤが乱れている場合にはその状況を把握でき、これにより保守作業の安全性と作業効率が向上する。
【００２１】また車上通信装置に情報表示部を追加し、地上通信装置に送信情報の設定を行う情報設定部及び外部装置との通信を行うインターフェース部を追加し、地上通信装置から車上通信装置に情報設定部で設定した情報を送信して情報表示部に表示させる。
【００２２】この地上通信装置の送信情報としては列車速度制限情報、保守作業中を示す情報等であり、これらの情報を車上通信装置に送信して表示させる。このため地上からの制限速度や作業区間あり等の情報を車上側の運転士等が確実に知ることができ、必要に応じて警報を鳴らすことができる。これにより、列車の運行をより安全に行うことができる。
【００２３】また車上通信装置を中継点とすることにより、異なる保守作業現場間の地上通信装置間で互いの進行状況を確認しながら作業を進めることができるため、保守作業の作業効率が向上する。
【００２４】更に、インターフェース部より地上通信装置に予め運行ダイヤや最終電車の列車番号などを入力しておくことにより、地上通信装置は車上通信装置からの情報に応じて適切な情報表示、例えば次の列車までの時間や最終電車があるかどうかなどや接近警報を行うことができ、保守作業員の作業中の負担をより軽くすることができる。
(車上・地上・拠点間の通信システム)本発明の列車通信システムは、列車通信装置及び地上通信装置に加え、更に固定通信装置を設ける。固定通信装置は基地や駅等の拠点に固定設置され、車上通信装置と拠点側に設置した外部装置との間で通信回線を確立する。また固定通信装置は、データの送受信を行う無線部と、通信装置の制御を行う制御部と、データを蓄えておくメモリと、外部装置との通信を行うインターフェース部とを備える。
【００２５】固定通信装置には外部装置として例えば中央指令室装置を接続する。この場合、固定通信装置は、車上通信装置から送信された列車情報信号に含まれる列車番号や保守状況等の情報を中央指令室装置に転送し、また中央指令室装置から送信された運行ダイヤ、運行ダイヤが乱れた際の復旧見込み、保守作業位置、他の列車の通過時間等の情報を車上通信装置に転送して表示させる。
【００２６】このように固定通信装置が運行指令室や保守基地などの拠点との間の通信回線を有することで、基地からの情報を固定通信装置から車上通信装置に送信すると共に、必要であればこの情報を地上通信装置に転送できるため、基地からの指令などの情報を目標とする列車に確実に送信することができる。
【００２７】また車上通信装置からの情報を受信した固定通信装置は、この情報を基地に送信し、車上通信装置は地上通信装置からの情報を必要であれば固定通信装置に転送できるため、基地で列車の運行状況や保守作業の状況などをリアルタイムで監視・把握することができる。
(監視カメラのモニタ)固定通信装置に外部装置として拠点を撮像する監視カメラを接続することもできる。こ

の場合、列車が固定通信装置の通信エリアに入った際に、監視カメラからの画像情報を車上通信装置に送信して表示させる。このため地上側の画像情報を車上側でモニタし、車上運転士が進入時や発進時の状態を確認することができ、列車の運行をより安全に行うことができる。

（地上設備の監視制御）地上通信装置は、インターフェース部を介して踏切、ポイント等の地上設備を接続し、車上通信装置に地上設備の状態を示す送信情報である検出信号を送信して情報表示部に表示させ、車上通信装置は必要に応じて地上設備の制御信号を地上通信装置に送信して地上設備を制御させる。

【００２８】このため地上通信装置から車上通信装置に対して地上設備の状態を知らせることができ、列車走行時の安全性が向上する。また列車側から地上設備を制御できるため、特に中央指令室などの制御下にない保守車両等の走行時における自動化、安全化、効率化を図ることができる。

【００２９】また地上通信装置は、前記地上設備を制御させる列車番号等の列車情報を情報設定部に予め設定し、車上通信装置から前記列車情報に一致する情報を受信した際に地上設備に制御信号を出力することで、列車からの列車番号に応じて自動的に地上設備を制御することができる。

（音声情報）本発明の列車通信システムに設けた各通信装置間で通信する情報を音声情報としてもよい。このように通信する情報を音声情報とすることにより、トランシーバや無線電話などを用いずに同一の装置で音声情報を送ることができ、車上に必要な設備の軽減や特定の対象に対する音声データが行えるため、連絡がより安全且つ確実となる。

（複数装置）本発明の列車通信システムは、地上通信装置を複数設置してもよく、複数の地上通信装置のいずれかで車上通信装置からの列車情報信号を受信した場合、他の地上通信装置に受信した列車情報信号を転送する。このように複数の地上通信装置を各々の通信エリア内に離して設置することで、各装置間でデータの通信を行い、列車からの信号を保守作業員がより離れた所から確認することができ、保守作業の安全性がさらに向上する。

【００３０】また車上通信装置を先頭車両と最後尾車両を含む複数の車両位置に複数設置し、複数の車上通信装置と地上通信装置との間で通信を行うことで、先頭列車が地上通信装置を通過した後でも、確実に地上通信装置との通信を行うことができる。

（携帯型）本発明の列車通信システムに使用する地上通信装置は携帯可能な装置とする。このように地上通信装置を固定設置型ではなく携帯型としたことにより、設置工事などを行わずに保守作業員が必要に応じて地上通信装置を使用することができ、また地上通信装置の設置費用がいらなくなる。

【００３１】

【発明の実施の形態】＜目　次＞

１．車上側を常時受信状態としたシステム
２．地上側を常時受信状態としたシステム
３．地上側に軌道回路を接続したシステム
４．複数装置を設置したシステム
５．地上側から設定情報を車上側に送信するシステム
６．固定通信装置を備えたシステム
７．監視カメラを備えたシステム
８．地上設備を監視制御するシステム

１．車上側を常時受信状態としたシステム

図１は本発明による列車通信システムの第１実施形態であり、この実施形態にあっては、車上側を常時受信状態とし、地上側からの送信要求に対し列車情報を応答送信するようにしたことを特徴とする。

【００３２】図１において、軌道２を走行する列車１には車上通信装置１０が搭載されている。一方、保守作業の現場となる地上側には地上通信装置１２が設置されている。地上通信装置１２は携帯型の装置であり、保守作業員が保守作業を行う場所に運んで列車１の進入側に配置したり、作業員が携帯しても良い。

【００３３】車上通信装置１０は常時受信状態となっている。一方、地上通信装置１２は例えば一定周期ごとに送信要求信号Ｅ１を送信している。地上通信装置１２は設置場所を中心に軌道２に沿って所定範囲に通信エリアを設定しており、この通信エリアに列車１が進入してくると、車上通信装置１０で地上通信装置１２からの送信要求信号Ｅ１が受信される。

【００３４】地上通信装置１２からの送信要求信号Ｅ１は常時受信状態にある車上通信装置１０の送信起動信号となる。このため、送信要求信号Ｅ１を受信した車上通信装置１０は、地上通信装置１２に対し列車番号などの情報を含む列車情報信号Ｅ２を送信要求応答信号として送信する。この車上通信装置１０からの列車情報信号Ｅ２を受信した地上通信装置１２は、地上通信装置１２の通信エリアに列車１が進入したことを認識して、少なくとも接近警報の出力を行って保守作業員に列車１の接近を知らせる。また、受信した列車情報である列車番号などを表示することもできる。

【００３５】図２は図１の車上通信装置１０のブロック図である。車上通信装置１０は、通信装置の制御を行う制御部１４、データの送受信を行う無線部１６、アンテナ１８、データを蓄えておくメモリ２０、車上側に送信する送信情報の設定を行う情報設定部２２、及び外部装置との入出力を行うインターフェース部（Ｉ／Ｆ部）２４で構成される。

【００３６】地上通信装置１２に対し送信されるデータは、情報設定部２２またはインターフェース部２４から入力され、メモリ２０に蓄えられる。メモリ２０のデー

タは制御部１４から無線部１６に渡され、搬送波に乗せられてアンテナ１８から地上通信装置１２に送信される。一方、アンテナ１８で受信された地上通信装置１２からの受信信号は無線部１６でベースバンド信号に復調され、制御部１４に渡され、制御部１４では受信データの判断処理を行う。

【００３７】図３は図１の地上通信装置１２のブロック図である。地上通信装置１２は、通信装置の制御部行う制御部２６、データの送受信を行う無線部２８、アンテナ３０、データを蓄えておくメモリ３２、情報を表示する表示部３４、警報を発する警報発生部３６を備える。

【００３８】地上通信装置１２から車上通信装置１０に対し送信されるデータは、制御部２６から無線部２８に渡され、搬送波に乗せられてアンテナ３０から車上通信装置１０に送信される。車上通信装置１０からの受信信号は無線部２８でベースバンド信号に復調され、制御部２６に渡される。制御部２６では受信データの判断処理を行い、受信情報に応じて表示部３４に受信データを表示したり、必要に応じて警報装置３６を作動させる。

【００３９】ここで図１の車上通信装置１０と地上通信装置１２との間の通信で用いられる周波数帯としては、例えばマイクロ波信号などで良い。また図２，図３の無線部１６，２８によるベースバンド信号の変復調方式は、ＦＳＫ，ＰＳＫなど適宜のデータ変復調方式を用いることができる。

【００４０】図４は図１の地上通信装置１２からの送信要求信号Ｅ１と車上通信装置１０からの列車情報信号Ｅ２のフォーマットの説明図である。図４（Ａ）は地上通信装置１２から送信される送信要求信号のフォーマットであり、ヘッダ６０、データ６２及びＥＣＣ６４で構成されており、データ６２には基本的に起動情報６６が含まれている。

【００４１】またデータ６２には必要に応じて列車番号６８がアドレス情報として含まれる。このアドレス情報としての列車番号６８は、地上通信装置１２からの送信要求に対し車上通信装置１０より送信要求信号Ｅ１を受信して得られた列車番号をセットして送り、車上通信装置１０側で自己の列車番号と送信要求信号の列車番号との一致を検出した際には、もはや送信要求応答は不要であることから、列車情報信号Ｅ２の返送を行わないようにするような制御に用いられる。

【００４２】図４（Ｂ）は車上通信装置１０からの送信要求応答信号となる列車情報信号のフォーマットであり、ヘッダ７０、データ７２及びＥＣＣコード７４で構成される。データ７２には列車番号７６と予め定められた列車情報７８が含まれる。この列車情報７８としては、例えば次のものが設定される。

【００４３】(1)最終列車であるかどうかの情報
(2)列車が保守車両である場合には保守作業予定時間
勿論、これ以外の列車情報も必要に応じてデータ７２に設定することができる。

【００４４】次に図１の列車通信システムの動作を説明する。地上通信装置１２は例えば一定周期ごとに送信要求信号Ｅ１を送信している。列車１が地上通信装置１２に接近してその通信エリアに入ると、車上通信装置１０は地上通信装置１２からの送信要求信号Ｅ１を受信するので、図２の車上通信装置１０の制御部１４は、情報設定部２２あるいはインターフェース部２４によってメモリ２０に予め設定してあった図４（Ｂ）のデータ７２について示す列車番号７６や列車情報７８などの送信情報を無線部１６からアンテナ１８によって地上通信装置１２に送信する。

【００４５】車上通信装置１０からの列車情報信号Ｅ２を受信した地上通信装置１２は、図３の無線部２８で復調したベースバンド信号として送信情報を制御部２６で受け取り、制御部２６において図４（Ｂ）のＥＣＣコード７４に基づいた誤り訂正検出処理やあるいは複数回受信した情報の比較処理などにより、受信情報が正しいか否か判断する。

【００４６】制御部２６で受信情報が正しいことが判断されると、車上通信装置１２に対し情報の正常受信を示す確認信号（ＡＣＫ信号）を送り返すと共に、表示部３４に受信情報を表示し、必要があれば警報発生部３６を作動させて保守作業員に列車接近の注意を喚起する。また制御部２６で正常受信情報が得られなかった場合には、車上通信装置１０に対し再送要求信号を送信する。

【００４７】このようにして地上通信装置１２側で車上通信装置１０からの列車情報信号の受信に基づく表示部３４に対する受信情報、例えば列車番号や最終列車であるかどうかの情報表示、また列車が保守車両であった場合には保守作業予定時間などが表示され、地上の保守作業員は表示部３４に表示されたこれらの受信情報と運行ダイヤなどを照らし合わせながら安全に保守作業を進めることができる。

【００４８】地上通信装置１２で一度、列車１の車上通信装置１０から列車番号などの列車情報を受信した後は、その後の送信要求信号Ｅ１を構成する図４（Ａ）のデータ６２にアドレスとしての列車番号６８を追加することで、一度地上側で正常に通信が終了した列車に対しては通信を実質的に中断でき、同一の列車と何度も同じ情報通信を行ってしまうことを回避できる。

【００４９】また送信要求信号Ｅ１を構成する図４（Ａ）のデータ６２に一度正常に通信を終了した列車の列車番号６８を追加することで、この列車番号６８をもつ列車との間でのみデータ通信を行うようにすることもできる。

【００５０】更に、地上通信装置１２の通信エリアに複数の列車が同時に進入してきた場合の列車情報信号Ｅ２の重複送信による衝突を回避するため、図２の車上通信装置１０側にはキャリアセンスによる重複送信回避機能

や送受信タイミングを装置ごとに異ならせる送信プロトコル調整を行うことで対応する。

【００５１】キャリアセンスによる重複送信の回避は、車上通信装置１０で列車情報信号Ｅ２を送信する際に、他の車上通信装置１０からの送信によるキャリアの有無をセンスし、キャリアなしをセンスして自己の送信動作を開始する。また送受信タイミングを調整する送信プロトコル機能は、地上通信装置１２から送信要求信号Ｅ１を受信した時点から送信を開始するまでの遅延時間を車上通信装置１０ごとに異ならせ、これによって異なるタイミングで車上通信装置１０からの送信が行われることで送信信号の衝突を回避することができる。

【００５２】図５は図３の地上通信装置１２の制御部２６による地上通信処理のフローチャートである。まずステップＳ１で内部タイマなどにより設定された送信要求タイミングか否かチェックしており、送信要求タイミングを判別すると、ステップＳ２に進み、送信要求信号Ｅ１を送信するための送信処理を実行する。続いてステップＳ３で車上通信装置１０からの列車情報信号の受信をチェックしている。

【００５３】ステップＳ３で列車情報信号を受信すると、ステップＳ４で受信情報が正しいか否かのエラー判定をＥＣＣ処理または比較照合により行い、ステップＳ５で受信エラーがなく正常受信であれば、ステップＳ６で車上通信装置１０に対し確認信号を送信した後、例えばステップＳ７で列車接近警報の発生を行い、ステップＳ８で受信情報として例えば列車番号、最終列車情報あるいは保守車両の場合の作業予定時間などの表示を行う。

【００５４】そしてステップＳ９で装置を停止するための終了指示か否かチェックし、終了指示がなければ再びステップＳ１に戻り、次の送信要求タイミングを待ってステップＳ２からの処理を繰り返す。一方、ステップＳ４の受信情報のエラー判定の結果、ステップＳ５で受信エラーがあったことが判別されると、ステップＳ１０で車上通信装置に対し再送要求を行い、ステップＳ３で新たな列車情報の受信を待つ。

【００５５】図６は図２の車上通信装置１０における車上通信処理のフローチャートである。車上通信装置１０は、ステップＳ１で送信要求信号の受信をチェックしている。ステップＳ１で地上通信装置１２からの送信要求信号の受信が判別されると、ステップＳ２に進み、予め設定されている列車番号などの送信要求応答情報としての列車情報を作成し、ステップＳ３で重複送信回避処理を行った後、ステップＳ４で列車情報信号を地上通信装置１２に送信する。

【００５６】続いてステップＳ５で地上通信装置１２からの確認信号の受信をチェックしており、確認信号を受信すると、ステップＳ６で送信処理を正常終了する。一方、ステップＳ５で確認信号が受信できなかった場合には、ステップＳ４に戻って列車情報信号を再度送信する。

【００５７】ステップＳ５で確認信号を受信すると、ステップＳ６の送信処理の正常終了となり、ステップＳ７で装置停止に先立つ終了指示があるまでステップＳ１～Ｓ６の処理を繰り返す。

【００５８】図７は図５の地上通信処理のステップＳ２における送信要求信号の送信処理の詳細であり、一度正常に列車情報信号を受信した後は、その列車番号をアドレス情報として送信要求信号に含めて送信要求を行うようにしたことを特徴とする。即ち、ステップＳ１で列車情報が正常に受信済みか否かチェックし、最初の受信にあっては列車情報は受信済みでないことから、ステップＳ３で列車番号を含まない送信要求信号を車上通信装置１０に送信する。これに対し一度列車情報信号を正常に受信した後は、ステップＳ２で列車番号を含む送信要求信号を車上通信装置に送信する。

【００５９】図８は図７の送信要求処理を含む地上通信処理に対応した車上通信処理のフローチャートである。ステップＳ１で地上通信装置１２からの送信要求信号を受信すると、ステップＳ２で列車番号が含まれているか否かチェックする。最初の送信要求信号の受信では列車番号はないことから、ステップＳ４に進み、列車番号等の送信要求応答情報即ち列車情報を作成し、ステップＳ５で重複送信回避処理を行った後、ステップＳ６で列車情報信号を送信する。

【００６０】２回目以降については、図７の送信要求処理により列車番号が受信されることから、ステップＳ３で自己の列車番号と一致するか否か比較判別し、一致すればステップＳ４以降の送信処理は行わず、ステップＳ１からの受信状態を維持する。これによって一度正常に列車情報信号を地上通信装置に通信できた後は、同じ列車情報を繰り返し送信することを回避できる。なお図８のステップＳ５～Ｓ１０の処理は、図６のステップＳ３～Ｓ８と同じである。

２．地上側を常時受信状態としたシステム

図９は本発明による列車通信システムの第２実施形態であり、この実施形態にあっては地上側を常時受信状態として車上側から自動的に列車情報信号を送信するようにしたことを特徴とする。

【００６１】図９において、保守作業などのために地上側に設置された地上通信装置１２は、常時受信状態にある。これに対し軌道２を走行する列車１に搭載された車上通信装置１０は、例えば一定周期ごとに繰り返し列車情報信号Ｅ１１を送信している。このため、列車１が地上通信装置１２に接近して車上通信装置１０から送信している列車情報信号Ｅ１１の通信エリアが地上通信装置１２に入ると、地上通信装置１２で列車情報信号Ｅ１１が受信され、列車情報信号Ｅ１１に含まれる列車番号などの列車情報に基づく表示や接近警報の発生を行う。

【００６２】地上通信装置１２は、列車情報信号Ｅ１１を受信すると確認信号Ｅ１２を送信する。この場合の車上通信装置１０の構成は図２のブロック図と同じであり、また地上通信装置１２も図３のブロック図と同じになる。

【００６３】図１０は図９のシステムにおける車上通信装置１０の通信処理のフローチャートである。車上通信装置１０はステップＳ１で内部タイマなどで決まる一定周期ごとの送信タイミングを判別しており、送信タイミングを判別するとステップＳ２に進み、列車番号などの列車情報を作成し、ステップＳ３でキャリアセンスあるいは送受信タイミング制御などによる重複送信回避処理を行った後、ステップＳ４で地上通信装置１２に対し列車情報信号Ｅ１１を送信する。

【００６４】続いてステップＳ５で地上通信装置１２からの再送要求信号の受信をチェックし、もし再送要求信号を受信すれば、ステップＳ３で再度列車情報信号の送信を行う。またステップＳ６で地上通信装置１２からの確認信号の受信をチェックしており、確認信号を受信すると、ステップＳ７で送信処理を正常終了し、一方、確認信号を受信しなければステップＳ３に戻って再度列車情報信号の送信を繰り返す。そしてステップＳ８で電源停止などに先立つ終了指示があるまで、ステップＳ１からの処理を繰り返している。

【００６５】図１１は図９のシステムにおける地上通信装置１２の通信処理のフローチャートである。地上通信装置１２は、ステップＳ１で車上通信装置１０からの列車情報信号の受信待ち状態にあり、列車情報信号を受信すると、ステップＳ２でＥＣＣや比較照合などにより受信情報のエラー判定を行った後、ステップＳ３で受信エラーがなく正常受信できれば、ステップＳ４で確認信号を送信した後、ステップＳ５で例えば列車接近警報を出し、またステップＳ６で受信情報の表示を行う。

【００６６】ステップＳ３で受信エラーを判別すると、ステップＳ８で再送要求を行う。このようなステップＳ１～Ｓ６の処理を、装置停止に先立つ終了指示があるまで繰り返す。また車上通信装置１０から一度正常に列車情報信号を受信して列車番号や列車情報が得られた後は、受信済みの列車番号と新たに受信した列車番号との比較照合を行い、一致した場合には受信情報の表示や警報処理を行わないようにすることで、同じ列車からの列車情報の受信処理の繰り返しを回避することができる。

３．地上側に軌道回路を接続したシステム

図１２は本発明による列車通信システムの第３実施形態であり、この実施形態にあっては地上通信装置に軌道回路を接続して、接続区間に対する列車の接近検出に基づいて送信要求を行うようにしたことを特徴とする。

【００６７】図１２において、保守作業などのために設置した地上通信装置１２に対しては、設置場所の閉塞区間３について設けられた軌道回路３８の出力が接続されている。軌道回路３８は軌道２の閉塞区間３に列車１が進入した時に接近検出信号Ｅ３を地上通信装置１２に出力する。

【００６８】図１３は図１２の地上通信装置１２のブロック図である。地上通信装置１２は、制御部２６、無線部２８、アンテナ３０、メモリ３２、表示部３４、警報発生部３６を備え、これらは図３のブロック図と同じであるが、新たに制御部２６に対し接点入力部４０を設けており、接点入力部４０に対し図１２の軌道回路３８から出力される接近検出信号Ｅ３を接点情報として入力している。　このため地上通信装置１２は、軌道回路３８において軌道２の閉塞区間３に列車１が進入して接近検出信号Ｅ３が得られ、この接近検出信号Ｅ３が接点入力部４０に入力したことを制御部２６が認識し、無線部２８、アンテナ３０より車上通信装置１０に対し送信要求信号Ｅ１を送信する。

【００６９】このように地上通信装置１２からの送信要求信号Ｅ１の送信を軌道回路３８に連動させることで、列車１が接近した場合にのみ地上通信装置１２から送信要求を行うことができ、列車が接近していない場合には地上通信装置１２の送信動作を行わないことで消費電力を減らすことができる。特に地上通信装置１２はバッテリーで動作する携帯型の装置であることから、軌道回路３８に送信動作を連動させることで消費電力を大幅に低減できる。

【００７０】尚、図１３の接点入力部４０に手動スイッチを接続し、保守作業員のマニアル操作で送信要求信号を列車に送信することもできる。

【００７１】図１４は図１２の軌道回路３８を接続した地上通信装置１２における通信処理のフローチャートである。地上通信装置１２は、ステップＳ１で接点入力、即ち地上通信装置１２の設置場所に対応した閉塞区間３に設けている軌道回路３８による接近検出信号の入力に基づく接点入力をチェックしており、接点入力があるとステップＳ２に進み、送信要求信号を車上通信装置１０に対し送信するようになる。

【００７２】接点入力に基づいて送信要求信号を車上通信装置１０に送信した後のステップＳ３～Ｓ１０の処理は、図５の第１実施形態の地上通信装置１２の処理と同じである。また図１２のシステムにおける車上通信装置１０の通信処理は図６のフローチャートに示した第１実施形態と同じである。

４．複数装置を設置したシステム

図１５は本発明による列車通信システムの第４実施形態であり、この実施形態にあっては地上通信装置を複数設置したことを特徴とする。

【００７３】まず保守作業などを行う地上側は、例えば軌道２の閉塞区間３Ａ，３Ｂに対応して地上通信装置１２Ａ，１２Ｂを設置している。列車１の進入側となる閉塞区間３Ａに設けた軌道回路３８は、図１２，図１３の

第３実施形態のように地上通信装置１２Ａに接続し、軌道回路３８による接近検出信号Ｅ３により地上通信装置１２Ａより送信要求信号Ｅ１を車上通信装置１０に送信するようにしている。

【００７４】地上通信装置１２Ａに続いて閉塞区間３Ｂに配置された地上通信装置１２Ｂは、地上通信装置１２Ａの通信エリアに入るように設置されている。このため、地上通信装置１２Ａ，１２Ｂ間で必要に応じて情報の通信を行うことができる。また列車１の進入側に設置した地上通信装置１２Ａに対し、地上通信装置１２Ｂは保守作業員が携帯するようにしても良い。

【００７５】次に図１５の第４実施形態の動作を説明する。地上通信装置１２Ａ，１２Ｂは常時受信待機状態となっている。軌道２を走行する列車１が接近して閉塞区間３Ａに進入すると、軌道回路３８が列車１の進入による短絡に基づき、接近検出信号Ｅ３を地上通信装置１２Ａに出力する。この接近検出信号Ｅ３を受けた地上通信装置１２Ａは、車上通信装置１０に対し送信要求信号Ｅ１を送信し、同時に地上通信装置１２Ｂに対し列車接近を示す転送信号Ｅ４を転送する。

【００７６】地上通信装置１２Ａからの送信要求信号Ｅ１を受けた車上通信装置１０は、列車番号などの列車情報信号Ｅ２を送信し、地上通信装置１２Ａが列車情報信号Ｅ２を受信して受信情報の表示や接近警報の発生を行う。同時に地上通信装置１２Ａは、受信した列車情報を地上通信装置１２Ｂに転送信号Ｅ４として転送し、地上通信装置１２Ｂ側においても接近警報や列車情報の表示が行われる。

【００７７】図１６は、図１５のシステムに設けた地上通信装置１２Ａの通信処理のフローチャートである。まずステップＳ１で軌道回路３８による閉塞区間３Ａに対する列車１の進入による接近検出信号Ｅ３に基づく接点入力をチェックしており、接点入力があるとステップＳ２で送信要求信号Ｅ１を車上通信装置１０に送信する。続いてステップＳ３で他の地上通信装置１２Ｂに対し列車接近信号を送信する。

【００７８】ステップＳ４では列車情報信号Ｅ２の受信をチェックしており、列車情報信号Ｅ２を受信すると、ステップＳ５でエラー判定を行う。ステップＳ６で受信エラーがなければ、ステップＳ７で確認信号を送信し、ステップＳ８で他の地上通信装置１２Ｂに列車情報信号を転送した後、自分自身での列車接近警報をステップＳ９で行い、また自己の表示部に対する受信情報の表示をステップＳ１０で行う。またステップＳ６で受信エラーがあれば、ステップＳ１２で再送要求を行う。

【００７９】図１５のシステムにおける車上通信装置１０の通信処理は、図６に示した第１実施形態の場合と同じである。また図１５のシステムにあっては２台の地上通信装置１２Ａ，１２Ｂを使用した場合を例にとっているが、３台以上の複数台についても全く同様に適用できる。

【００８０】更に図１５の他の形態として、列車１が複数車両を連結しているような場合には、先頭車両と最後尾車両にそれぞれ車上通信装置１０を設ける。このように先頭車両と最後尾車両にそれぞれ車上通信装置１０を設置した場合には、先頭車両の車上通信装置が保守区間の進入位置に設置した地上通信装置１２Ａを通過して、その通信エリアを通り過ぎても、最後尾車両に設置している車上通信装置１０が地上通信装置１２Ａの通信エリアに進入して通信を行うことができる。

【００８１】これによって連結の長い列車であっても地上通信装置１２Ａの設置場所を通過する間、車上側との間で通信を継続できる。もちろん、列車１側に設置する車上通信装置１０についても、先頭車両と最後尾車両を含む複数車両に３台以上設置しても良い。このように車上通信装置及び地上通信装置を複数使用する形態は、図１，図９のシステムについてもそのまま適用できる。

５．地上側から設定情報を車上側に送信するシステム

図１７は本発明による列車通信システムの第５実施形態であり、この実施形態にあっては地上通信装置側から予め設定した情報を車上通信装置に送信するようにしたことを特徴とする。

【００８２】図１７において、保守区間などに設置された地上通信装置１２は、例えば一定周期ごとに送信要求信号Ｅ１を送信している。この送信要求信号Ｅ１は図４（Ａ）のフォーマットを持ち、データ６２の先頭に位置する軌道情報６６に続き、地上通信装置１２側で設定した各種の設定情報が含まれている。

【００８３】図１８は図１７の地上通信装置１２のブロック図である。地上通信装置１２は図３の第１実施形態と同様、制御部２６、無線部２８、アンテナ３０、メモリ３２、表示部３４及び警報発生部３６を備えるが、これに加えて新たに情報設定部４２とインターフェース部（Ｉ／Ｆ部）４４を設けている。

【００８４】情報設定部４２あるいはインターフェース部４４は、車上通信装置１０に対する送信要求信号Ｅ１に含まれる設定情報を予めメモリ３２に蓄えておく。地上通信装置１２から車上通信装置１０に送信する設定情報としては、

(1)列車の制限速度情報

(2)保守作業中であることを示す情報

などがある。図１７の車上通信装置１０は図２の第１実施形態のブロック図と同じである。

【００８５】次に図１７，図１８のシステム動作を説明する。地上通信装置１２は例えば一定周期ごとに車上通信装置１０に対し送信要求信号Ｅ１を送信しており、この送信要求信号Ｅ１には図１８の情報設定部４２あるいはインターフェース部４４により予め設定されたメモリ３２に蓄えられた列車制御速度情報などの設定情報が含まれている。

【００８６】列車１が地上通信装置１２に接近してその通信エリアに入ると、地上通信装置１２からの送信要求信号Ｅ１が受信され、ＥＣＣ処理やデータ比較処理などにより正常データの受信であることを判断すると、表示部に受信した設定情報例えば列車制限速度を表示し、必要があれば警報発生を行う。

【００８７】このため、保守作業を行っている地上通信装置１２に接近した列車１の運転士は送信要求信号Ｅ１の受信で得られた制限速度となるように列車の減速を行い、地上通信装置１２が設置されている保守作業の区間を安全に通過することができる。

【００８８】また図１７の第５実施形態にあっては、通信エリアを越えて設置されている２台の地上通信装置の間の通信を車上通信装置１０を経由して中継することができる。即ち、車上通信装置１０の制御部に再生中継機能を持たせておくことで、ある地上通信装置の送信要求信号から設定情報を復調した場合、この復調した設定情報を再度変調して送信することで、別の地上通信装置に設定情報を中継伝送することができる。

【００８９】図１９は、図１７，図１８の第５実施形態に設けた地上通信装置１２における通信処理のフローチャートである。地上通信装置１２は、ステップＳ１で制限速度情報や保守作業中情報などの情報を情報設定部４２あるいはインターフェース部４４により設定することでメモリ３２に予め蓄える。続いてステップＳ２で内部タイマなどによる一定周期の送信要求タイミングを判別すると、ステップＳ３に進み、メモリ３２に蓄えた設定情報を含む送信要求信号を車上通信装置１０に対し送信する。

【００９０】続いてステップＳ４で列車情報信号Ｅ２の受信を待ち、列車情報信号を受信すると、ステップＳ５でＥＣＣや比較照合などによりエラー判定を行った後、受信エラーがなければステップＳ６からＳ７に進んで確認信号を送信する。受信エラーがあればステップＳ１１で再生要求を行う。確認信号をステップＳ７で送信すると、ステップＳ８で例えば列車接近警報を行った後、ステップＳ９で受信情報の表示を行い、ステップＳ１０で終了指示があるまで、ステップＳ２からの処理を繰り返す。

【００９１】図２０は図１７の車上通信装置１０の通信処理のフローチャートである。車上通信装置１０は、ステップＳ１で地上通信装置１２からの送信要求信号Ｅ１の受信をチェックしている。地上通信装置１２からの送信要求信号Ｅ１を受信すると、ステップＳ２で列車番号などの情報を含む送信要求応答情報を作成し、ステップＳ３で重複送信回避処理を行った後、ステップＳ４で列車情報信号Ｅ２を地上通信装置１２に送信する。

【００９２】続いてステップＳ５で確認信号の受信をチェックし、確認信号が受信されていればステップＳ６で正常終了となり、確認信号が受信できなければステップＳ４で再度列車情報信号を送信する。続いてステップＳ７で送信要求信号Ｅ１に含まれている設定情報を解読し、ステップＳ８で制限速度や保守作業中などの設定情報を表示部に表示し、必要があれば速度警報などを出し、これをステップＳ９で終了指示があるまで繰り返す。

【００９３】勿論、他の地上通信装置１２に対する再生中継機能が制御部に設定されている場合には、ステップＳ８の設定情報の表示と同時に、受信した設定情報を再度変調して送信するようになる。この他の地上通信装置１２に対する設定情報の再生中継の送信は、ステップＳ２の列車情報信号Ｅ２の送信情報に含ませてもよいし、別々に送信しても良い。

６．固定通信装置を備えたシステム

図２１は、本発明による列車通信システムの第６実施形態であり、この実施形態にあっては、車上通信装置及び地上通信装置に加えて、更に駅や基地などの拠点に設置される固定通信装置を設けたことを特徴とする。

【００９４】図２１において、軌道に設置された拠点となる例えば駅４８には、固定無線局として機能する固定通信装置４６が設置されている。固定通信装置４６の構成は図２の第１実施形態について示した車上通信装置１０と同じになる。この固定通信装置４６には、例えば駅４８に設置された拠点装置として例えば中央指令室装置５０が回線接続されている。

【００９５】また、この実施形態にあっては、固定通信装置４６は地上通信装置１２と同様、車上通信装置に対し送信要求信号を送信している。固定通信装置４６による送信要求信号Ｅ５の送信タイミングは、内部タイマによる一定周期ごとでも良いし、例えば図１２の第３実施形態のように軌道回路３８による列車の接近検出に基づくものであっても良い。もちろん、手動スイッチなどによりマニアルで送信要求信号Ｅ５を送信することもできる。

【００９６】駅４８の両側には、この場合には２台の列車１Ａ，１Ｂが走行しており、それぞれ車上通信装置１０Ａ，１０Ｂを搭載している。今、列車１Ａが固定通信装置４６の通信エリアにあり、このため固定通信装置４６からの送信要求信号Ｅ５を受信し、これに対する応答として列車情報信号Ｅ６を送り返している。

【００９７】一方、列車１Ｂは保守作業などのために設置した地上通信装置１２の通信エリアにあり、地上通信装置１２からの送信要求信号Ｅ１を車上通信装置１０Ｂが受信し、列車情報信号Ｅ２を地上通信装置１２に送り返している。

【００９８】固定通信装置４６からの送信要求信号Ｅ５には、送信要求となる軌道情報に加えて、中央指令室装置５０から伝送された運行状況を示す情報が含まれている。この運行状況を示す情報としては

(1)ダイヤの運行状況

(2)ダイヤが乱れている際の復旧見込み
(3)保守作業を行っている位置
(4)前の列車の通過時間
などがある。
【００９９】一方、固定通信装置４６からの送信要求信号Ｅ５を受信した車上通信装置１０Ａは、列車情報信号Ｅ６を送信するが、この列車情報信号Ｅ６には列車番号などの列車情報に加え、保守区間に設置した地上通信装置１２との通信で得られた保守状況を示す情報を含めて送信する。このように車上通信装置１０Ａから送信される保守状況を示す情報としては
(1)保守作業の進行状況
(2)事故などが起こった時の状況
などがある。
【０１００】一方、固定通信装置４６との通信を終了した後に地上通信装置１２の設置場所を通過する列車１Ｂの車上通信装置１０Ｂにあっては、地上通信装置１２から送信要求信号Ｅ１を受信した際に返送する列車情報信号Ｅ２に、列車番号などの列車情報に加え、固定通信装置４６との通信で得られた中央指令室装置５０からの運行情報例えばダイヤの運行状況、ダイヤが乱れている際の復旧見込み、保守作業を行っている位置、前の列車の通過時間などを送信し、これらの運行状況を示す情報を地上通信装置１２側に知らせることができる。
【０１０１】次に図２１のシステム動作を説明する。列車１Ａが駅４８に接近して固定通信装置４６の通信エリアに入ると、送信要求信号Ｅ５を受信する。この送信要求信号Ｅ５には中央指令室装置５０から固定通信装置４６に転送されたダイヤ運行状況などの運行状況に関する情報が含まれており、この運行状況に関する情報を車上通信装置１０Ａで運転士に表示し、中央指令室装置５０からの指令をリアルタイムで列車１Ａの運転士に伝えることができる。
【０１０２】固定通信装置４６からの送信要求信号Ｅ５を受信した車上通信装置１０Ａは、列車情報信号Ｅ６として列車番号などの列車情報に加えて、保守区間などに設置された地上通信装置との通信で得られた保守状況を示す情報を固定通信装置４６に通信し、固定通信装置４６は列車側から受信した保守状況を示す情報を中央指令室装置５０に転送して保守の進行状況などを伝えることができる。
【０１０３】また車上通信装置１０Ａは送信要求信号Ｅ５によって固定通信装置４６から送られた運行状況を示す情報の内、列車に関する情報については表示や警報を行うが、地上通信装置１２に対する情報についてはメモリに蓄えておき、列車１Ｂのように地上通信装置１２の通信エリアに入った時に列車情報信号Ｅ２により運行状況などの情報として地上通信装置１２に送信して表示させ、これによって中央指令室装置５０からの指令を固定通信装置４６の通信エリアから遠く離れた場所に設置されている地上通信装置１２に伝えることができる。
【０１０４】図２２は、図２１の固定通信装置４６の通信処理のフローチャートである。固定通信装置４６はステップＳ１で例えば内部タイマによる一定周期ごとの送信要求タイミングをチェックしており、送信要求タイミングになるとステップＳ２に進み、このとき中央指令室装置５０から送られてきているダイヤ運行状況、ダイヤ復旧見込み、保守作業位置、先行列車通過時刻などの情報を含む送信要求信号Ｅ５を送信する。
【０１０５】続いてステップＳ３で列車情報信号の受信をチェックしており、列車情報信号が受信されると、ステップＳ４でエラー判定を行い、ステップＳ５で受信エラーがなければ、ステップＳ６で確認信号を送信する。受信エラーがあればステップＳ９で再送要求を行う。ステップＳ６で確認信号を送信した後は、ステップＳ７で列車情報信号の受信情報に含まれる中央指令室装置５０に必要な保守作業進行状況、列車番号、事故状況などの必要情報を抽出して、拠点としての例えば中央指令室装置５０に送信する。
【０１０６】図２３は、図２１のシステムにおける車上通信装置１０Ａ，１０Ｂの通信処理のフローチャートである。ステップＳ１で送信要求信号を受信すると、ステップＳ２で固定通信装置４６からの送信要求信号か否かチェックする。固定通信装置４６からの送信要求信号であれば、ステップＳ３に進み、列車番号などの列車情報に加え、保守区間などに設置した地上通信装置１２との通信で得られた保守作業進行状況、事故状況などの受信情報を含む応答情報を作成し、ステップＳ５で重複送信回避処理を行った後、ステップＳ６で列車情報信号として固定通信装置４６に対し送信する。
【０１０７】一方、地上通信装置１２からの送信要求信号であった場合には、ステップＳ４に進み、既に固定通信装置との通信により地上側に伝える運行状況の情報があれば、この情報を抽出して列車番号などの列車情報と共に応答情報を作成し、同様にステップＳ５で重複送信回避処理を行った後、ステップＳ６で地上通信装置１２に対し列車情報信号を送信する。
【０１０８】固定通信装置４６または地上通信装置１２に列車情報信号を送信した後については、ステップＳ７で確認信号の受信をチェックし、確認信号を受信できればステップＳ８で送信処理を正常終了とし、受信できなければステップＳ１０で送信処理を異常終了とし、ステップＳ９で終了指示があるまで、ステップＳ１からの処理を繰り返す。
７．監視カメラを備えたシステム
図２４は本発明の列車通信システムの第７実施形態であり、この実施形態にあっては、固定通信装置に監視カメラを接続して、列車側に駅や基地などの拠点の画像情報を伝送するようにしたことを特徴とする。
【０１０９】図２４において、拠点となる駅４８には固

定通信装置４６が設置されている。固定通信装置４６は図２の第１実施形態と同じ構成を備える。固定通信装置４６には監視カメラ５２が接続されており、監視カメラ５２で撮影した駅４８の画像情報を車上通信装置１０に対する送信要求信号Ｅ５に含ませている。

【０１１０】固定通信装置４６から車上通信装置１０に送信する監視カメラ５２で撮影した画像情報は、静止画像であることから例えばＭＰＥＧ１に従って変調し、これを車上通信装置１０側で復調してディスプレイなどの表示部に表示させる。

【０１１１】図２５は図２４の監視カメラ５２を接続した固定通信装置４６の通信処理のフローチャートである。まずステップＳ１で監視カメラ５２の撮影画像情報をメモリに格納する。続いてステップＳ２で内部タイマなどによる一定周期の送信要求タイミングか否かチェックし、送信要求タイミングを判別すると、ステップＳ３で監視カメラで撮像した画像情報を含む送信要求信号Ｅ５を車上通信装置１０に対し送信する。

【０１１２】続いてステップＳ４で車上通信装置１０からの列車情報信号の受信をチェックしており、列車情報信号を受信すると、ステップＳ５でエラー判定を行った後、ステップＳ６で受信エラーがなければ、ステップＳ７で確認信号を送信し、必要があればステップＳ８で受信情報の表示を行う。またステップＳ６で受信エラーが判別されれば、ステップＳ１０で再送要求を行い、ステップＳ５で再度、画像情報を含む送信要求信号を送信する。

【０１１３】図２６は、図２４のシステムにおける車上通信装置１０における通信処理のフローチャートである。まずステップＳ１で送信要求信号の受信をチェックしており、固定通信装置４６より送信要求信号を受信すると、ステップＳ２で列車番号などの送信要求応答情報としての列車情報を作成し、ステップＳ３で重複送信回避処理を行った後、ステップＳ４で列車情報信号Ｅ６を固定通信装置４６に送信する。

【０１１４】続いてステップＳ５で確認信号の受信をチェックし、確認信号を受信すればステップＳ６で送信処理を正常終了とし、確認信号を受信しなければステップＳ９で送信処理を異常終了とする。ステップＳ６で送信処理が正常終了となった場合には、ステップＳ７で送信要求信号に含まれる画像情報を表示する。

【０１１５】このような固定通信装置４６から監視カメラによる駅などの設置場所の画像が駅に接近する列車でリアルタイムに表示されるため、監視カメラ５２の監視映像に対応した適切な列車１の運転操作を行うことができる。

【０１１６】尚、図２４にあっては、監視カメラ５２の監視対象を駅４８の例えばホームとしているが、踏切などの他の拠点についても同様に適用できる。また監視カメラ５２を接続して画像情報を送信する装置は、固定通信装置４６に限定されず、車上通信装置１０や地上通信装置１２についても全く同様に適用できる。

８．地上設備を監視制御するシステム

図２７は本発明による列車通信システムの第８実施形態であり、この実施形態にあっては、地上通信装置及び車上通信装置によって踏切やポイントなどの地上設備の監視制御を行うようにしたことを特徴とする。

【０１１７】図２７において、この実施形態にあっては地上設備として踏切５６を例にとっており、踏切５６は踏切制御装置５４によって、列車１の運行に伴い、踏切５６の開閉制御を行っている。この踏切制御装置５４は地上通信装置１２に接続されている。地上通信装置１２は例えば一定周期ごとに送信要求信号Ｅ１を送信している。

【０１１８】この送信要求信号Ｅ１には地上設備の状態を示す検出情報、即ち踏切５６の場合には踏切５６の開閉状態を示す検出情報が含まれている。このため、列車１が踏切５６に接近して地上通信装置１２の通信エリアに入ると、送信要求信号Ｅ１が受信でき、送信要求信号Ｅ１に含まれる踏切５６の開閉状態が表示される。

【０１１９】この踏切５６の検出情報の表示に対し、車上通信装置１０側にあっては、装置自身の判断あるいは列車１の運転士の判断により、例えば踏切５６が開いている場合には、地上設備の制御信号として踏切５６の閉鎖制御信号を列車情報信号Ｅ２に含ませて地上通信装置１２に送信する。

【０１２０】このため、列車情報信号Ｅ２を受信した地上通信装置１２は、列車情報信号Ｅ２に含まれる踏切閉鎖信号に基づき踏切制御装置５４を閉鎖制御し、列車１からの指示で踏切５６を閉鎖する。この場合、地上通信装置１２は踏切５６の状態をリアルタイムで列車１側に知らせるため、踏切５６の開閉状態の検出情報を含む送信要求信号Ｅ１を繰り返し車上通信装置１０側に送信する。

【０１２１】また図２７の第８実施形態の他の例として、地上通信装置１２側に特定の列車番号を予め設定しておき、車上通信装置１０との通信で得られた列車番号を設定列車番号と比較し、一致した場合に踏切５６を閉鎖する制御を行うようにしても良い。このように地上通信装置１２側の設定で踏切５６を制御することは、例えば中央指令室の監視外にある保守車両の通過に対する踏切５６の開閉制御に有効である。

【０１２２】図２８は、図２７の実施形態における地上通信装置１２の通信処理のフローチャートである。地上通信装置１２は、ステップＳ１で踏切、ポイントなどの地上設備の種類と状態を検出しており、ステップＳ２で内部タイマによる所定の送信要求タイミングに達すると、ステップＳ３に進み、ステップＳ１で得られた地上設備情報を含む送信要求信号を車上通信装置１０に対し送信する。

【０１２３】続いてステップＳ４で列車情報信号の受信をチェックしており、列車情報信号を受信すると、ステップＳ５で受信情報のエラー判定を行い、ステップＳ６で受信エラーがなければ、ステップＳ７で確認信号を送信し、ステップＳ９で受信情報に地上設備制御信号があるか否かチェックする。もし制御信号があれば、ステップＳ１０で制御信号を地上設備に出力して制御する。もちろん、ステップＳ６で受信エラーがあれば、ステップＳ１２で再送要求を行う。

【０１２４】図２９は図２７の実施形態における車上通信装置１０の通信処理のフローチャートである。車上通信装置１０は、ステップＳ１で送信要求信号の受信をチェックしており、送信要求信号を受信すると、ステップＳ２で送信要求信号に含まれる地上設備情報を表示する。続いてステップＳ３で地上設備が列車の接近に対し正常な状態にあるか否かチェックする。

【０１２５】もし地上設備が列車接近に伴う正常な状態になければ、ステップＳ４で警報出力を行った後、ステップ５で地上設備制御信号を送信する。続いてステップＳ６で確認信号の受信をチェックしており、確認信号を受信すれば、ステップＳ７で送信処理を正常終了とする。一方、確認信号が受信されない場合には、ステップＳ５で確認信号を得るまで地上設備制御信号の送信を繰り返す。

【０１２６】尚、上記の各実施形態は、車上通信装置と地上通信装置、もしくは車上通信装置、地上通信装置、固定通信装置との各々の間で文字や記号などの情報、画像情報を通信する場合を例にとっているが、これ以外に音声データを通信するようにしても良い。このように音声データを通信情報に含めることにより、音声無線などを用いることなく、車上、地上、固定局の相互間で連絡ができ、より安全且つ確実な列車の運行や保守作業ができる。

【０１２７】また本発明は上記の実施形態に限定されず、本発明の目的を損わない範囲で行われる適宜の変形を含む。

【０１２８】

【発明の効果】以上説明してきたように本発明によれば、車上通信装置と地上通信装置、あるいは車上通信装置、地上通信装置、固定通信装置によって列車通信システムを構築することで、列車からの情報を地上側で確実に知ることができ、例えば２線以上の線区であって、列車が同時に各線を走行してきた場合、列車情報信号を正常に受信すれば、同じ列車の繰り返し送信を回避できるため、複数の列車に対しても各列車からの情報を確実に知ることができる。

【０１２９】また保守作業区間に地上通信装置を設置したり保守作業員が携帯していた場合には、保守作業区間に対する列車の接近を確実に知らせて接近警報を出し、また列車番号などから列車の運行状況を把握できることで、保守作業の安全性と作業効率を大幅に向上することができる。

【０１３０】また車上通信装置及び地上通信装置に加えて駅や基地などの拠点に設置する固定通信装置を設けた列車通信システムを構築することで、固定通信装置から中央指令室などから列車に伝えたい運行ダイヤ、運行ダイヤが乱れた場合の復旧見込み、保守作業の位置などをリアルタイムで通知でき、また列車側から固定通信装置を経由して中央指令室などに対し保守の進行状況や事故の状況などを伝えることができ、列車の運行を適切且つ安全に行うことができる。

【０１３１】また車上通信装置、地上通信装置あるいは固定通信装置に監視カメラを接続することで監視場所の画像情報をリアルタイムでモニタでき、列車の運行をより安全に行うことができる。

【０１３２】また踏切やポイントなどの地上設備の状態を地上通信装置から車上通信装置に送って表示させることで、列車の運行状況に応じて地上設備の適切な監視制御ができる。

【０１３３】更に本発明にあっては、地上通信装置から列車通信装置に対し制限速度や保守作業区間ありなどの情報を送信して運転士などに確実に知らせることができ、保守作業区間に進入する際の減速運転や警報の鳴動などを適切に行うことができる。また車上通信装置を中継点として通信エリアが離れた他の地上通信装置との間の連絡ができる。このため列車の運行をより安全に行うことができ、更に通信エリアが離れた異なる保守作業現場の間で互いの進行状況を確認しながら作業を進めることができるため、保守作業の作業効率が向上する。

【図面の簡単な説明】

【図１】車上通信装置を常時受信状態として地上通信装置から送信要求を行う本発明の第１実施形態の説明図

【図２】図１の車上通信装置のブロック図

【図３】図１の地上通信装置のブロック図

【図４】図１の送信要求信号と列車情報信号のフォーマット説明図

【図５】図３の地上通信装置による通信処理のフローチャート

【図６】図２の車上通信装置による通信処理のフローチャート

【図７】図５の地上通信処理における列車番号を含む送信要求処理のフローチャート

【図８】図７の送信要求に対する図６の送信要求応答処理のフローチャート

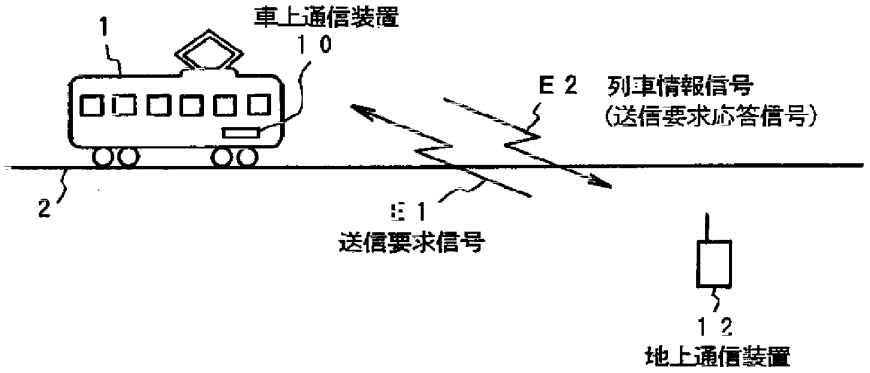
【図９】地上通信装置を常時受信状態として車上通信装置から列車情報信号を送信する本発明の第２実施形態の説明図

【図１０】図９の車上通信装置による通信処理のフローチャート

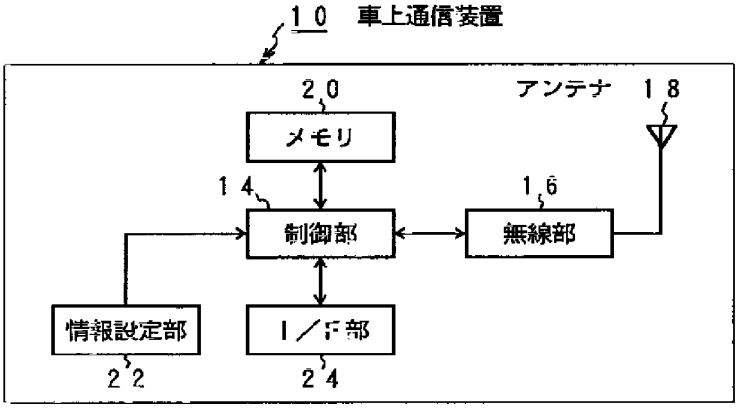
【図１１】図９の地上通信装置による通信処理のフロー

チャート
【図１２】軌道回路からの接近検出信号により地上通信装置から送信要求を行う本発明の第３実施形態の説明図
【図１３】図１２の地上通信装置のブロック図
【図１４】図１３の地上通信装置による通信処理のフローチャート
【図１５】地上通信装置を複数設置した本発明の第４実施形態の説明図
【図１６】図１５の地上通信装置による通信処理のフローチャート
【図１７】車上通信装置で地上側から送られた情報を表示する本発明の第５実施形態の説明図
【図１８】図１７の地上通信装置のブロック図
【図１９】図１８の地上通信装置による通信処理のフローチャート
【図２０】図１８の車上通信装置による通信処理のフローチャート
【図２１】地上通信装置及び車上通信装置に加えて更に地上固定通信装置を設けた本発明の第５実施形態の説明図
【図２２】図２１の固定通信装置による通信処理のフローチャート
【図２３】図２１の車上通信装置による通信処理のフローチャート
【図２４】駅などの拠点に設置した監視カメラの画像を地上側から車上側に送信表示させる本発明の第７実施形態の説明図
【図２５】図２４の固定通信装置による通信処理のフローチャート
【図２６】図２４の車上通信装置による通信処理のフローチャート
【図２７】踏切・ポイント等の地上設備を監視制御する本発明の第８実施形態の説明図
【図２８】図２７の地上通信装置による通信処理のフローチャート
【図２９】図２７の車上通信装置による通信処理のフローチャート
【符号の説明】
１，１Ａ，１Ｂ：列車
２：軌道
３，３Ａ，３Ｂ：閉塞区間
１０：車上通信装置
１２，１２Ａ，１２Ｂ：地上通信装置
１４，２６：制御部
１６，２８：無線部
１８，３０：アンテナ
２０，３２：メモリ
２２，４２：情報設定部
２４，４４：Ｉ／Ｆ部
３４：表示部
３６：警報発生部
３８：軌道回路
４０：接点入力部
４２：情報設定部
４６：固定通信装置
４８：駅（拠点）
５０：指令室装置
５２：監視カメラ
５４：踏切制御装置
５６：踏切
６０，７０：ヘッダ
６２，７２：データ
６４，７４：ＥＣＣコード（エラー検出訂正コード）
６６：起動情報
６８，７６：列車番号（アドレス）
７８：列車情報

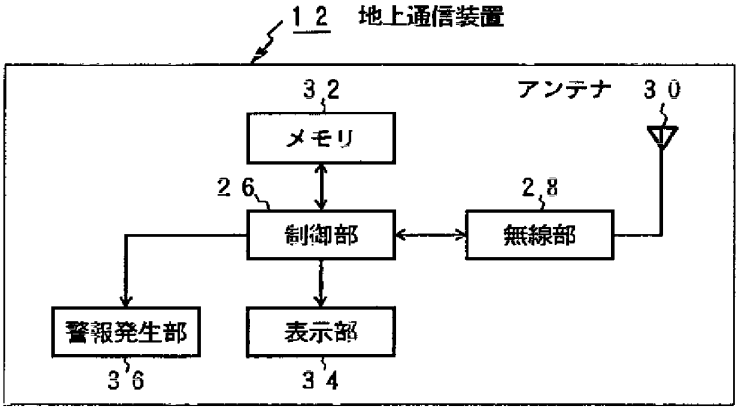
【図１】



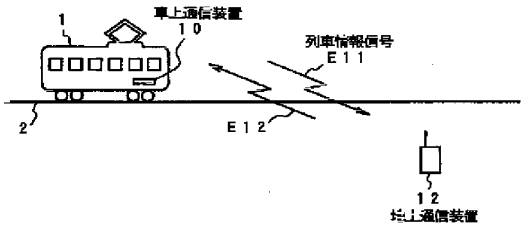
【図２】


１０　車上通信装置
２０
メモリ
アンテナ　１８
１４
１６
制御部
無線部
情報設定部
２２
Ｉ／Ｆ部
２４

【図３】


１２　地上通信装置
３２
メモリ
アンテナ　３０
２６
２８
制御部
無線部
警報発生部
３６
表示部
３４

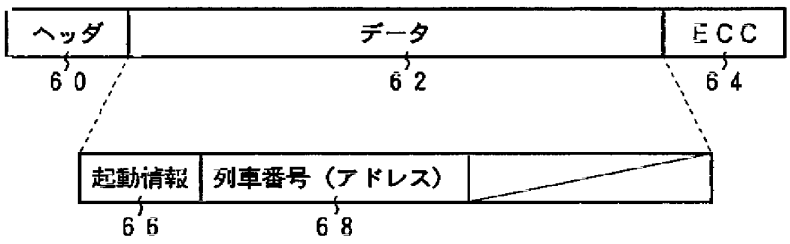
【図９】


車上通信装置
１０
１
列車情報信号
Ｅ１１
２
Ｅ１２
１２
地上通信装置

【図４】

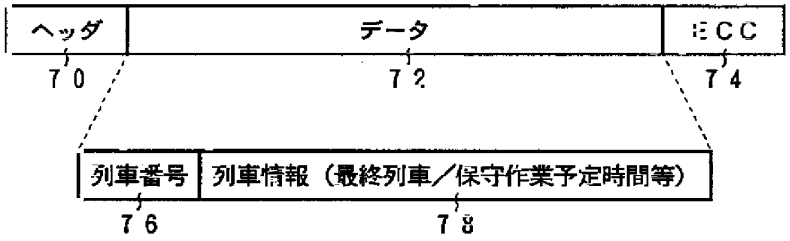
（Ａ）

送信要求信号フォーマット

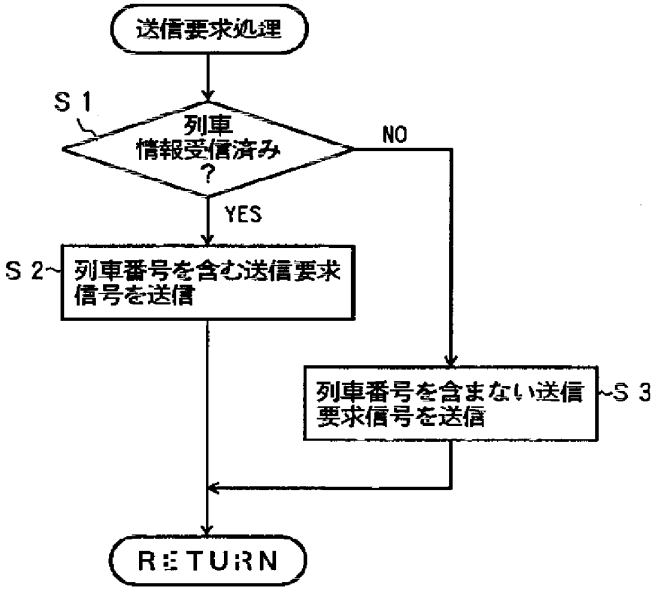


（Ｂ）

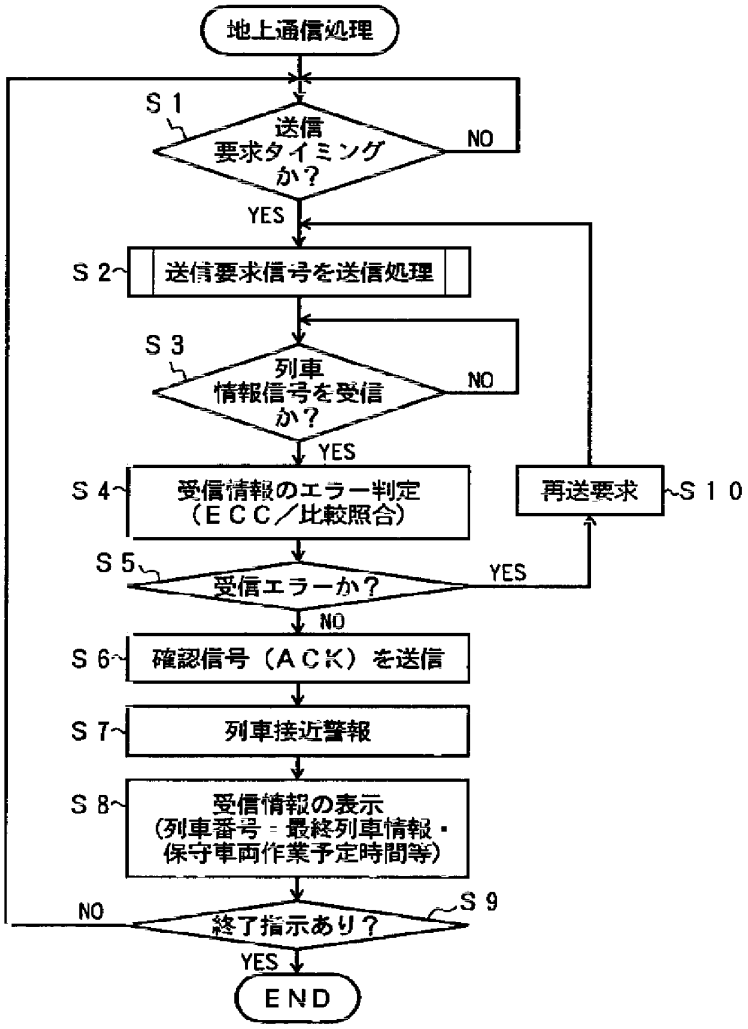
列車情報信号フォーマット



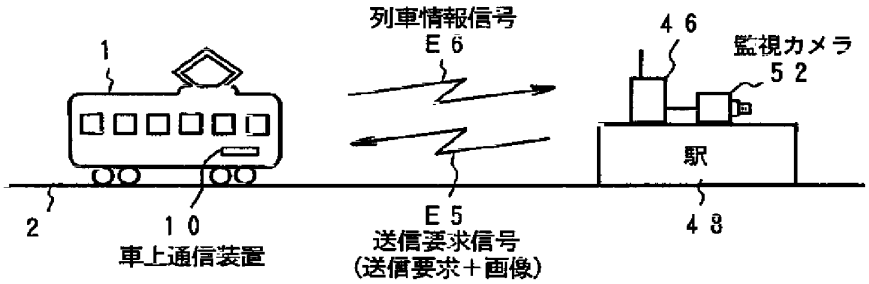
【図７】



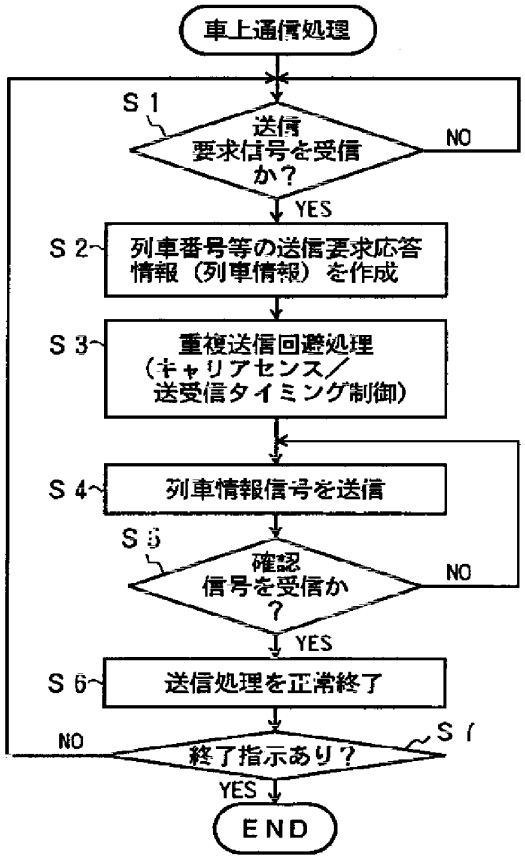
【図５】


地上通信処理
S 1
送信
要求タイミング
か？
NO
YES
S 2
送信要求信号を送信処理
S 3
列車
情報信号を受信
か？
NO
YES
S 4
受信情報のエラー判定
（ＥＣＣ／比較照合）
再送要求
S１０
S 5
受信エラーか？
YES
NO
S 6
確認信号（ＡＣＫ）を送信
S 7
列車接近警報
S 8
受信情報の表示
(列車番号・最終列車情報・
保守車両作業予定時間等)
NO
終了指示あり？
S 9
YES
ＥＮＤ

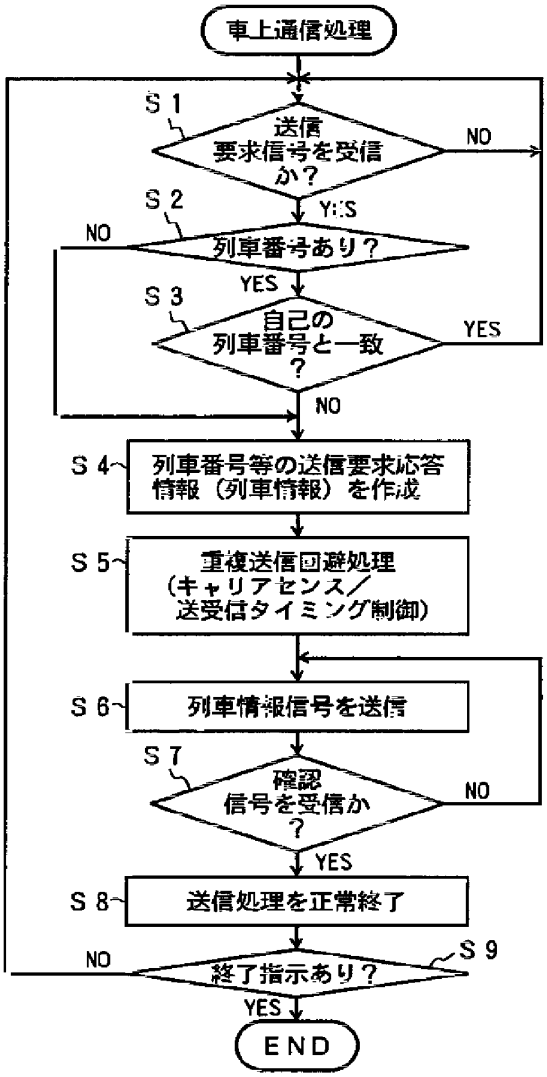
【図２４】


1
列車情報信号
Ｅ６
４６
監視カメラ
５２
駅
2
１０
車上通信装置
Ｅ５
送信要求信号
(送信要求＋画像)
４８

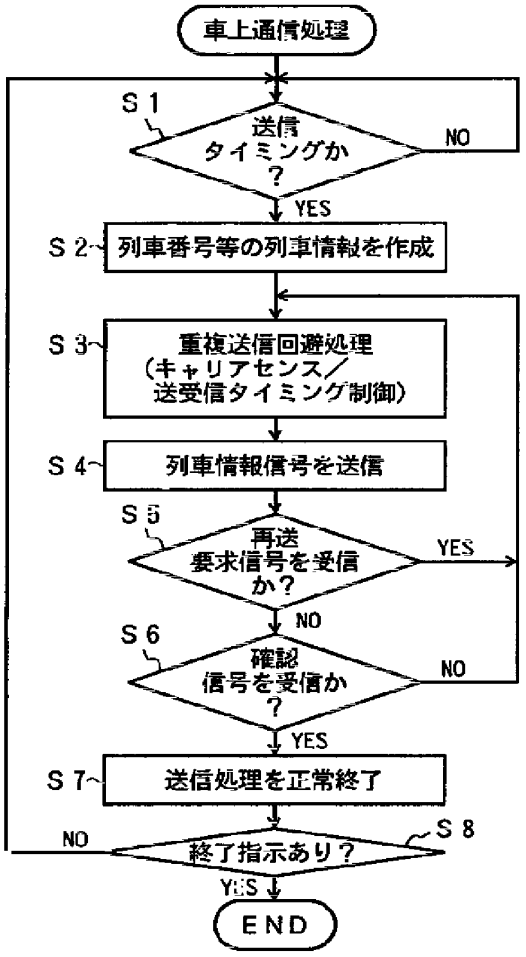
【図６】


車上通信処理
S 1
送信
要求信号を受信
か？
NO
YES
S 2
列車番号等の送信要求応答
情報（列車情報）を作成
S 3
重複送信回避処理
（キャリアセンス／
送受信タイミング制御）
S 4
列車情報信号を送信
S 5
確認
信号を受信か
？
NO
YES
S 6
送信処理を正常終了
NO
終了指示あり？
S 7
YES
END

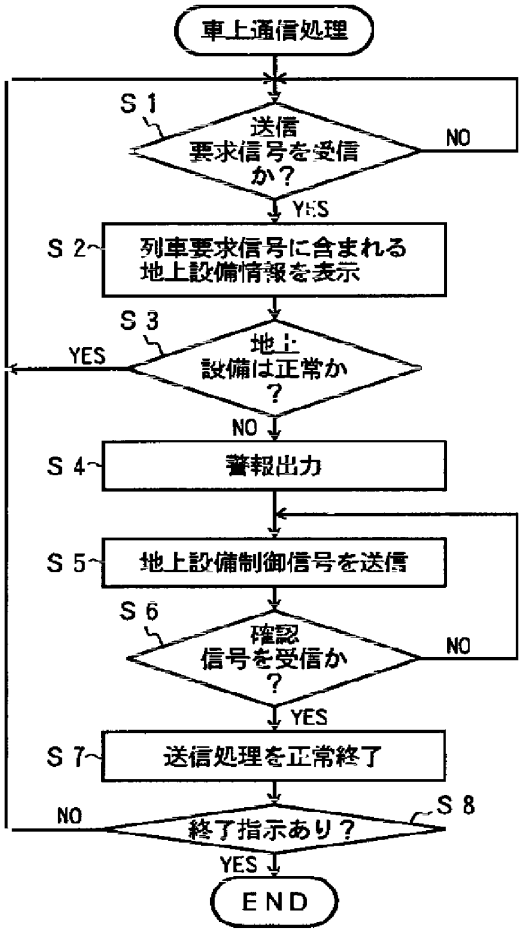
【図８】


車上通信処理
S 1
送信
要求信号を受信
か？
NO
S 2
YES
NO
列車番号あり？
YES
S 3
自己の
列車番号と一致
？
YES
NO
S 4
列車番号等の送信要求応答
情報（列車情報）を作成
S 5
重複送信回避処理
（キャリアセンス／
送受信タイミング制御）
S 6
列車情報信号を送信
S 7
確認
信号を受信か
？
NO
YES
S 8
送信処理を正常終了
NO
終了指示あり？
S 9
YES
END

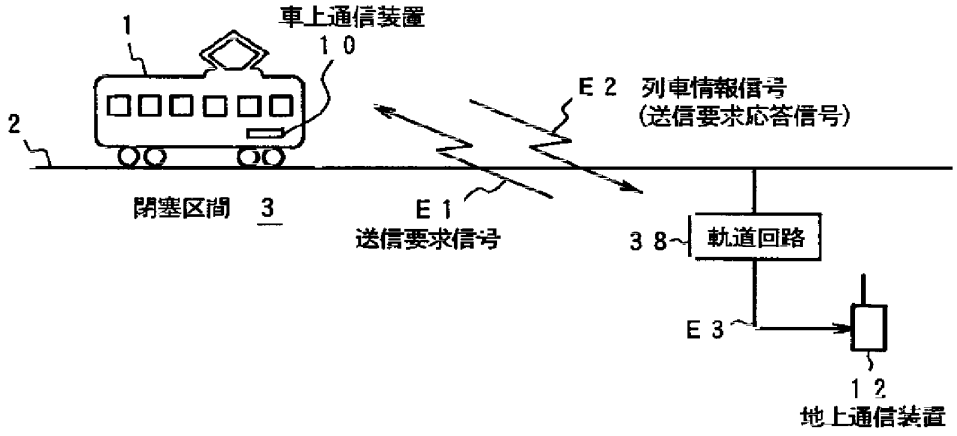
【図10】


車上通信処理
S1
送信タイミングか？
NO
YES
S2
列車番号等の列車情報を作成
S3
重複送信回避処理
(キャリアセンス／送受信タイミング制御)
S4
列車情報信号を送信
S5
再送要求信号を受信か？
YES
NO
S6
確認信号を受信か？
NO
YES
S7
送信処理を正常終了
NO
終了指示あり？
S8
YES
END

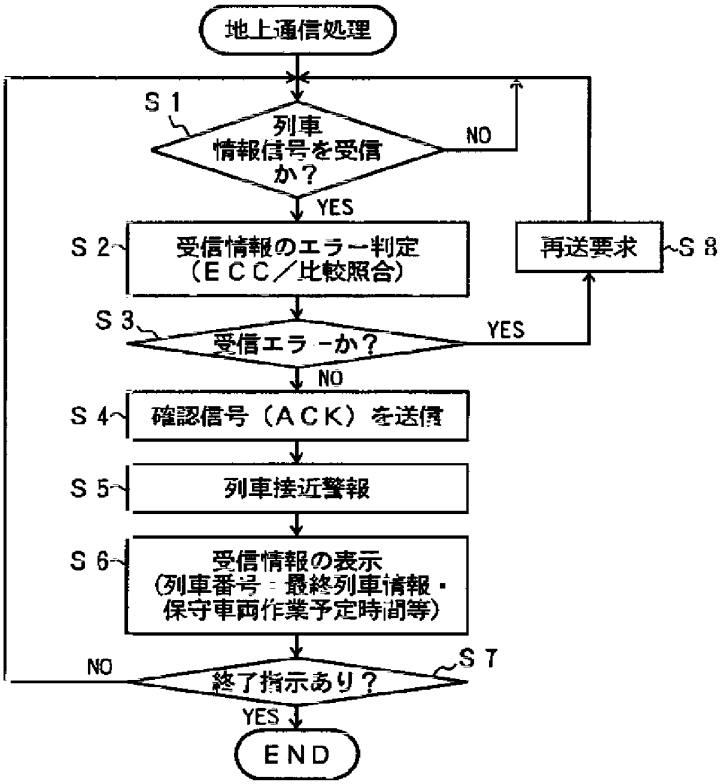
【図29】


車上通信処理
S1
送信要求信号を受信か？
NO
YES
S2
列車要求信号に含まれる地上設備情報を表示
S3
地上設備は正常か？
YES
NO
S4
警報出力
S5
地上設備制御信号を送信
S6
確認信号を受信か？
NO
YES
S7
送信処理を正常終了
NO
終了指示あり？
S8
YES
END

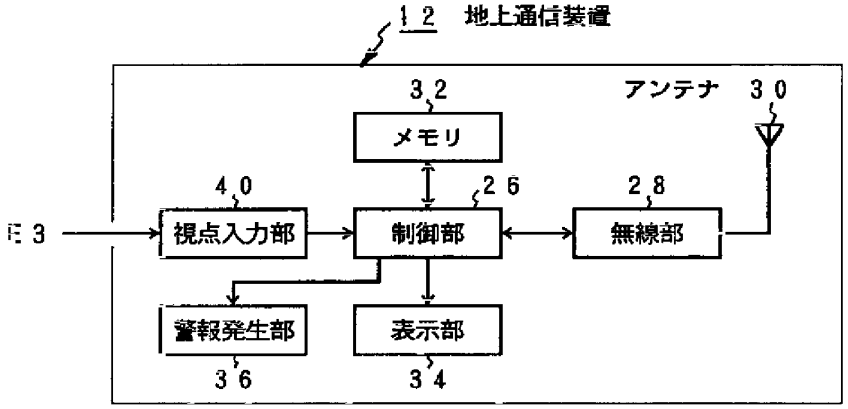
【図12】


1
車上通信装置
10
2
E2 列車情報信号
(送信要求応答信号)
閉塞区間 3
E1
送信要求信号
38
軌道回路
E3
12
地上通信装置

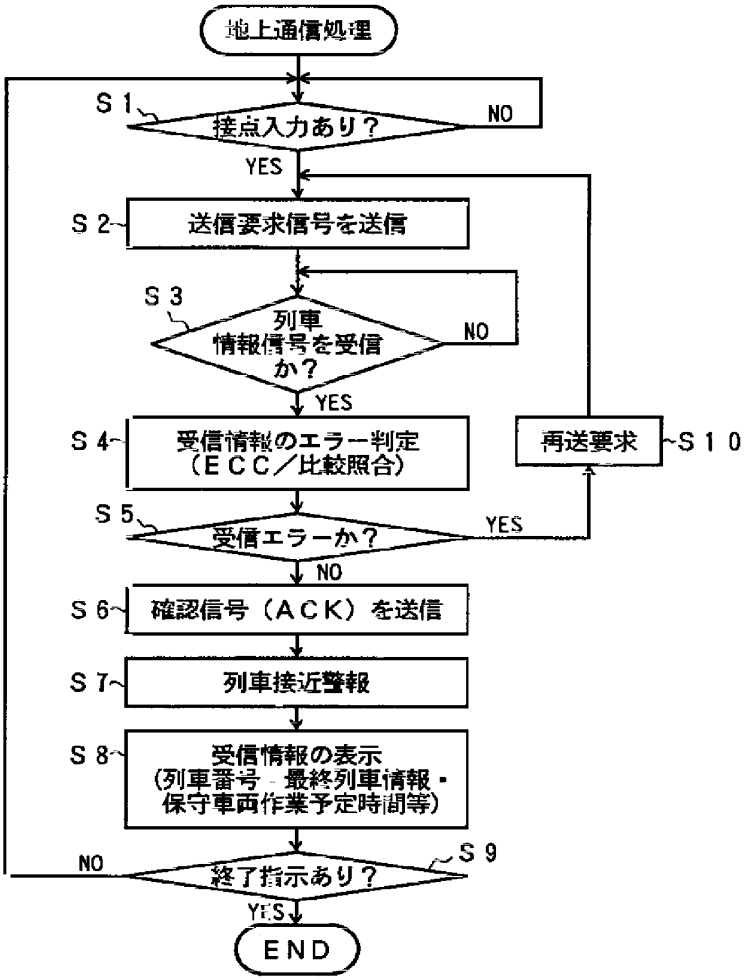
【図１１】


地上通信処理
S 1
列車
情報信号を受信
か？
NO
YES
S 2
受信情報のエラー判定
（ＥＣＣ／比較照合）
再送要求
S 8
S 3
受信エラ －か？
YES
NO
S 4
確認信号（ＡＣＫ）を送信
S 5
列車接近警報
S 6
受信情報の表示
(列車番号・最終列車情報・
保守車両作業予定時間等)
NO
終了指示あり？
S 7
YES
ＥＮＤ

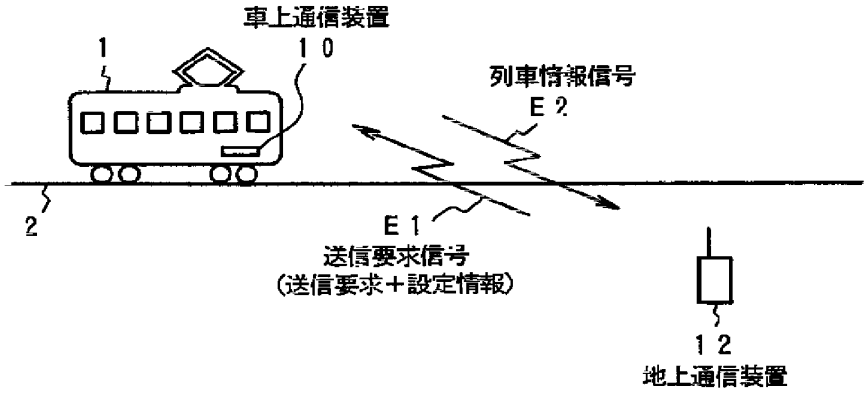
【図１３】


12 地上通信装置
32
メモリ
アンテナ 30
40
26
28
E 3
視点入力部
制御部
無線部
警報発生部
表示部
36
34

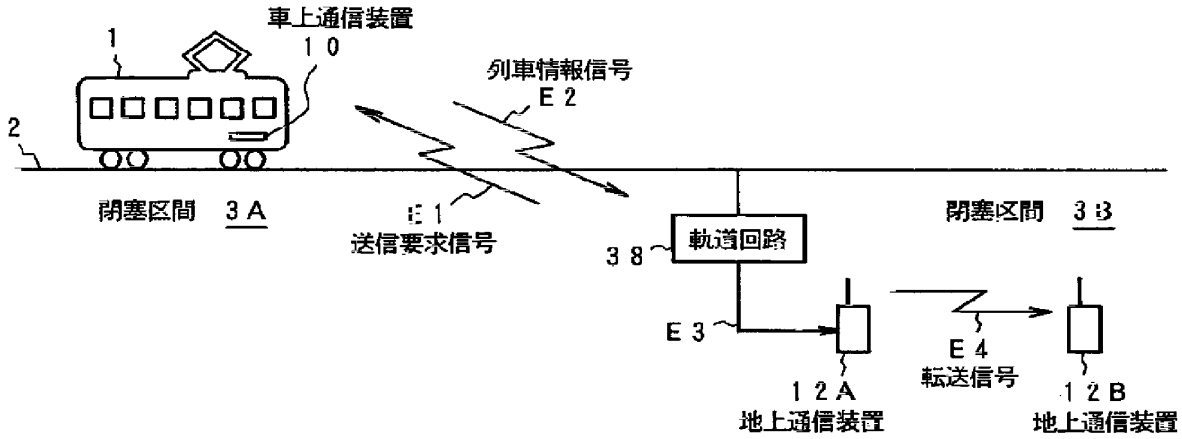
【図１４】


地上通信処理
S 1
接点入力あり？
NO
YES
S 2
送信要求信号を送信
S 3
列車
情報信号を受信
か？
NO
YES
S 4
受信情報のエラー判定
（ＥＣＣ／比較照合）
再送要求
S１０
S 5
受信エラーか？
YES
NO
S 6
確認信号（ＡＣＫ）を送信
S 7
列車接近警報
S 8
受信情報の表示
（列車番号・最終列車情報・
保守車両作業予定時間等）
NO
終了指示あり？
S 9
YES
END

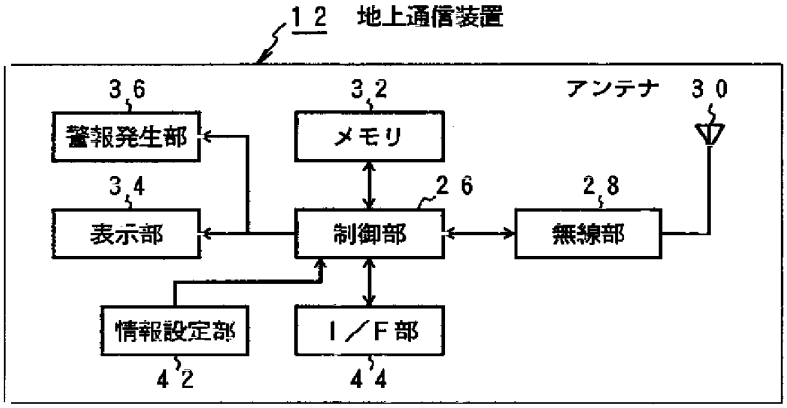
【図１７】


車上通信装置
1
１０
列車情報信号
Ｅ２
2
Ｅ１
送信要求信号
（送信要求＋設定情報）
１２
地上通信装置

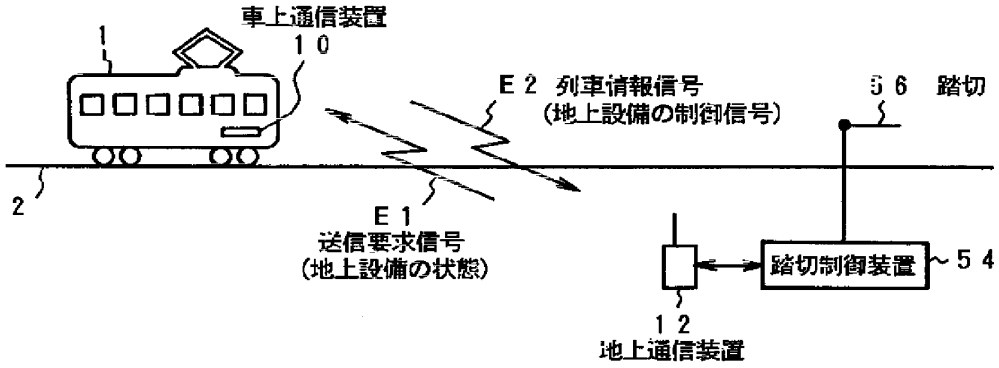
【図１５】


車上通信装置
１０
１
２
列車情報信号
Ｅ２
閉塞区間　３Ａ
Ｅ１
送信要求信号
閉塞区間　３Ｂ
３８
軌道回路
Ｅ３
Ｅ４
転送信号
１２Ａ
地上通信装置
１２Ｂ
地上通信装置

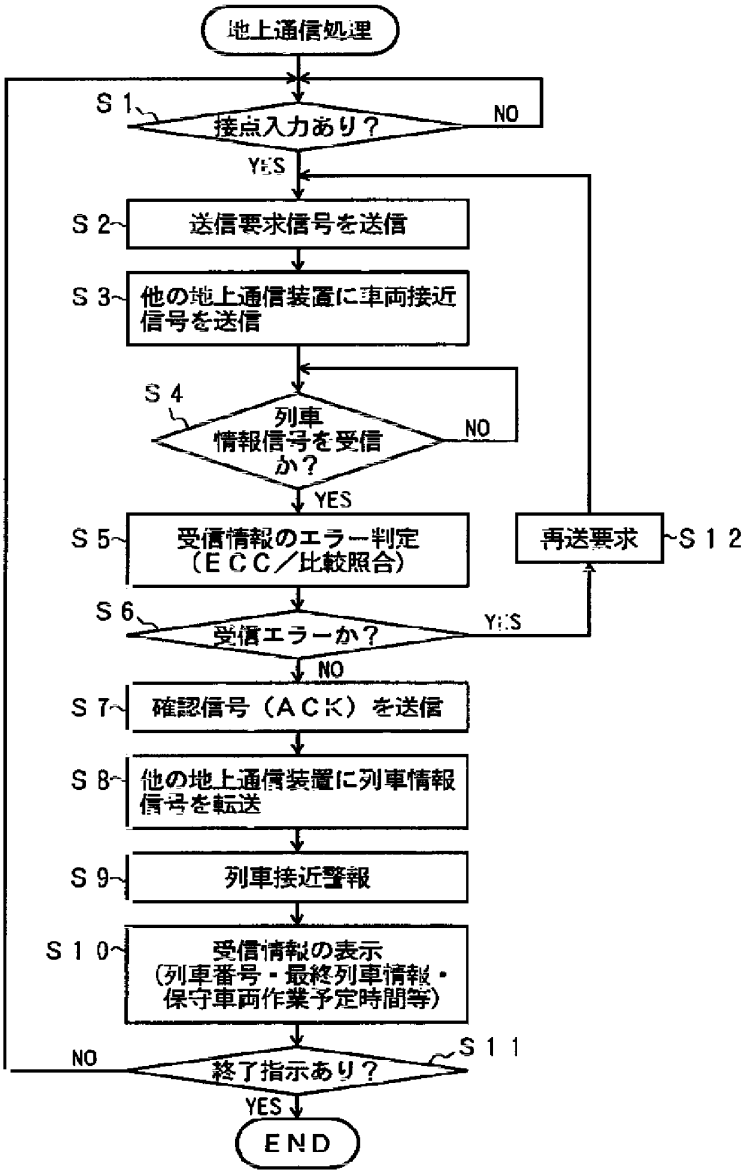
【図１８】


１２　地上通信装置
３６
警報発生部
３２
メモリ
アンテナ　３０
３４
表示部
２６
制御部
２８
無線部
情報設定部
４２
Ｉ／Ｆ部
４４

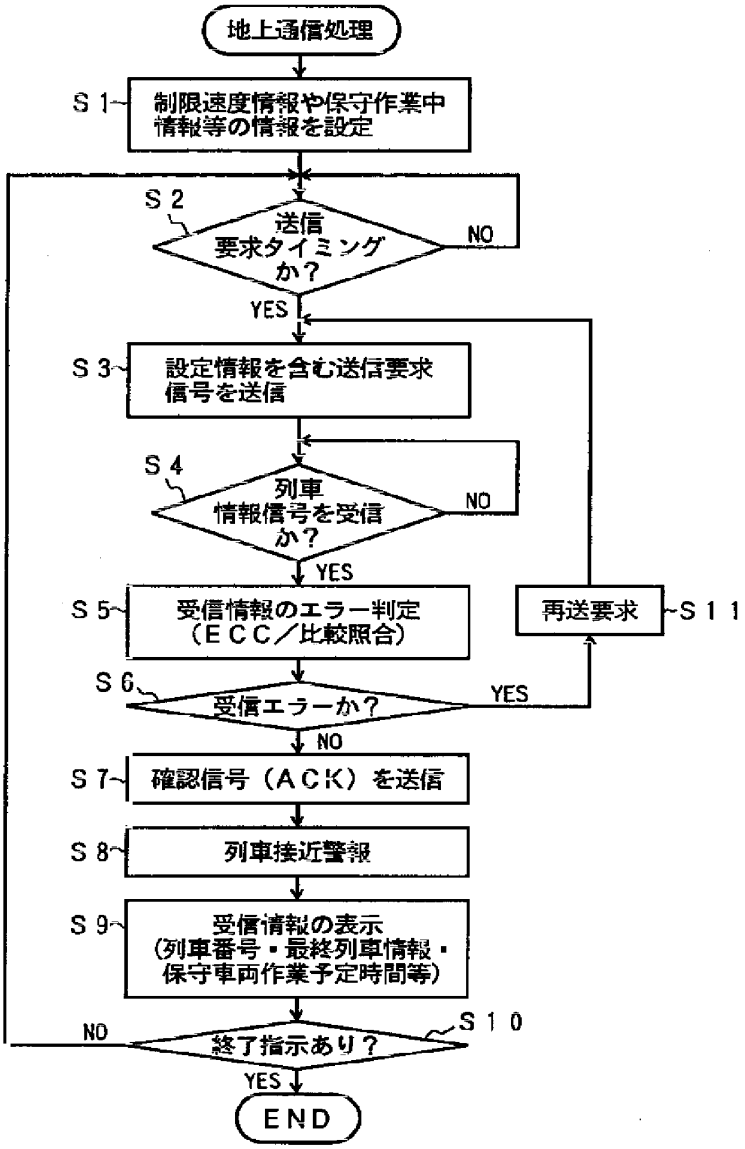
【図２７】


車上通信装置
１０
１
２
Ｅ２　列車情報信号
（地上設備の制御信号）
５６　踏切
Ｅ１
送信要求信号
（地上設備の状態）
踏切制御装置
５４
１２
地上通信装置

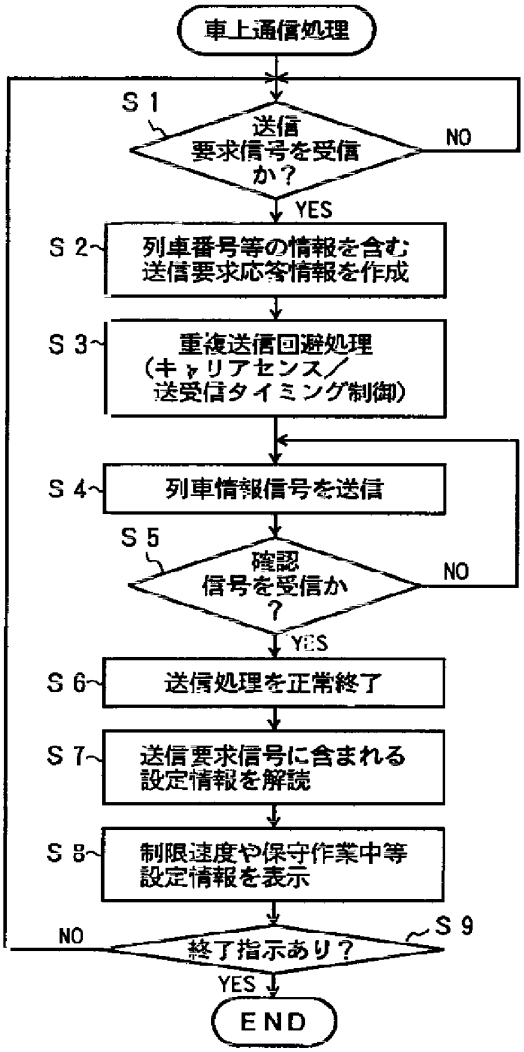
【図16】


地上通信処理
S1
接点入力あり？
NO
YES
S2
送信要求信号を送信
S3
他の地上通信装置に車両接近信号を送信
S4
列車情報信号を受信か？
NO
YES
S5
受信情報のエラー判定（ECC／比較照合）
S6
受信エラーか？
YES
NO
再送要求
S12
S7
確認信号（ACK）を送信
S8
他の地上通信装置に列車情報信号を転送
S9
列車接近警報
S10
受信情報の表示（列車番号・最終列車情報・保守車両作業予定時間等）
S11
終了指示あり？
NO
YES
END

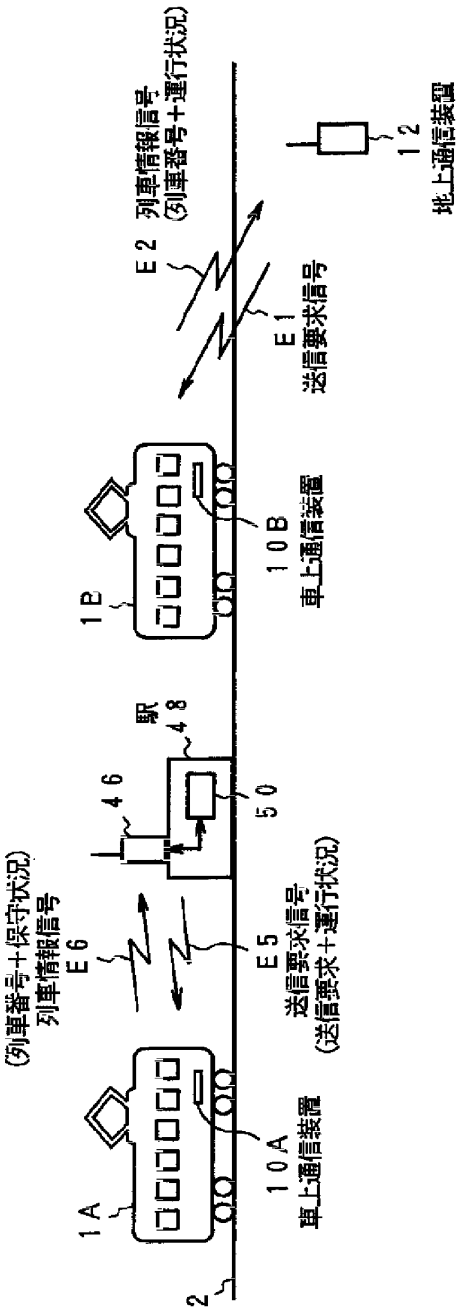
【図19】


地上通信処理
S1
制限速度情報や保守作業中情報等の情報を設定
S2
送信要求タイミングか？
NO
YES
S3
設定情報を含む送信要求信号を送信
S4
列車情報信号を受信か？
NO
YES
S5
受信情報のエラー判定（ＥＣＣ／比較照合）
再送要求
S11
S6
受信エラーか？
YES
NO
S7
確認信号（ＡＣＫ）を送信
S8
列車接近警報
S9
受信情報の表示（列車番号・最終列車情報・保守車両作業予定時間等）
S10
NO
終了指示あり？
YES
END

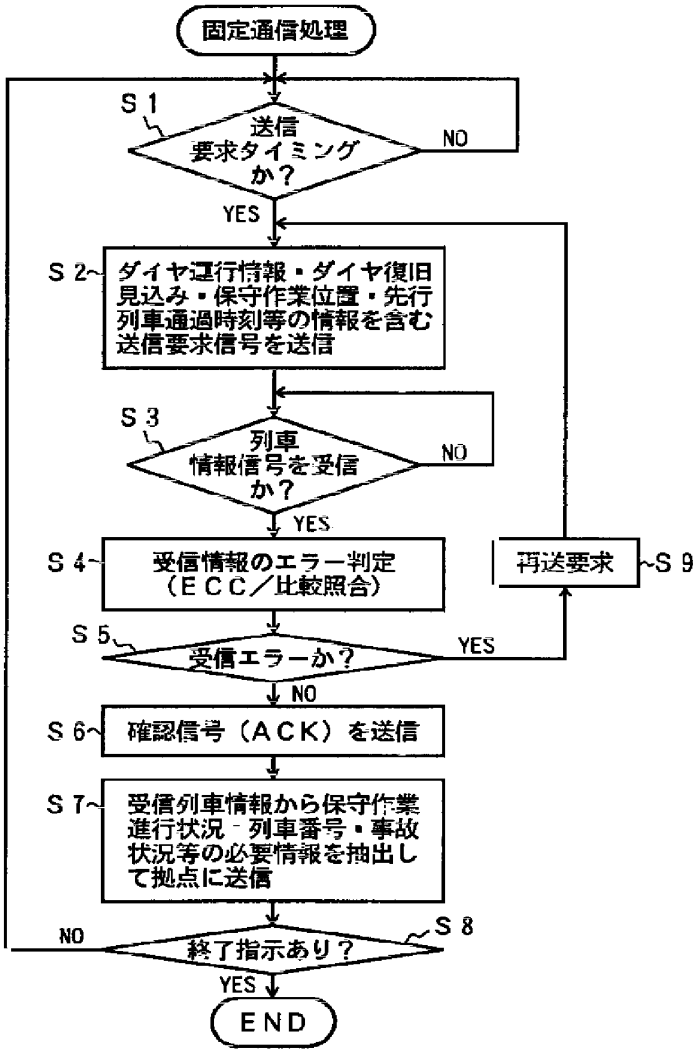
【図２０】


車上通信処理
S 1
送信要求信号を受信か？
NO
YES
S 2
列車番号等の情報を含む送信要求応答情報を作成
S 3
重複送信回避処理（キャリアセンス／送受信タイミング制御）
S 4
列車情報信号を送信
S 5
確認信号を受信か？
NO
YES
S 6
送信処理を正常終了
S 7
送信要求信号に含まれる設定情報を解読
S 8
制限速度や保守作業中等設定情報を表示
S 9
NO
終了指示あり？
YES
END

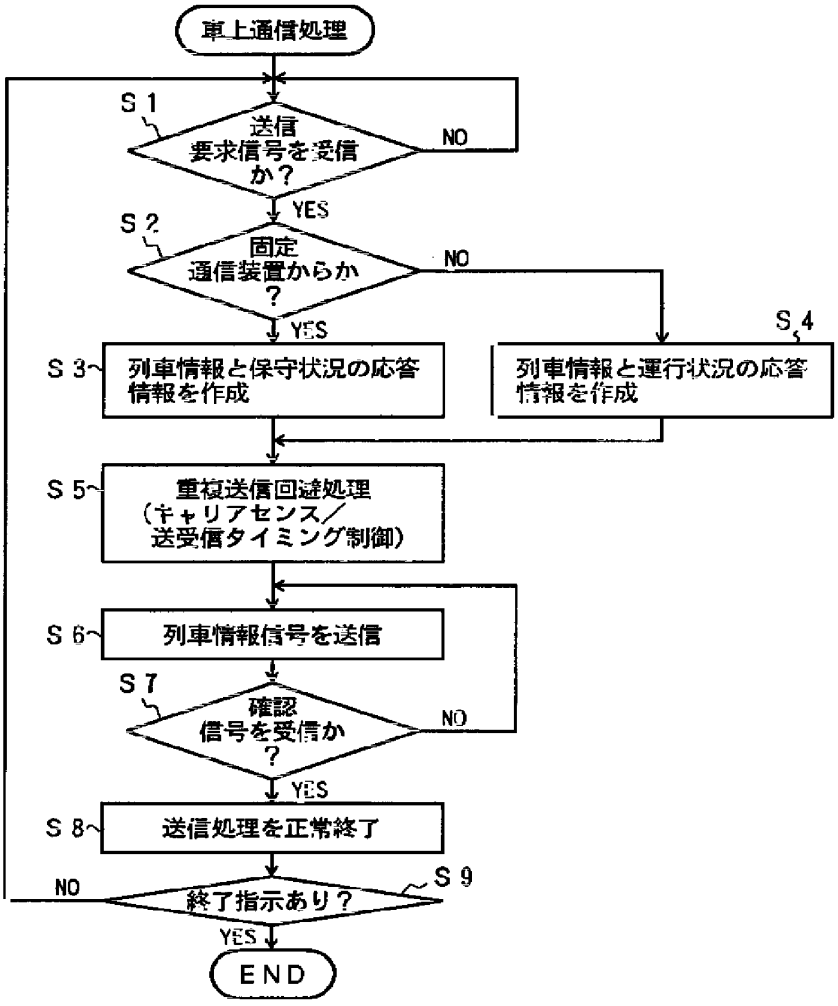
【図21】


E2 列車情報信号
(列車番号+運行状況)
E1
送信要求信号
12
地上通信装置
1B
10B
車上通信装置
駅
48
46
50
(列車番号+保守状況)
列車情報信号
E6
E5
送信要求信号
(送信要求+運行状況)
1A
10A
車上通信装置
2

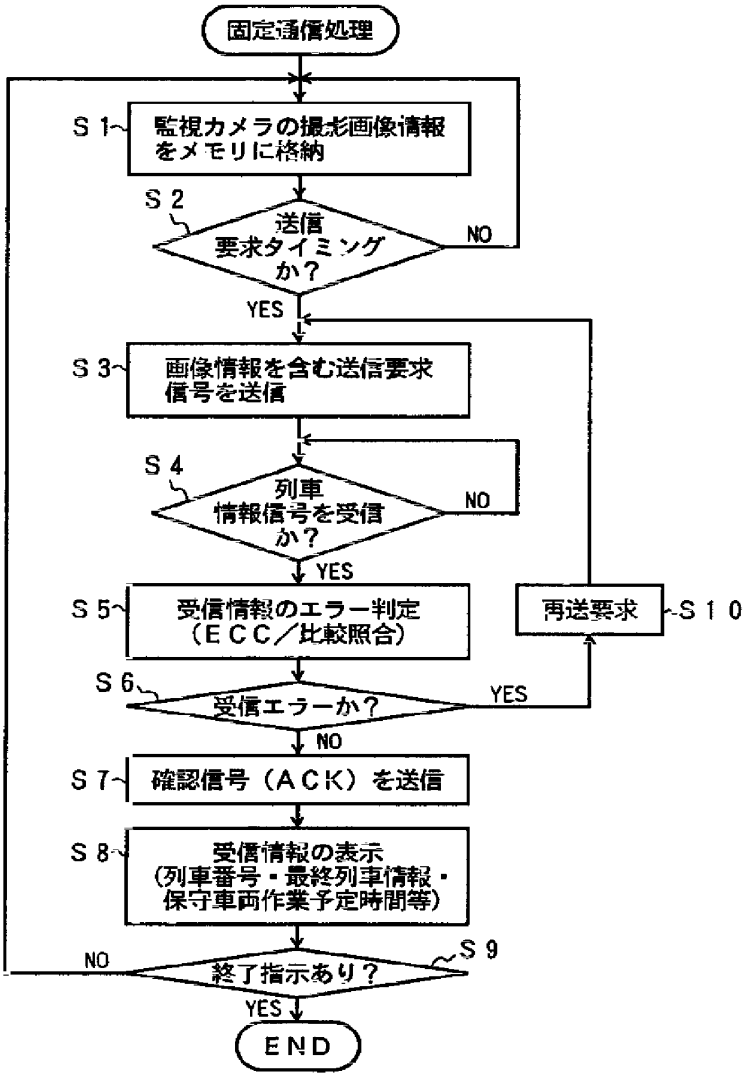
【図22】


固定通信処理
S 1
送信
要求タイミング
か？
NO
YES
S 2
ダイヤ運行情報・ダイヤ復旧
見込み・保守作業位置・先行
列車通過時刻等の情報を含む
送信要求信号を送信
S 3
列車
情報信号を受信
か？
NO
YES
S 4
受信情報のエラー判定
（ＥＣＣ／比較照合）
S 5
受信エラーか？
YES
NO
再送要求
S 9
S 6
確認信号（ＡＣＫ）を送信
S 7
受信列車情報から保守作業
進行状況・列車番号・事故
状況等の必要情報を抽出し
て拠点に送信
S 8
NO
終了指示あり？
YES
ＥＮＤ

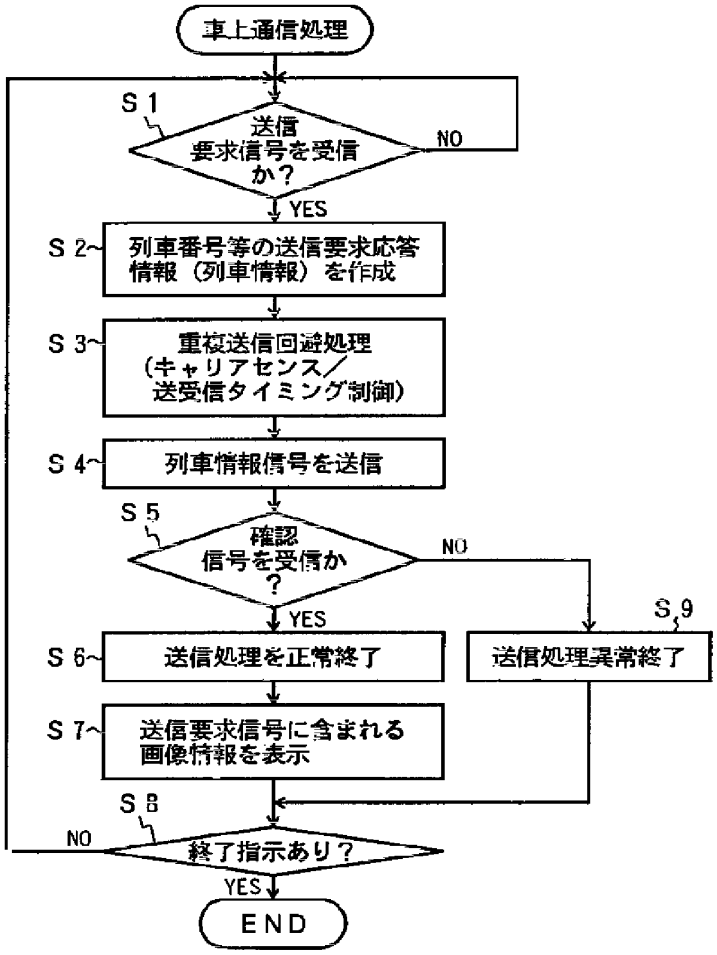
【図２３】


車上通信処理
S 1
送信
要求信号を受信
か？
NO
YES
S 2
固定
通信装置からか
？
NO
YES
S 3
列車情報と保守状況の応答
情報を作成
S 4
列車情報と運行状況の応答
情報を作成
S 5
重複送信回避処理
（キャリアセンス／
送受信タイミング制御）
S 6
列車情報信号を送信
S 7
確認
信号を受信か
？
NO
YES
S 8
送信処理を正常終了
S 9
NO
終了指示あり？
YES
END

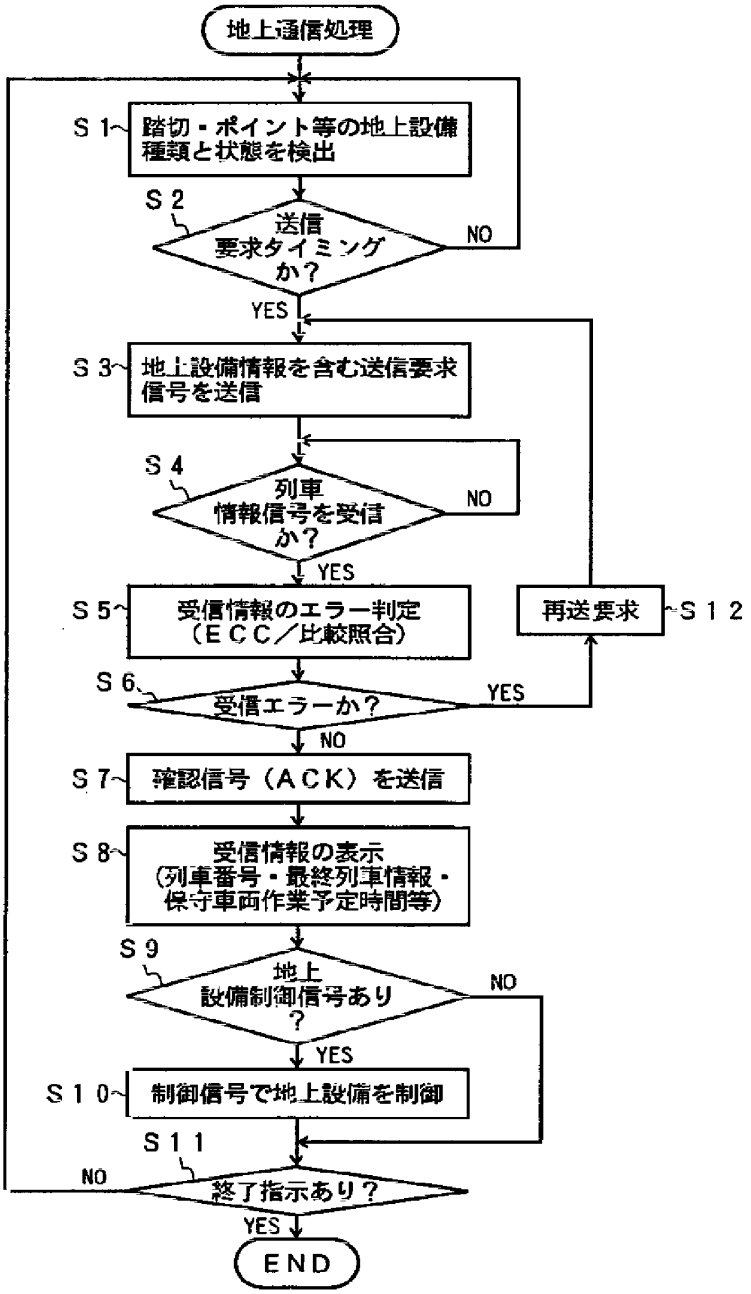
【図２５】


固定通信処理
S 1
監視カメラの撮影画像情報をメモリに格納
S 2
送信要求タイミングか？
NO
YES
S 3
画像情報を含む送信要求信号を送信
S 4
列車情報信号を受信か？
NO
YES
S 5
受信情報のエラー判定（ＥＣＣ／比較照合）
S 6
受信エラーか？
YES
NO
再送要求
S 10
S 7
確認信号（ＡＣＫ）を送信
S 8
受信情報の表示（列車番号・最終列車情報・保守車両作業予定時間等）
S 9
NO
終了指示あり？
YES
END

【図２６】


車上通信処理
S 1
送信要求信号を受信か？
NO
YES
S 2
列車番号等の送信要求応答情報（列車情報）を作成
S 3
重複送信回避処理（キャリアセンス／送受信タイミング制御）
S 4
列車情報信号を送信
S 5
確認信号を受信か？
NO
YES
S 9
送信処理異常終了
S 6
送信処理を正常終了
S 7
送信要求信号に含まれる画像情報を表示
S 8
NO
終了指示あり？
YES
END

【図２８】



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SIGNAL PROTECTION DEVICE

Inventor(s): INOUE TOMOKI, ; TAMOTSU TAKAYUKI

Applicant(s): HITACHI LTD

Classification: **- international:** ***B61L3/08***
- cooperative:

Application number: JP20060007663 20060116 Global Dossier

Priority number(s): JP20060007663 20060116

Also published as: JP2007186162 (A)

Abstract of JP2007186162 (A)

PROBLEM TO BE SOLVED: To provide a signal protection device capable of reliably determining the advance to an adjacent block section by the communication of a minimum ground narrow-band communication means provided on a boundary of a block section with a narrow-band communication means provided on a vehicle, and the wireless communication between the vehicle and the ground. ;SOLUTION: A narrow-band wireless communication instrument communicable when it is brought close to a specified range is installed on a boundary of a ground block section. A narrow-band communication instrument is provided on a vehicle. A wireless device capable of performing the wide-band communication between the ground and the vehicle is provided. An on-vehicle train control unit and an on-ground train control device perform the communication via these devices. The on-ground train control device receives the moving distance of the train after the communication on the boundary of the block section between the on-vehicle communication instrument and the on-ground communication instrument via the wireless device. When the received moving distance is not less than the set value, the advance from the block section is determined. ;COPYRIGHT: (C)2007,JPO&INPIT

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最終頁に続く

(54)【発明の名称】信号保安装置及び在線検知方法

(57)【特許請求の範囲】
【請求項１】
特定の範囲に近接することにより狭域で通信可能な地上無線通信子および車上無線通信子と、
地上ー車上間で広域無線通信が可能な地上無線装置および車上無線装置と、
前記地上無線通信子と前記車上無線通信子が通信した位置からの列車の移動距離情報を前記車上無線装置及び前記地上無線装置を介して地上列車制御装置へ送信する送信手段と、を備え、
前記地上列車制御装置は、前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が設置された閉そく区間に隣接する閉そく区間への前記列車の進入を検知し、
前記移動距離情報に基づいて、前記地上無線通信子が設置された閉そく区間からの列車の進出を検知する在線検知手段を備えることを特徴とする信号保安装置。
【請求項２】
請求項１記載の信号保安装置において、
前記在線検知手段は、前記地上無線通信子を介して受信した前記列車の識別情報及び前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が設置された閉そく区間に隣接する閉そく区間への列車の進入を検知し、
前記地上無線装置を介して受信した前記列車の識別情報及び前記移動距離情報に基づいて前記地上無線通信子が設置された閉そく区間からの前記列車の進出を検知することを特

徴とする信号保安装置。
【請求項３】
請求項１又は請求項２に記載の信号保安装置において、
前記地上列車制御装置は、前記移動距離情報が予め定めた一定距離以上の場合、前記地上無線通信子が設置された閉そく区間を列車が進出したことを検知し、前記閉そく区間は列車不在と判断することを特徴とする信号保安装置。
【請求項４】
請求項１乃至請求項３のいずれかに記載の信号保安装置において、
前記地上列車制御装置は、前記車上無線通信子と前記地上無線通信子との通信が終了した場合に、前記無線通信子が設置された閉そく区間に隣接する閉そく区間への前記列車の進入を検知することを特徴とする信号保安装置。
【請求項５】
請求項１乃至請求項４のいずれかに記載の信号保安装置において、
前記地上列車制御装置は、前記在線検知手段で検知された情報から列車の速度を制限するための情報を生成する手段と、当該情報を前記地上無線通信子を介して車上無線通信子へ送信する送信手段と、を備えることを特徴とする信号保安装置。
【請求項６】
特定の範囲に近接することにより狭域で通信可能な地上無線通信子および車上無線通信子と、
地上－車上間で広域無線通信が可能な地上無線装置および車上無線装置と、
前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が設置された閉そく区間に隣接する閉そく区間への前記列車の進入を検知する地上列車制御装置と、
前記地上無線通信子と前記車上無線通信子が通信した位置からの列車の移動距離を算出し、前記移動距離情報に基づいて前記地上無線通信子が設置された閉そく区間の境界を列車が進出したことを検出する車上列車制御部と、を備えたことを特徴とする信号保安装置。
【請求項７】
請求項６記載の信号保安装置において、
前記地上列車制御装置は、前記地上無線通信子を介して受信した前記列車の識別情報及び前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が設置された閉そく区間に隣接する閉そく区間への列車の進入を検知し、
前記地上無線装置を介して受信した前記列車の識別情報及び前記移動距離情報に基づいて前記地上無線通信子が設置された閉そく区間からの前記列車の進出を検知することを特徴とする信号保安装置。
【請求項８】
請求項６または請求項７記載の信号保安装置において、
前記車上列車制御部は、前記地上無線通信子と前記車上無線通信子とが通信した位置からの列車の前記移動距離情報が予め定めた一定距離以上の場合、前記地上無線通信子が設置された閉そく区間を列車が進出したことを判断することを特徴とする信号保安装置。
【請求項９】
請求項６乃至請求項８のいずれかに記載の信号保安装置において、
地上列車制御装置は、前記地上無線通信子が設置された閉そく区間からの列車の前記進出情報および予め登録された列車の識別情報を前記車上無線装置及び地上無線装置を介して受信することを特徴とする信号保安装置。
【請求項１０】
請求項６乃至請求項９のいずれかに記載の信号保安装置において、
前記地上列車制御装置は、前記広域無線通信を介して受信した閉そく区間からの列車の進出情報を受信した場合、前記閉そく区間は列車不在と判断することを特徴とする信号保安装置。

【請求項１１】
請求項６乃至請求項１０のいずれかに記載の信号保安装置において、
前記地上列車制御装置は、前記在線状態の情報から生成される列車の速度を制限するための情報を前記地上無線通信子を介して車上無線通信子へ送信する送信手段を備えることを特徴とする信号保安装置。
【請求項１２】
請求項３または請求項８記載の信号保安装置において、
前記一定距離とは、前記地上無線通信子と前記車上無線通信子とが通信した位置から前記列車が隣接する次の閉そく区間との境界を通過するまでの前記列車の移動距離であることを特徴とする信号保安装置。
【請求項１３】
特定の範囲に近接することで狭域で通信可能な地上無線通信子および車上無線通信子と、
地上－車上間で広域無線通信が可能な地上無線装置および車上無線装置と、
前記地上無線通信子および前記地上無線装置と情報通信可能に接続される地上列車制御装置と、を利用する在線検知方法であって、
前記地上無線通信子と車上無線通信子との通信後の列車移動距離を算出し、
前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が設置された閉そく区間に隣接する閉そく区間への前記列車の進入を検知し、
前記移動距離の情報に基づいて、前記地上無線通信子の設置された閉そく区間からの列車進出を判断することを特徴とする在線検知方法。
【請求項１４】
請求項１３記載の在線検知方法において、
前記地上無線通信子を介して受信した前記列車の識別情報及び前記車上無線通信子と前記地上無線通信子の通信状態に基づいて前記無線通信子が配設された閉そく区間に隣接する閉そく区間への列車の進入を検知し、
前記地上無線装置を介して受信した前記列車の識別情報及び前記移動距離情報に基づいて前記地上無線通信子が設置された閉そく区間からの前記列車の進出を検知することを特徴とする在線検知方法。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、鉄道およびモノレール、ＬＲＴ（Light Rail Transit）、ＡＧＴ（Automated Guided Train）などの都市交通等、軌道上を車両が移動することで輸送を行う輸送システムの信号保安装置に関する。
【背景技術】
【０００２】
地上、車上に取り付けられた小型の通信装置として使われるトランスポンダやバリスなどの狭域無線通信手段（以下、「トランスポンダ」を例に説明）を用いて列車を検知するで保安制御システムにおいては、軌道上に離散的に設けられたトランスポンダによって車両ＩＤを地上、車上間で通信することで列車の在、不在を特定する。すなわち、別の領域に設けられたトランスポンダによって車両ＩＤを受信することで、過去に同じ車両ＩＤを受けたトランスポンダの設置された領域には列車がいないものとするチェックイン－チェックアウト方式によって実施していた。これはある場所における存在確認により他の場所の不在証明を行うものである。
【０００３】
１列車の存在のみを許容する区間（以下、閉そく区間と呼ぶ）単位で列車の在、不在を判定するが、隣接する閉そく区間のトランスポンダに到達するまで手前の閉そく区間の不在を判定できないため、速やかな不在判定を実施するため特許文献１に見られるように、トランスポンダを閉そく区間の境界手前に設置し、トランスポンダ通過時の列車速度を用

いてこれが一定値以上の場合、十分隣接する閉そく区間に進出できると判断して手前の閉そく区間を不在判定していた。また、閉そく区間の境界手前にトランスポンダを設け、尚且つ隣接する閉そく区間において車両が完全に隣接閉そく区間に進出しきった際に車上のトランスポンダ車上子と通信可能な軌道上にトランスポンダ地上子を設置し、閉そく区間の境界出側に設けられた該地上子と車上子が通信することで、隣接閉そく区間への進出を検出して、手前の閉そく区間を不在判定する手法が用いられる。

【特許文献１】特開２００４－２０３２５８号公報

【発明の開示】

【発明が解決しようとする課題】

【０００４】

従来の閉そく区間の境界手前にトランスポンダを設置し、トランスポンダ通過時の速度を用いて隣接閉そく区間への進出を検知する方式においては、通過速度が異常停止によっても確実に隣接する閉そく区間に進出しきることが可能な値であるかを判断して進出中の閉そく区間の不在判定を行なうが、路線形状あるいは車両長などの関係により、閉そく区間を進出するために十分な通過速度が確保できない場合、不在判定ができない問題があった。一方、隣接閉そく区間に入口にトランスポンダ地上子を設置し、該地上子が列車のトランスポンダ車上子と通信することにより、隣接閉そく区間への進出を検出する方式においては、閉そく区間の出口と入口にそれぞれトランスポンダ地上子を設置する必要があり、閉そく区間の数に応じてコストが増加する。

【０００５】

本発明の目的は、最小限の狭域無線通信手段と広域で通信可能な無線通信手段を併用することで閉そく区間間での列車移動を速やかに検出する信号保安装置を提供することである。

【課題を解決するための手段】

【０００６】

上記目的を達成するために、本発明の信号保安装置は、特定の範囲に近接することで狭域で通信可能な地上無線通信子と車上無線通信子と、また、地上－車上間で広域無線通信が可能な地上無線装置と車上無線装置とを設け、前記地上無線通信子、前記車上無線通信子、前記地上無線装置、及び、前記車上無線装置を介して車上列車制御部と地上列車制御装置とが通信することで列車の在線検知を行ない、前記地上無線通信子と前記車上無線通信子を利用して制御情報を前記車上列車制御部に送信することで列車の速度制御を実施する信号保安装置において、

前記地上無線装置は、ある基準点からの前記列車の移動距離を受信することを特徴とする。

【発明の効果】

【０００７】

本発明によれば、閉そく区間の境界に設けた最小限の地上狭域通信手段と、車上に設けた狭域通信手段との通信および無線による車上－地上間通信により、確実な隣接する閉そく区間への進出判定が可能となる。

【発明を実施するための最良の形態】

【０００８】

以下、本発明の実施例を図面を参照して説明する。

【実施例１】

【０００９】

図１は、本発明の実施例１の信号保安装置の構成を示す。信号保安装置は車両１００を制御対象として、地上側の中央処理部である地上列車制御装置１０４、車両内の情報を地上側へ送信するための車上通信手段１１０、軌道１０８に設置された車上通信手段１１０と通信可能な地上通信手段１０１および中継器１０２、地上列車制御装置１０４と地上通信手段１０１を繋ぐ、端末１０３および制御用ＬＡＮ１０５、車両の移動距離情報を受信する（無線）基地局１２０、車上側のアンテナ１２１により構成される。

【００１０】
図１では、車上通信手段１１０が車両１００の前方に取り付けられ、地上通信手段１０１がホーム１０６の前方に取り付けられた例が示されている。軌道１０８に設けられた地上通信手段１０１は通常ホーム１０６上に設置され、車両１００がホーム１０６に停止した際、車上通信手段１１０と地上通信手段１０１間で通信可能となる位置に設置される。地上通信手段１０１はトランスポンダ、バリスなどの通信範囲が限定された通信手段であり、この狭域通信手段を用いた車両１００と地上間の通信は車両１００が地上通信手段１０１の設置された部位に移動し、車上通信手段１１０が通信可能な範囲内に入ってはじめて実施される。
【００１１】
地上列車制御装置１０４は、中継器１０２、端末１０３および制御用ＬＡＮ１０５を介して地上通信手段１０１と接続され、車上通信手段１１０を介して車両１００より送信された車両ＩＤを受信する。
【００１２】
また、基地局１２０と車上側のアンテナ１２１間の広域で通信可能な空間波利用の無線通信は、軌道１０８上の全域において車上、地上間通信を可能とする。
地上列車制御装置１０４は、基地局１２０と接続され、アンテナ１２１を介して車両１００より、列車の車両ＩＤおよび基準点から移動距離を受信する。地上列車制御装置１０４は、地上通信手段１０１を介して受信した車両ＩＤおよび基地局１２０、アンテナ１２１を介して受信した車両ＩＤおよび移動距離を利用して車両１００の在線位置を把握、管理する。
【００１３】
また、地上列車制御装置１０４は、車両１００の速度を制限する情報を生成し、これを同様に車上通信手段１１０および地上通信手段１０１を介して車両１００に与える。車両１００は地上列車制御装置１０４より送られてくる車両１００の速度を制限するための停止位置などの情報と軌道１０８の形状に応じて予め用意した安全な運行を実現するために必要な速度上限カーブの情報を用いて、次の停止位置に到達するまでの区間、車両１００が守るべき速度上限カーブを生成し、これを超えないように車両１００の速度を自動制御する。
【００１４】
列車位置の把握は一列車のみの存在を許す閉そく区間１０７毎にそこへ列車が存在するか否かを判定する。本実施例では一閉そく区間に一駅存在する仮定で話を進めるが、駅間が長い場合などでは駅間に複数の閉そく区間１０７を設けることも考えられる。この場合、ホームのない駅間の閉そく区間にも、一つの閉そく区間に対して地上通信手段１０１を設置する。
【００１５】
本発明の実施例１では、地上列車制御装置１０４は、車上通信手段１１０と地上通信手段１０１間で通信が実施された位置からの車両１００の移動距離を基地局１２０、アンテナ１２１介した無線通信で受信し、受信した移動距離が一定距離以上である場合、隣接する閉そく区間に車両１００が進出したと判断し、地上通信手段１０１を介して通信を行った閉そく区間は列車不在と判断する。
【００１６】
尚、閉そく区間とその列車の在線、不在の管理は地上列車制御装置が図４に記載のような在線テーブルにて管理されている。詳細は後述する。
【００１７】
図２に、車両１００内の信号保安装置の構成を示す。図示のように、車両１００には、車上制御部２００、送受信部２０１、車上通信手段１１０、駆動部２０２、速度検出部２０３、無線送受信部２０４、及びアンテナ１２１が搭載される。
【００１８】
車上制御部２００は、車上通信手段１１０、送受信部２０１を介して、地上列車制御装

置１０４から受信した次の停止位置に基づいた速度制御、および自列車の移動距離算出等の主な機能が実施される。その自列車の移動距離算出では、駆動部２０２をモニタしている速度検出部２０３からは車軸回転数が得られているが、これが車上制御部２００で積分されることで、自列車の移動距離が算出される。また、車上制御部２００は自列車の移動距離情報を無線送受信部２０４とアンテナ１２１を介して地上列車制御装置１０４に送信する。更に、車上通信手段１１０は、地上通信手段１０１と通信を行うことで、現在位置情報、次の停止位置の受信や、車両識別情報、速度情報及び進行方向情報等の送信等、地上－車上間通信に使用される。

【００１９】

図３に、車上制御部２００の内部構成例を示す。図示のように、車上制御部２００は、移動距離算出部３００、防護パターン生成部３０１、ブレーキ制御部３０２、車両ＩＤ生成部３０３および車上ＤＢ（ＤＢ：データベース）３０４から構成される。このうち、移動距離算出部３００では、速度検出部２０３からの車軸回転数情報を基に、車軸回転数が積分されることで、車上通信手段１１０と地上通信手段１０１間での通信位置を基点として移動距離を算出する。移動距離は車両ＩＤ生成部３０４で生成された車両ＩＤとともに無線送受信部２０４、基地局１２０、アンテナ１２１を介して、地上列車制御装置１０４に送信される。

【００２０】

防護パターン生成部３０１では、地上列車制御装置１０４から送受信部２０１を介し地上通信手段１０１より受信される現在位置と次の停止位置を基に、これを越えないように、停止し得る速度上限パターン（以下、「防護パターン」と称す。）が生成される。これには、勾配や速度制限情報等の線形情報を利用する必要があるため、車上ＤＢ３０４が参照されつつ、生成される。

【００２１】

ブレーキ制御部３０２では、防護パターン生成部３０１で生成された防護パターンを基に、移動距離算出部３００で算出した自列車の位置情報と現在の速度情報を用い、現在の速度情報が、現在の位置に対応した防護パターン上の速度を超えているか否かが判定されており、超えている場合は、減速指令が駆動部２０２に発せられる。

【００２２】

車両ＩＤ生成部３０３では、車両ＩＤが生成され、移動距離算出部３００で算出された移動距離とともに、無線送受信部２０４、基地局１２０、アンテナ１２１を介して、地上列車制御装置１０４に送信される。また、車両ＩＤは、移動距離算出部３００において管理されている現在の速度情報や進行方向情報、ドア開閉情報等の情報とともに、送受信部２０１、車上通信手段１１０、地上通信手段１０１を介して、地上列車制御装置１０４に送信される。

【００２３】

図４に、地上列車制御装置１０４の有する在線テーブル４００を示す。地上列車制御装置１０４は、車両１００より地上通信手段１０１を介して車両ＩＤを受信し、また、基地局１２０、アンテナ１２１を介して車両ＩＤおよび移動距離を受信することで列車の在線位置を把握、管理するが、在線テーブル４００はこのための管理テーブルである。閉そく区間１０７の数だけ列が用意され、それぞれの閉そく区間に列車が在線するか否かでそれぞれ“１”、“０”を割り当てる。図ではＮｏ１と４の閉そく区間において列車が在線していることを示している。

【００２４】

図５に、地上列車制御装置１０４の有する進出判定距離テーブル５００を示す。
地上列車制御装置１０４は車両１００より基地局１２０、アンテナ１２１を介して車両ＩＤおよび移動距離を受信し、車両１００のある基準点からの移動距離が設定値以上である場合、隣接する閉そく区間に車両１００が完全に進出したと判断し、該閉そく区間は列車不在と判断するが、進出判定距離テーブル５００はこのための管理テーブルであり、地上列車制御装置１０４内の地上ＤＢ（ＤＢ：データベース）に登録される。進出元閉そく区

間から進出可能な隣接する進出先閉そく区間に対して、それぞれの閉そく区間に列車が完全に進出するまでの基準点からの移動距離が進出判定距離として登録される。また、地上列車制御装置１０４は移動距離と同時に車両ＩＤを受信するため、車両長に対応した進出判定距離を設定することも可能である。

【００２５】

続いて、地上列車制御装置１０４による列車在線把握手順について、図６に処理フローを示し詳細に述べる。また、このときの地上、列車間の動きを示す模式図を図７、図８に示し、これらを参照しつつ説明を行う。

【００２６】

処理Ｓ６－１において、地上列車制御装置１０４は車両ＩＤ（ここでは、＃ｉとする）を車上通信手段１１０より受信したかどうか判定する。受信されない場合は、列車がホームに到着していないことを意味するため、処理Ｓ６－１を繰り返す。列車がホーム定位置に到着すると、車上通信手段１１０と地上通信手段１０１間で通信が実施されて車両ＩＤ（＃ｉ）を地上列車制御装置１０４が受信することで、処理をＳ６－２に移し、列車の駅到着を検知する。このときの様子は図７の状態１で示される。

【００２７】

図７では、ａ駅に対応する閉そく区間（＃ｊ－１）を列車が移動した後ａ駅に到着した様子を示している。ａ駅の閉そく区間（＃ｊ－１）では列車は在線であり、ｂ駅の閉そく区間（＃ｊ）では不在である。

【００２８】

車両ＩＤ（＃ｉ）を受信すると、処理をＳ６－３に移し、地上列車制御装置１０４は、車上通信手段１１０と地上通信手段１０１間で通信が終了したかどうかを判定する。通信が終了している場合は処理をＳ６－４に移し、車両１００の進出する閉そく区間（＃ｊ）を在線とする。このときの様子は図７の状態２に示され、車両１００がａ駅を出発することにより、車上通信手段１１０と地上通信手段１０１間の通信が終了していることを示している。また、車上制御部２００は車上通信手段１１０と地上通信手段１０１間で通信した列車位置（この例では駅停車位置となる）を基準点として、移動距離を算出し、無線送受信部２０４、基地局１２０、アンテナ１２１を介して地上列車制御装置１０４に移動距離を送信する。

【００２９】

列車はａ駅を出発することでｂ駅の閉そく区間（＃ｊ）に進入するため、車両１００の進出する閉そく区間すなわちｂ駅の閉そく区間（＃ｊ）を在線とする。通信が終了していない場合は、ａ駅のホームに依然として停車していることを意味し、処理をＳ６－３へ戻す。処理Ｓ６－５では、地上列車制御装置１０４は、車上制御部２００から基地局１２０およびアンテナ１２１を介して、車両１００の車両ＩＤ（＃ｉ）および車上通信手段１１０と地上通信手段１０１間で通信した列車位置を基準点とした移動距離を受信する。地上列車制御装置１０４は、地上ＤＢの進出判定距離テーブル５００を参照し、受信した移動距離が予め設定した移動距離を超えているかどうか判定する。このときの設定値は車上通信手段１１０と地上通信手段１０１間で通信した列車位置から車両１００が隣接閉そく区間（＃ｊ）に進入し、閉そく区間（＃ｊ－１）との閉そく境界を完全に進出するために必要な移動距離とする。図７の状態３がこの様子を示しており、車両１００は閉そく境界を通過中であり、車上制御部２００から無線送受信部２０４、基地局１２０、アンテナ１２１を介して、車両ＩＤ（＃ｉ）およびこのときの車両１００の移動距離が地上列車制御装置１０４へ送信される。ここで送信される車両１００の移動距離は移動距離算出検出部３００によってリアルタイムに算出される列車の移動距離である。

【００３０】

移動距離が設定値を超えている場合は処理をＳ６－８に移し、車両１００の出発した閉そく区間（＃ｊ－１）を不在とする。このときの様子は図７の状態４に示される。車両１００はａ駅の閉そく区間を完全に進出し、ｂ駅の閉そく区間に移動しており、ａ駅の閉そく区間（＃ｊ－１）は不在、ｂ駅の閉そく区間（＃ｊ）は在線と認識されている。

【００３１】
処理Ｓ６－５において移動距離が設定値を超過しない場合は、処理をＳ６－６に移す。Ｓ６－６では車両１００の進出した閉そく区間（＃ｊ）において車上通信手段１１０と地上通信手段１０１間で通信が成立し、車両ＩＤを受信したかどうか判定する。車両１００の進出した閉そく区間（＃ｊ）の地上通信手段１０１において通信が成立しない場合は、処理をＳ６－５に戻す。通信が成立し、車両ＩＤを受信した場合は処理をＳ６－７に移す。ここで、処理Ｓ６－６、Ｓ６－７は、車両１００の車両ＩＤ（＃ｉ）および移動距離が地上列車制御装置１０４で受信できない場合に、車両１００の隣の閉そく区間（＃ｊ）への進出を検出する代用手法を実施している。

【００３２】
図８に、この場合の処理の概念図を示す。車両１００がａ駅を出発後、無線送受信部２０４、基地局１１１、アンテナ１１２を介した空間波利用の無線通信が成立しなかった場合、状態２のようにｂ駅の閉そく区間（＃ｊ）に移動したにもかかわらずａ駅閉そく区間（＃ｊ－１）において在線状態のままになっている。ｂ駅閉そく区間（＃ｊ）への進出を検出するために、車両１００のｂ駅への到着を待ってａ駅閉そく区間（＃ｊ－１）を不在判定するものである。ここで車両１００がｂ駅に到着したことを確認するために、ｂ駅で受信された車両ＩＤとａ駅で受信された車両ＩＤの一致を判定する。処理Ｓ６－７では、進出した閉そく区間（＃ｊ）において受信した車両ＩＤが車両ＩＤ（＃ｉ）と一致するかどうかを判定し、一致する場合は、処理をＳ６－８に移し、一致しない場合は、ａ駅閉そく区間を進出した車両１００がｂ駅閉そく区間（＃ｊ）に到着せず、別の列車が到着したものと見なし、ａ駅閉そく区間（＃ｊ－１）を在線のままとする。処理Ｓ６－８では車両１００の進出した閉そく区間（＃ｊ－１）を不在とする。

【００３３】
続いて、車上制御部２００において基準点からの移動距離による進出判定を実施し、地上列車制御装置１０４は、該閉そく区間からの進出情報を無線送受信部２０４、基地局１２０、アンテナ１２１を介して受信し、地上列車制御装置１０４で該閉そく区間を列車不在と判定する手法について説明する。

この場合、図５の進出判定距離テーブル５００は、車上制御部２００内の車上ＤＢ３０４に格納される。移動距離算出部２００は、車上通信手段１１０と地上通信手段１０１を介して地上列車制御装置１０４から現在位置および次停止位置を受信し、また、車上通信手段１１０と地上通信手段１０１間で通信した位置からの車両１００の移動距離を算出する。移動距離算出部２００は、車上ＤＢ３０４内の進出判定距離テーブルを参照し、移動距離が閉そく区間を完全に進出する設定値以上である場合、該閉そく区間を進出したと判断し、進出情報を、無線送受信部２０４を介して無線通信により、地上列車制御装置１０４に送信する。地上列車制御装置１０４は、該閉そく区間からの進出情報を受信することで、隣接する閉そく区間に車両１００が進出したと判断し、地上通信手段１０１を介して通信を行った閉そく区間は列車不在と判断する。

【００３４】
図９に、本手法における車上制御部の処理フローを、図１０に地上列車制御装置の処理フローを示し詳細に述べる。処理Ｓ９－１では、現在位置および次の停止位置を地上通信手段１０１より受信したかどうか判定する。受信されない場合は、列車が移動距離の算出を開始する基準点（車上通信手段１１０と地上通信手段１０１間での通信位置であり、ここでは駅停止位置とする）に達していないことを意味するため、処理Ｓ９－１を繰り返す。車上通信手段１１０と地上通信手段１０１間で通信が実施されて現在位置および次の停止位置を車上制御部２００が受信することで、処理をＳ９－２に移し、移動距離算出部３００で車両１００の基準点からの移動距離の算出を開始する。

【００３５】
処理Ｓ９－３では、移動距離算出部３００は車上ＤＢ内の進出判定距離テーブル５００を参照し、算出した移動距離が予め設定した移動距離を超えているかどうか判定する。移動距離が設定値を超えている場合は処理をＳ９－４に移し、車上制御部２００は無線送受

信部２０４を介して、車両ＩＤおよび該閉そく区間からの進出情報を送信する。

【００３６】

処理Ｓ１０－１において、地上列車制御装置１０４は、車両ＩＤ（ここでは、＃ｉとする）を車上通信手段１１０より受信したかどうか判定し、受信されない場合は、処理Ｓ１０－１を繰り返す。列車がホーム定位置に到着すると、車上通信手段１１０と地上通信手段１０１間で通信が実施されて車両ＩＤ（＃ｉ）を地上列車制御装置１０４が受信することで、処理をＳ１０－２に移し、列車の駅到着を検知する。

【００３７】

車両ＩＤ（＃ｉ）を受信すると、処理をＳ１０－３に移し、地上列車制御装置１０４は、車上通信手段１１０と地上通信手段１０１間で通信が終了したかどうかを判定し、通信が終了している場合は処理をＳ１０－４に移し、車両１００の進出する閉そく区間（＃ｊ）を在線とする。通信が終了していない場合は、ａ駅のホームに依然として停車していることを意味し、処理をＳ１０－３へ戻す。

【実施例２】

【００３８】

図１０の処理フローには、本発明の実施例２である列車の閉そく区間からの進出情報を地上無線装置で受信する構成が含まれている。

処理Ｓ１０－５では、地上列車制御装置１０４は、車上制御部２００から無線送受信部２０４、基地局１２０、アンテナ１２１を介して、車両１００の車両ＩＤ（＃ｉ）および該閉そく区間の進出情報を受信する。地上列車制御装置１０４は、受信した進出情報が該閉そく区間を進出済みである場合、処理をＳ１０－８に移し、車両１００は該閉そく区間（＃ｊ－１）を完全に進出し、隣接する閉そく区間に移動したとして、該閉そく区間（＃ｊ－１）を不在とする。

【００３９】

処理Ｓ１０－５において閉そく区間からの進出情報が進出済みではない場合は、処理をＳ１０－６に移す。Ｓ１０－６では車両１００の進出した閉そく区間（＃ｊ）において車上通信手段１１０と地上通信手段１０１間で通信が成立し、車両ＩＤを受信したかどうか判定する。車両１００の進出した閉そく区間（＃ｊ）の地上通信手段１０１において通信が成立しない場合は、処理をＳ１０－５に戻す。通信が成立し、車両ＩＤを受信した場合は処理をＳ１０－７に移す。ここで、処理Ｓ１０－６、Ｓ１０－７は、車両１００の車両ＩＤ（＃ｉ）および進出情報が地上列車制御装置１０４で受信できない場合に、車両１００の隣の閉そく区間（＃ｊ）への進出を検出する代用手法を実施している。

【００４０】

処理Ｓ１０－７では、進出した閉そく区間（＃ｊ）において受信した車両ＩＤが車両ＩＤ（＃ｉ）と一致するかどうかを判定し、一致する場合は、処理をＳ１０－８に移し、一致しない場合は、該閉そく区間を進出した車両１００が閉そく区間（＃ｊ）に到着せず、別の列車が到着したものと見なし、該閉そく区間（＃ｊ－１）を在線のままとする。処理Ｓ１０－８では車両１００の進出した閉そく区間（＃ｊ－１）を不在とする。

【図面の簡単な説明】

【００４１】

【図１】本発明の実施例１の信号保安装置を示す図である。

【図２】本発明の車両内の信号保安装置の一機能構成図である。

【図３】本発明の車上制御部の一構成例を示す図である。

【図４】本発明の地上列車制御装置の在線テーブルの一構成例を示す図である。

【図５】本発明の地上列車制御装置あるいは車上列車制御部の進出判定距離テーブルの一構成例を示す図である。

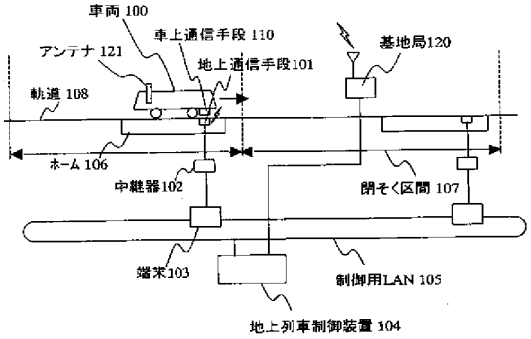
【図６】本発明の地上列車制御装置における列車位置判定処理の処理フローを示す図である。

【図７】本発明の在線位置判定処理の一概念を示す図である。

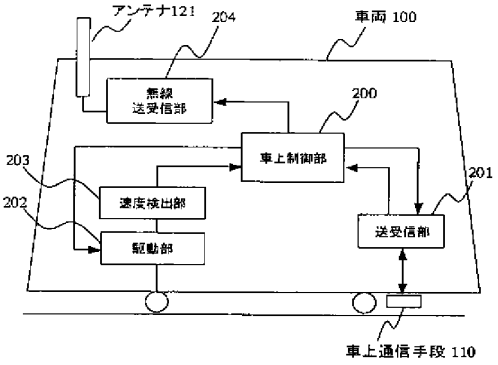
【図８】本発明の在線位置判定処理の一概念を示す図である。

【図９】本発明の車上制御部における列車位置判定処理の処理フローを示す図である。
【図１０】本発明の実施例２の地上列車制御装置における列車位置判定処理を含む処理フローを示す図である。
【符号の説明】
【００４２】
１００　車両
１０１　地上通信手段
１０２　中継器
１０３　端末
１０４　地上列車制御装置
１０５　制御用ＬＡＮ
１０６　ホーム
１０７　閉そく区間
１０８　軌道
１１０　車上通信手段
１２０　基地局
１２１　アンテナ
２００　車上制御部
２０１　送受信部
２０２　駆動部
２０３　速度検出部
２０４　無線送受信部
３００　移動距離算出部
３０１　防護パターン生成部
３０２　ブレーキ制御部
３０３　車両ＩＤ生成部
３０４　車上ＤＢ
４００　在線テーブル
５００　進出判定距離テーブル

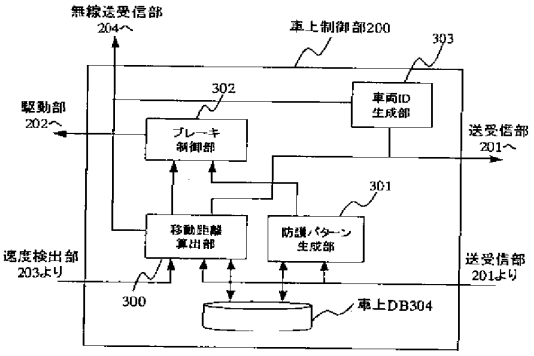
【図１】



【図２】



【図３】



【図４】

在線テーブル 400

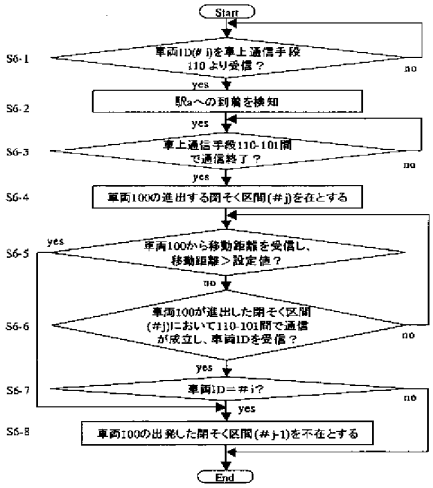
閉そくNo	1	2	3	4	・・・・	N
在線(1)／不在(0)	1	0	0	1	・・・・	0

【図５】

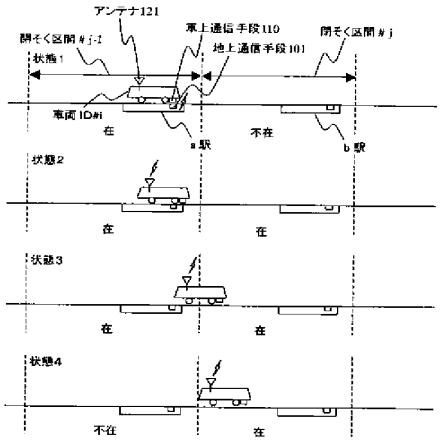
進出判定距離テーブル 500

進出元閉そく区間	進出先閉そく区間	進出判定距離
閉そくNo1	閉そくNo2	距離1,1 (m)
閉そくNo1	閉そくNo3	距離1,2 (m)
閉そくNo1	閉そくNo m	距離2,(m-2) (m)
閉そくNo2	閉そくNo3	距離2,1 (m)
閉そくNo2	閉そくNo4	距離2,2 (m)
：	：	：
閉そくNo2	閉そくNo n	距離2,(n-2) (m)
⋮	⋮	⋮
閉そくNo N	閉そくNo 1	距離N,(1-N) (m)

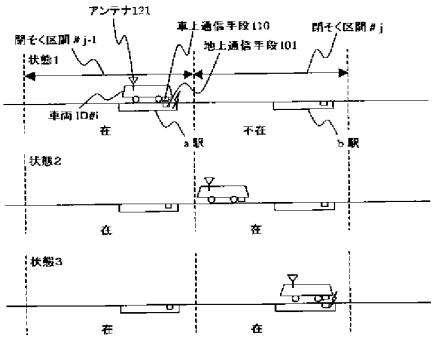
【図６】



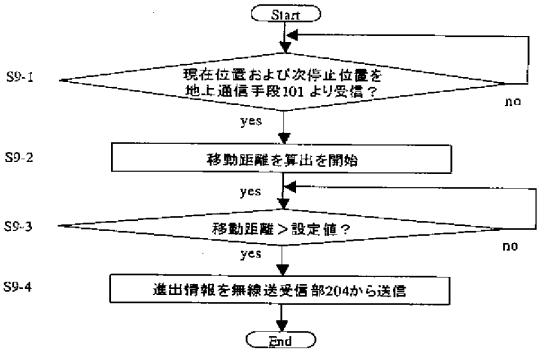
【図７】


アンテナ121
車上通信手段110
閉そく区間＃j-1
地上通信手段101
閉そく区間＃j
状態1
車両ID#i
在
不在
a駅
b駅
状態2
状態3
状態4

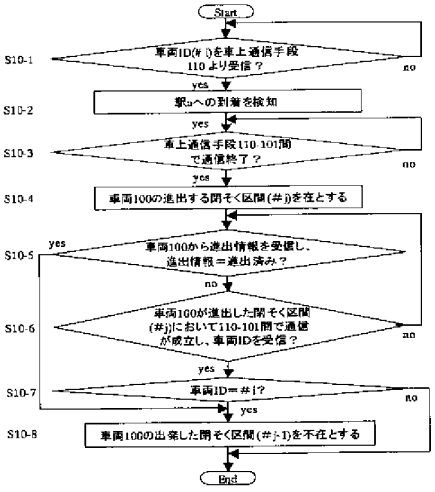
【図８】


アンテナ121
車上通信手段110
閉そく区間＃j-1
地上通信手段101
閉そく区間＃j
状態1
車両ID#i
在
不在
a駅
b駅
状態2
状態3

【図９】


Start
S9-1
現在位置および次停止位置を
地上通信手段101より受信？
no
yes
S9-2
移動距離を算出を開始
yes
S9-3
移動距離＞設定値？
no
yes
S9-4
進出情報を無線送受信部204から送信
End

【図１０】


Start
S10-1
車両ID(＃i)を車上通信手段
110より受信？
no
yes
S10-2
駅aへの到着を検知
yes
S10-3
車上通信手段110-101間
で通信終了？
no
yes
S10-4
車両100の進出する閉そく区間(＃j)を在とする
yes
S10-5
車両100から進出情報を受信し、
進出情報＝進出済み？
no
S10-6
車両100が進出した閉そく区間
(＃j)において110-101間で通信
が成立し、車両IDを受信？
no
yes
S10-7
車両ID＝＃i？
no
yes
S10-8
車両100の出発した閉そく区間(＃j-1)を不在とする
End

フロントページの続き

(56)参考文献 特開２００５－１７８６６７（ＪＰ，Ａ）
特開平０９－２７２４３７（ＪＰ，Ａ）
特開２００１－０７１９０８（ＪＰ，Ａ）
特開２００４－２０３２５８（ＪＰ，Ａ）
特開２００２－２４０７１７（ＪＰ，Ａ）

(58)調査した分野(Int.Cl.，ＤＢ名)
Ｂ６１Ｌ １／００～２９／３２

Electronic Acknowledgement Receipt

EFS ID:	36848730
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	12-AUG-2019
Filing Date:	18-JUL-2019
Time Stamp:	16:05:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	63154US03_IDS_transmittal_letter.pdf	28341 6e94e31a241ec9d25a36679f10cb01c9544c33ab	no	2

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	63154US03_SB08a.pdf	1007966 e192903d7f89f3efda76e417a76d0af62fe5ffb9	no	6
Warnings:					
Information:					
3	Foreign Reference	KR100975289B1.pdf	400549 6f309211cfab79b18bf37404f94ce24c4f88c7cd	no	9
Warnings:					
Information:					
4	Foreign Reference	KR20140017157A.pdf	759272 a50feaff98a915e7fcaf8f3c0b1b2e8bfff6e7fc	no	12
Warnings:					
Information:					
5	Foreign Reference	KR100733599B1.pdf	1075371 ff018ec4a7af79dc1f054678ce4973b4b9262f20	no	22
Warnings:					
Information:					
6	Foreign Reference	KR20050097843.pdf	536473 af8739addaef66194799df7fc7ab403f2531a71c	no	7
Warnings:					
Information:					
7	Foreign Reference	CN201323574.pdf	1388696 77732dc264dded028af30e5cdb41a1e870c35950	no	29
Warnings:					
Information:					
8	Foreign Reference	CA2220819C.pdf	968193 f2bb99cf6f6559a2068e2b7a4b603d3755240eae	no	35
Warnings:					
Information:					

9	Foreign Reference	JP4755521B2.pdf	764067 667403c081e08e270018f58bcd8ef8856cd22868	no	17
Warnings:					
Information:					
10	Foreign Reference	JP2001106074A.pdf	1247306 2b7d7fac429b3b8c77a98fbb6587462d66868381	no	32
Warnings:					
Information:					
11	Foreign Reference	JP4917313.pdf	614693 e73f627a56c747effa2d3dcb83d7aa72e8b8aae0	no	14
Warnings:					
Information:					
		Total Files Size (in bytes):	8790927		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE
Attorney Docket No. 63154US03

In the Application of:	
Richard C. Carlson, et al.	Group Art Unit No.: 3617
Serial No. : 16/515,903	Confirmation No.: 2880
Filed: July 18, 2019	
For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	
Examiner: Not yet assigned	

CERTIFICATION OF ELECTRONIC FILING

I hereby certify that this correspondence is being electronically filed with the United States Patent and Trademark Office on August 12, 2019.

Rami N. Moussa
Reg. No. 69,528

/Rami N. Moussa/
Signature

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT AFTER APPLICATION FILING DATE

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

Enclosed are the following:

(1) A completed PTO Form SB/08a which has 6 page(s); and,

(2) A copy of the foreign references listed in Form SB08A and not previously provided to or by the PTO in this application.

This IDS is being submitted prior to receipt of a first Office Action. This submission is in no way intended as an admission that the above-cited references constitute prior art under any subsection of 35 U.S.C. § 102. Applicant expressly retains the right to take any actions necessary to remove the above-cited references from the available prior art. Consideration of the above-identified references in the examination of the present patent application is respectfully requested.

In regard to 37 C.F.R. §1.98(a)(3)(i), the applicant notes the relevance of the references that are not in English is that such references were cited in search reports and/or office actions for foreign counterpart(s) of the present application. Moreover, the applicant does not warrant the accuracy of any English language translation presented herewith. Such translations are provided for the convenience of the Examiner and to comply with the requirements of 37 C.F.R. §1.98(a)(3)(ii).

The Commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to Account No. 13-0017.

Respectfully submitted,

/Rami N. Moussa/
Rami N. Moussa
Registration No. 69,528
Attorney for Applicant

Date: August 12, 2019

McAndrews, Held & Malloy, Ltd.
500 W. Madison, 34th Floor
Chicago, IL 60661
Telephone: (312) 775-8000
Facsimile: (312) 775-8100

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Richard C. Carlson
Art Unit	3617
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5420883		1995-05-30	Swensen et al.	
	2	7725252		2010-05-25	Heddebaut et al.	
	3	9002546		2015-04-07	Whitwam et al.	
	4	9128815		2015-09-08	Kanner et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20170245192		2017-08-24	Sadri et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-09-05
Name/Print	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	37081022
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	05-SEP-2019
Filing Date:	18-JUL-2019
Time Stamp:	18:02:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	63154US03_IDS_transmittal_letter.pdf	27161 bb99d2c32342530adf5c48bbeb72f69b5f239938	no	2

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	63154US03_SB08a.pdf	1007083 6f3561b270401a9e2a51eac4fad96ba5f41b2b7a	no	4
Warnings:					
Information:					
			Total Files Size (in bytes):	1034244	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE
Attorney Docket No. 63154US03

In the Application of:	
Richard C. Carlson, et al.	Group Art Unit No.: 3617
Serial No. : 16/515,903	Confirmation No.: 2880
Filed: July 18, 2019	
For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	
Examiner: Not yet assigned	

CERTIFICATION OF ELECTRONIC FILING

I hereby certify that this correspondence is being electronically filed with the United States Patent and Trademark Office on September 5, 2019.

Rami N. Moussa
Reg. No. 69,528

/Rami N. Moussa/
Signature

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT AFTER APPLICATION FILING DATE

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dear Examiner:

Enclosed are the following:

(1) A completed PTO Form SB/08a which has 4 page(s).

This IDS is being submitted prior to receipt of a first Office Action. This submission is in no way intended as an admission that the above-cited references constitute prior art under any subsection of 35 U.S.C. § 102. Applicant expressly retains the right to take any actions necessary to remove the above-cited references from the available prior art. Consideration of the above-identified references in the examination of the present patent application is respectfully requested.

The Commissioner is hereby authorized to charge any additional fees which may be required or credit any overpayment to Account No. 13-0017.

Respectfully submitted,

/Rami N. Moussa/
Rami N. Moussa
Registration No. 69,528
Attorney for Applicant

Date: September 5, 2019

McAndrews, Held & Malloy, Ltd.
500 W. Madison, 34th Floor
Chicago, IL 60661
Telephone: (312) 775-8000
Facsimile: (312) 775-8100

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 09/10/2019

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER	
ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
09/10/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 16/515,903	**Applicant(s)** Carlson et al.	
	Examiner BRIAN W BROWN	**Art Unit** OPET	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 18 July 2019 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to BRIAN BROWN at (571)272-5338.

In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/BRIAN W BROWN/ Petitions Examiner, OPET	

U.S. Patent and Trademark Office
PTO-2298 (Rev. 02-2012)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 09/23/2019

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER
LE, MARK T

ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
09/23/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Office Action Summary	**Application No.** 16/515,903	**Applicant(s)** Carlson et al.	
	Examiner MARK T LE	**Art Unit** 3617	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☐ Claim(s) _____ is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☑ Claim(s) 1-20 are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Election/Restriction

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-12, drawn to a train mount device, classified in B61L23/00.

II. Claims 13-19, drawn to a wayside device, classified in B61L23/00.

III. Claim 20, drawn to a system, classified in B61L23/00.

2. The inventions are independent or distinct, each from the other because:

Inventions Groups I and II are related as subcombinations disclosed as usable together in a single combination. The subcombinations are distinct if they do not overlap in scope and are not obvious variants, and if it is shown that at least one subcombination is separately usable. In the instant case, subcombination, such as claim 13 of Group II has separate utility such as a roadside device for communicating with roadway vehicles. See MPEP § 806.05(d).

The examiner has required restriction between subcombinations usable together. Where applicant elects a subcombination and claims thereto are subsequently found allowable, any claim(s) depending from or otherwise requiring all the limitations of the allowable subcombination will be examined for patentability in accordance with 37 CFR 1.104. See MPEP § 821.04(a). Applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

Inventions and Groups I-II and Group III are related as combinations and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombinations as claimed because the combination, such as claim 20, does not require the particular of the subcombination, such as the features recited in subcombination claim 2 or 13. The subcombination, such as the combination of claim 2 or claim 13 has separate utility such as such as a roadway system, with a roadway device communicating with a roadway vehicle device.

The examiner has required restriction between combination and subcombination inventions. Where applicant elects a subcombination, and claims thereto are subsequently found allowable, any claim(s) depending from or otherwise requiring all the limitations of the allowable subcombination will be examined for patentability in accordance with 37 CFR 1.104. See MPEP § 821.04(a). Applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

3. Restriction for examination purposes as indicated is proper because all the inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and/or examination burden if restriction were not required because one or more of the following reasons apply:

- The inventions require different fields of searches (e.g. searching different classes/subclasses or electronic resources, or employing different search strategies or search queries).

4. **Applicant is advised that the reply to this requirement to be complete must include (i) an election of a invention to be examined** even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention**.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other invention.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be corrected in compliance with 37 CFR 1.48(a) if one

or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. A request to correct inventorship under 37 CFR 1.48(a) must be accompanied by an application data sheet in accordance with 37 CFR 1.76 that identifies each inventor by his or her legal name and by the processing fee required under 37 CFR 1.17(i).

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MARK T LE whose telephone number is (571)272-6682. The examiner can normally be reached on Mon-Tue, Thu-Fri 6am-4:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samuel Morano can be reached on 571-272-6684. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

MARK T. LE
Primary Examiner
Art Unit 3617

/MARK T LE/
Primary Examiner, Art Unit 3617

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/515,903	Filing Date 07/18/2019	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	10/23/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 12	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/TONI R HAKIM/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I certify this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: October 23, 2019.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The Applicant submits this amendment and election ("Election") in response to the restriction requirement in the office action of Sep. 23, 2019 ("Office Action") in the above-identified application ("Application"). The Applicant respectfully requests entry of these amendments and consideration of these remarks.

Listing of the Claims begins on page 2 of this paper.

Remarks and Arguments begin on page 5 of this paper.

Electronic Acknowledgement Receipt

EFS ID:	37541628
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	23-OCT-2019
Filing Date:	18-JUL-2019
Time Stamp:	16:52:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		63154US03_OA1_Rest_Rsp.pdf	46489 d583f931d957b5476e3edb9e7399420e264 21780	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	5	6
	Claims	2	4
	Response to Election / Restriction Filed	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	46489	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REMARKS AND ARGUMENTS

Claims 1-20 are pending in this Application, of which claims 1, 13 and 20 are independent claims, and claims 2-12 and 14-19 are dependent claims, depending from independent claims 1 and 13. In this correspondence, claims 1-19 are canceled without prejudice, and new claims 21-31 are added.

In the Office Action, the Examiner asserts restriction(s) and correspondingly requirement(s) for election based thereon, under 35 U.S.C. § 121. Office Action at 2-5. The Examiner identified three alleged distinct "inventions": (I) Claims 1-12; (II) Claims 13-19; and (III) Claim 20.

The Applicant traverses the restrictions asserted by the Examiner. Nonetheless, to advance prosecution, the Applicant elects invention III. The claims corresponding to Inventions I and II (Claims 1-19) are canceled without prejudice. The Applicant adds, however, new dependent claims 21-31, which depend from elected independent claim 20.

Final Remarks

In general, the Office Action makes various statements that are now moot in light of the above remarks. Thus, the Applicant will not address such statements at the present time. However, the Applicant expressly reserves the right to challenge such statements should the need arise (*e.g.,* if such statement should become relevant by appearing in a rejection of any current or future claim or be relied upon in any proceeding involving this Application or a corresponding patent).

CONCLUSION

The Applicant believes that claims 20-31 are in condition for allowance. If the Examiner has questions or the Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is authorized to charge any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

A Notice of Allowability is courteously solicited.

Respectfully submitted,

Date: October 23, 2019

/Rami N. Moussa/
Rami N. Moussa
Attorney for Applicant
Registration No. 69,528

MCANDREWS, HELD & MALLOY, LTD.
500 WEST MADISON STREET, 34TH FLOOR
CHICAGO, ILLINOIS 60661
(312) 775-8000

LISTING OF THE CLAIMS

1-19. (Canceled)

20. (Original) A system for providing decentralized control operations in a railway network, the system comprises:

a plurality of wayside units, each configured for placement on or near tracks in the railway network; and

one or more train-mounted units, each configured for deployment on a train operating in the railway network;

wherein each train-mounted unit is configured to:

communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and

generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network.

21. (New) The system of claim 20, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than the processing of the ultra-wideband (UWB) based signals.

22. (New) The system of claim 21, wherein the train-mounted unit is configured to:

assess based on the processing of the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

when at least one condition meets one or more particular criteria, determine one or more responsive actions; and

perform or cause performing each of the one or more responsive actions.

23. (New) The system of claim 22, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:

monitor actions of the train operator;

assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

24. (New) The train-mounted unit of claim 20, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.

25. (New) The train-mounted unit of claim 20, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

26. (New) The train-mounted unit of claim 20, wherein the train-mounted unit is configured for handling satellite based signals.

27. (New) The train-mounted unit of claim 26, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

28. (New) The train-mounted unit of claim 20, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.

29. (New) The train-mounted unit of claim 20, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.

30. (New) The train-mounted unit of claim 20, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.

31. (New) The train-mounted unit of claim 20, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/515,903	07/18/2019	Richard C. Carlson	63154US03

CONFIRMATION NO. 2880

23446
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

PUBLICATION NOTICE



Title:METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Publication No.US-2019-0337545-A1
Publication Date:11/07/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 11/20/2019

MCANDREWS HELD & MALLOY, LTD
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SUITE 3400
CHICAGO, IL 60661

EXAMINER	
LE, MARK T	

ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
11/20/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Office Action Summary	Application No. 16/515,903	Applicant(s) Carlson et al.	
	Examiner MARK T LE	Art Unit 3617	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 23 October 2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 20-31 is/are pending in the application.

5a) Of the above claim(s) 24-31 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 20-23 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

2. The prior art cited in the indicated Parent Applications 16290576 and 16055905 has been reviewed.

3. Applicant's election of invention Group III, drawn to the system, in the reply filed on October 23, 2019 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.01(a)).

4. It is noted that the elected invention for examination is the system of Group III. Among claims 20-31, only claims 20-23 are directed to the system in accordance with the elected invention (Group III), whereas claims 24-31 are directed specifically to the non-elected train-mounted unit instead of to the elected system of Group III. Therefore, claims 24-31 are withdrawn from further consideration as these claims drawn to a non-elected invention. It should be noted that claims 24-31 are improper dependent claim because they are worded in such a manner that excludes certain limitations of the base claim.

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

6. Claim(s) 20-22 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Soderi (US 2013/0138276).

Soderi discloses a system, having features as recited in the instant claims, comprising wayside units 108 for placement near tracks, such as track 110, a train mount unit 104, 308 configured to communicate with the wayside unit within range and control train functions, wherein the communication includes the use of ultra-wideband based pulses/signals (UWB) (see para [0014]), and wherein such communication is used to estimate a stopping distance for controlling vehicle braking to stop at a stopping point.

The structure of Soderi are considered to comprise the combination of features that are configured, arranged, and capable of the function/operation as recited in instant claim 20.

Regarding instant claim 21, the train mounted unit of Soderi is also configured to generate at least part of the control information based on other sources, such as the data storage unit for storage of the reference distance (para [0006]) and the device that provides speed information.

Regarding instant claim 22, the determination of a condition (e.g. the distance to a stopping point) and a control action (such as braking of the vehicle) of Soderi are considered to require the train unit to be capable of performing the operation recited in instant claim 22.

7. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have

> been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

8. Claims 21-23 is/are rejected under 35 U.S.C. 103 as being unpatentable over the prior art applied to claim 20 above and further in view of Chung (US 9,434,397).

Chung discloses a train control system that is configured to generate control information based on a plurality of sources for controlling braking stopping (col. 22, ll. 54-63). In view of Chung, it would have been obvious to one of ordinary skill in the art to use multiple sources for detecting the vehicle position or distance to a stopping point, as suggested by Chung, in the structure of Soderi to improve accuracy and reliability (col. 9, ll.4-11). The structure of Soderi, as modified, is considered to include the combination of features of claim 21

Regarding instant claim 22, the determination of a condition (e.g. the distance to a stopping point) and a control action (such as braking of the vehicle) of Soderi, as modified, are considered to require the train unit to be capable of performing the operation recited in instant claim 22.

Regarding instant claim 23, consider the description in Chung, col. 10, ll. 44-58, it would have been obvious to one of ordinary skill in the art to configure the train control unit of Soderi for performing the operations, similar to that taught by Chung, so as to enhance operational safety by initiating automatic emergency stop when a train operator fails to take action as being alerted and monitored by the train system.

9. A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process... may obtain a patent therefor..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the claims that are directed to the same invention so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

10. Claim 20 is provisionally rejected under 35 U.S.C. 101 as claiming the same invention as that of claim 20 of copending Application No. 16/290,576 (reference application). This is a provisional statutory double patenting rejection since the claims directed to the same invention have not in fact been patented.

11. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent

and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may

be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

12. Claims 1 and 22 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claim 7 of copending Application No. 16/055,905 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because the copending application claim includes the combination of features of instant application claims 1 and 22.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MARK T LE whose telephone number is (571)272-6682. The examiner can normally be reached on Mon-Tue,Thu-Fri 6am-4:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samuel Morano can be reached on 571-272-6684. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for

published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

MARK T. LE
Primary Examiner
Art Unit 3617

/MARK T LE/
Primary Examiner, Art Unit 3617

Notice of References Cited	Application/Control No. 16/515,903	Applicant(s)/Patent Under Reexamination Carlson et al.	
	Examiner MARK T LE	Art Unit 3617	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20130138276-A1	05-2013	Soderi; Simone	B61L3/008	701/19
*	B	US-9434397-B2	09-2016	Chung; Kevin Kwong-Tai	B61L25/025	1/1
	C					
	D					
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	J					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
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	R					
	S					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	Art Unit
	MARK T LE	3617

CPC - Searched*		
Symbol	**Date**	**Examiner**
(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	10/09/2019	ml
(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	10/10/2019	ml

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
246	220	10/10/2019	ml

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See EAST Search History (including updated searches)	11/12/2019	ml
Parent Applications 16290576 and 16055905 checked	11/12/2019	ml

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

Bibliographic Data

Application No: 16/515,903

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /MARK T LE/ (Examiner's Signature) | (Initials)

Title: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
07/18/2019	246	3617	63154US03
RULE			

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Marc Wayne Cygnus Mundelein, IL, UNITED STATES

CONTINUING DATA

This application is a CON of 16290576 03/01/2019

16290576 is a CIP of 16055905 08/06/2018

16290576 has PRO of 62637774 03/02/2018

16055905 has PRO of 62541454 08/04/2017

FOREIGN APPLICATIONS

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Carlson
Art Unit	
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	102923158	CN		2013-02-13	Chen Gengtian		
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	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

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	1	PCT, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, in International application no. PCT/US2014/053900, dated February 18, 2015 (21 pages).	
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EXAMINER SIGNATURE

Examiner Signature	/MARK T LE/	Date Considered	11/08/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

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	Art Unit	
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-07-18
Name/Print	Rami N. Moussa	Registration Number	69528

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(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Richard C. Carlson
Art Unit	3617
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5995881		1999-11-30	Kull	
	2	6135396		2000-10-24	Whitfield et al.	
	3	6666411		2003-12-23	Hart et al.	
	4	8998149		2015-04-07	Takahashi et al.	
	5	9022325		2015-05-05	Tsukamoto	
	6	8126035		2012-02-28	Hashimoto et al.	
	7	6732023		2004-05-04	Sugita et al.	
	8	8344877		2013-01-01	Sheardown et al.	

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	9	8423240		2013-04-16	Mian	
	10	8245983		2012-08-21	Gilbertson	

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	1	20060015224		2006-01-19	Hilleary	
	2	20090212168		2009-08-27	Kumar	
	3	20120123617		2012-05-17	Noffsinger et al.	

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	1	100975289	KR		2010-08-12	KRRI	English Language Abstract provided	☓
	2	20140017157	KR		2014-02-11	Hyundai Rotem Co.	English Language Abstract provided	☒

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	Examiner Name	Not yet assigned
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	3	100733599	KR		2007-07-03	Kyong Bong Technology Co., Ltd.	English Language Abstract provided	☒
	4	20050097843	KR		2005-10-10	Shalom Engineering Co., Ltd.	English Language Abstract provided	☒
	5	201323574	CN		2009-10-07	Signal & Communication Research Institute, et al.	English Language Abstract provided	☒
	6	22220819	CA		2000-01-11	Union Switch & Signal Inc.	English Language Abstract provided	☒
	7	4755521	JP		2011-08-24	Railway Technical Res. Inst.	English Language Abstract provided	☒
	8	2001106074	JP		2001-04-17	Tokimec Inc; Nishinippon Ryokaku Tetsudo KK; et al	English Language Abstract provided	☒
	9	4917313	JP		2012-04-18	Hitachi Ltd.	English Language Abstract provided	☐

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EXAMINER SIGNATURE			
Examiner Signature	/MARK T LE/	Date Considered	11/08/2019

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Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-08-12
Name/Print	Rami N. Moussa	Registration Number	69528

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	1	5420883		1995-05-30	Swensen et al.	
	2	7725252		2010-05-25	Heddebaut et al.	
	3	9002546		2015-04-07	Whitwam et al.	
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	1	20170245192		2017-08-24	Sadri et al.	

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"16118941"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 09:23
S2	102	("20150060608" | "20100327125" | "20120126065" | "20130166114" | "20140214248" | "20140263856" | "20160339934" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20110075641" | "20040155760" | "20120286563" | "20140046514" | "20140214247" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "20170245192" | "9128815" | "20160280240" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20170282944" | "5620155" | "5675190" | "6208260" | "20160046308" | "20030214417" | "20110046845" | "20110172856" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "9002546" | "20090326746" | "20050010338" | "20060151672" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20170101116" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "5554982" | "5652570" | "8952805" | "9002546" | "20150344048" | "20170113707" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "9128815" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "20140191089" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.	US-PGPUB; USPAT	ADJ	ON	2019/10/09 09:32

S3	2	(("9002546") or ("9128815")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/09 10:26
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S18	15	S17 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:23
S21	409	S19 and S20	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S20	526770	railroad or railway	US-PGPUB;	ADJ	ON	2019/10/09

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S23	8213	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 07:08
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S42	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/10/10 10:58
S43	24	("3676669" | "3794977" | "3944986" | "3976272" | "4257032" | "4611291" | "4619425" | "5050823" | "5129605" | "5398894" | "5533695" | "5678789" | "5740046" | "5950966" | "6032905" | "6122571").PN. OR ("6556898").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:02
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S47	6	(("6113037") or ("20110075641") or ("9283945") or ("20110006912") or ("5415369") or ("5050823")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/10 11:45
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S48	8249	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:44
S51	24441	S48 or S49 or S50	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:45
S50	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS;	OR	OFF	2019/11/05 14:45

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S56	89348	(train or locomotive) near4 control$4	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:35
S59	1426	S57 and S58	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:36
S58	74261	B61L$.cpc.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:36
S61	2736299	operator	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S60	56230	emergency near4 (stop or stopping or break or breaking)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S63	52	S58 and S62	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:24
S62	3694	S60 with S61	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:24
S65	325442	position near (sensing or detecting)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S64	1053209	train or locomotive	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S67	393	S65 with S66	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2019/11/12 09:08

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S73	59	S69 and S72	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:14
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EAST Search History (Interference)

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PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Carlson
Art Unit	3659
Examiner Name	Not yet assigned
Attorney Docket Number	63154US03

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5675190		1997-10-07	Morita	
	2	4302811		1981-11-24	McElhenny	
	3	4327415		1982-04-27	Rush et al.	
	4	4459668		1984-07-10	Inoue et al.	
	5	4495578		1985-01-22	Sibley et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2019-07-18
	First Named Inventor	Carlson
	Art Unit	3659
	Examiner Name	Not yet assigned
	Attorney Docket Number	63154US03

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	Examiner Name	Not yet assigned
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	1	102923158	CN		2013-02-13	Chen Gengtian		
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	1	PCT, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, in International application no. PCT/US2014/053900, dated February 18, 2015 (21 pages).	
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EXAMINER SIGNATURE

Examiner Signature	/MARK T LE/	Date Considered	11/08/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2019-07-30
Name/Print	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: Feb. 20, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.111

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the non-final office action of Nov. 20, 2019 ("Office Action") in the above-identified application ("Application"). The Applicant respectfully requests entry of the following amendments and consideration of the following remarks.

Listing of the Claims begins on page 2 of this paper.

Remarks and Arguments begin on page 6 of this paper.

LISTING OF THE CLAIMS

1-19. (Canceled)

20. (Currently amended) A system for providing decentralized control operations in a railway network, the system comprises:

a plurality of wayside units, each configured for placement on or near tracks in the railway network; and

one or more train-mounted units, each configured for deployment on a train operating in the railway network;

wherein each train-mounted unit is configured to:

communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and

generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network,

wherein generating the control information comprises or is based on substantially continually determining absolute position of the train, and

wherein determining the absolute position of the train comprises:

determining absolute positioning information based on information obtained from each wayside as the train passes the wayside unit,

determining ranging information based on ultra-wideband (UWB) based signals communicated with one or more of the plurality of wayside units, and

determining the absolute position of the train based on the absolute positioning information and the ranging information.

21. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than the processing of the ultra-wideband (UWB) based signals.

22. (Previously presented) The system of claim 21, wherein the train-mounted unit is configured to:

assess based on the processing of the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

when at least one condition meets one or more particular criteria, determine one or more responsive actions; and

perform or cause performing each of the one or more responsive actions.

23. (Previously presented) The system of claim 22, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:

monitor actions of the train operator;

assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

24. (Canceled)

25. (Canceled)

26. (Canceled)

27. (Canceled)

28. (Canceled)

29. (Canceled)

30. (Canceled)

31. (Canceled)

32. (New) The system of claim 20, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.

33. (New) The system of claim 20, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

34. (New) The system of claim 20, wherein the train-mounted unit is configured for handling satellite based signals.

35. (New) The system of claim 34, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

36. (New) The system of claim 20, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.

37. (New) The system of claim 20, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.

38. (New) The system of claim 20, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.

39. (New) The system of claim 20, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.

REMARKS AND ARGUMENTS

The Examiner notes that this Application is being examined under the first inventor to file provisions of the AIA (America Invents Act). Office Action at 2. Initially, the Applicant notes that a goal of patent examination is to provide a prompt and complete examination of a patent application:

> It is essential that patent applicants obtain a prompt yet complete examination of their applications. Under the principles of compact prosecution, each claim should be reviewed for compliance with every statutory requirement for patentability in the initial review of the application, even if one or more claims are found to be deficient with respect to some statutory requirement. Thus, USPTO personnel should state all reasons and bases for rejecting claims in the first Office action. Deficiencies should be explained clearly, particularly when they serve as a basis for a rejection. Whenever practicable, USPTO personnel should indicate how rejections may be overcome and how problems may be resolved. A failure to follow this approach can lead to unnecessary delays in the prosecution of the application.

See Manual of Patent Examining Procedure (MPEP) § 2103(I). As such, the Applicant assumes, based on the goals of patent examination noted above, that the present Office Action has set forth "all reasons and bases" for rejecting the claims.

Claims 20-31 are pending in this Application, of which claim 20 is an independent claims, and claims 21-31 are dependent claims, depending from independent claim 20. Claims 1-19 were previously canceled. In this correspondence, claim 20 is amended, claims 24-31 are canceled, and new claims 32-39 are added.

Claims 20-23 stand rejected. In particular, claims 20-22 stand rejected under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi et al. (U.S. Patent Publication No. 2013/0138276; hereinafter "Soderi"). Claims 21-23 stand rejected under 35 U.S.C. § 103 for allegedly being unpatentable over Soderi in view of Chung et al. (U.S. Patent No. 9,434,397; hereinafter "Chung"). Claims 20-23 also stand rejected on double patenting grounds.

Claims 24-31 are withdrawn from further consideration by the Examiner.

The Applicant respectfully traverses these rejections at least based on the following remarks. In addition, the Applicant also reserves the right to argue additional reasons beyond those set forth herein to support allowability of the claims, should a need arise in the future.

Initial Comments

As noted above, claims 24-31 are withdrawn from further consideration by the Examiner in the Office Action, for allegedly being directed to one of the non-elected groups of invention. Office Action at 2. The Applicant traverses the withdrawing of these claims, and notes that these claims are clearly related to the elected group, and that it was merely a typographical error in these claims that made them appear directed to one of the non-elected groups. Nonetheless, the Applicant cancels these claims, and add new claims (claims 32-39) with corrected reference to independent claim 20, reciting similar features as those in now-canceled claims 24-31.

Double Patenting Claim Rejections

1. REJECTION OF CLAIM 20 ON SAME INVENTION GROUNDS

The Examiner rejects claim 20 on double patenting grounds. In this regard, the Examiner alleges that claim 20, as pending when the Office Action was issued, claims the "same invention" as that of claim 20 of Applicant's U.S. Patent Application Serial No. 16/290,576 (hereinafter "'576 application"), and as such claim 20 is subject to rejection on double patenting grounds for being directed to the "same invention" which is prohibited under 35 U.S.C. § 101. Office Action at 5. The Examiner further notes that this rejection cannot be overcome by submission of a terminal disclaimer, and that this rejection can only be "overcome by canceling or amending the claims." *Id.*

The Applicant submits that in view of the amendments made in the correspondence to claim 20, as described in more detail below, claim 20 is no long identical to claim 20 of the '576 application, rendering this rejection moot.

Accordingly, the Applicant respectfully requests that the double patenting based rejection of claim 20 on "same invention" grounds be withdrawn. The Applicant also reserves the right to argue additional reasons beyond those set forth herein to support the allowability of claims 1-20, should such a need arise.

2. REJECTION OF CLAIMS 1 AND 22 ON NONSTATUTORY DOUBLE PATENTING GROUNDS

The Examiner rejects claims 1 and 22 on nonstatutory obviousness-type double patenting grounds for allegedly being unpatentable over claim 7 of Applicant's copending U.S. Patent Application Serial No. 16/055,905 (hereinafter "'576 application"), Office Action at 7.

The Applicant respectfully traverses these rejections. As an initial matter, the Applicant notes that includes a now-canceled claim (claim 1) in this rejection, so it is unclear if that was intentional or by mistake. Irrespective, in order to further prosecution, the Applicant submits herewith this correspondence terminal disclaimer, in compliance with 37 C.F.R. § 1.321(c), directed to the '576 application, to obviate these double patenting rejections.

Accordingly, the Applicant respectfully requests that the Examiner's double patenting based rejection of claims 1 and 22 be withdrawn. The Applicant also reserves the right to argue additional reasons beyond those set forth herein, should a need arise in the future.

Claim Rejections under 35 U.S.C. § 102

With respect to the claim rejections on anticipation grounds under 35 U.S.C. § 102, the Applicant notes that "[a] claim is anticipated only if ***each and every element*** as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *See* MPEP § 2131 (internal citation omitted). Furthermore, "[t]he

identical invention must be shown in as complete detail as is contained in the … claim." *See id.* (internal citation omitted).

With those principles in mind, and without conceding that Soderi would qualify as prior art under 35 U.S.C. § 102(a)(1), the Applicant respectfully traverses the claim rejections under § 102 for the follow reasons.

I. REJECTION OF INDEPENDENT CLAIM 20

With regard to the rejection of the independent claim 20 under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi, the Applicant traverses the rejection, and maintains that claim 20 as pending when the Office Action are not anticipated by Soderi. Nonetheless, the Applicant submits that in order to advance prosecution, claim 20 are amended, rendering the rejection moot.

In particular, claim 20 is amended such that it now recites: "[a] system for providing decentralized control operations in a railway network, the system comprises: a plurality of wayside units, each configured for placement on or near tracks in the railway network; and one or more train-mounted units, each configured for deployment on a train operating in the railway network; wherein each train-mounted unit is configured to: communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network, *wherein generating the control information comprises or is based on substantially continually determining absolute position of the train, and wherein determining the absolute position of the train comprises: determining absolute positioning information based on information obtained from each wayside as the train passes the wayside unit, determining ranging information based on ultra-wideband (UWB) based signals communicated with one or more of the plurality of wayside units, and determining the*

absolute position of the train based on the absolute positioning information and the ranging information." (Emphasis added).

The Applicant submits that Soderi does not teach or disclose all the limitations of amended claim 20. In particular, the Applicant submits that Soderi does not teach (or suggest) that its train mount unit 104 may be configured to continually determine absolute position of the train, particularly where determining the absolute position of the train includes determining absolute positioning information based on information obtained from each wayside that the train passes, as the train passes the wayside unit, determining ranging information based on ultra-wideband (UWB) based signals communicated with one or more wayside units, and determining the absolute position of the train based on the absolute positioning information and the ranging information.

Therefore, claim 20 as amended is not anticipated by Soderi.

Accordingly, the Applicant respectfully requests that the rejections of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi be withdrawn. The Applicant also reserves the right to argue additional reasons beyond those set forth herein, should a need arise in the future.

II. REJECTION OF DEPENDENT CLAIMS 21 AND 22

The Examiner rejects claims 21 and 22 under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi. Office Action at 3. The Applicant traverses these rejections, and submits that these claims, as pending when the Office Action was issued, are not anticipated by Soderi.

Based on at least the foregoing, however, the Applicant believes that the rejection of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi has been overcome.

Therefore, because claims 21 and 22 depend from independent claim 20, the Applicant submit that claims 21 and 22 are consequently not anticipated by Soderi at least for the reasons stated above with regard to the rejections of claim 20.

Accordingly, the Applicant respectfully requests that the rejections of claims 21 and 22 under 35 U.S.C. § 102(a)(1) based on Soderi be withdrawn. The Applicant also reserves the right to argue additional reasons beyond those set forth herein, should a need arise in the future.

Claim Rejections under 35 U.S.C. § 103

With respect to the claim rejections on obviousness grounds under 35 U.S.C. § 103, the Applicant notes that the determination of obviousness is a legal conclusion based on underlying findings fact. *Sanofi-Synthelabo v. Apotex, Inc.*, 550 F.3d 1075, 1085 (Fed. Cir. 2008). The factual inquiries include: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the relevant art, and (4) any objective indicia of non-obviousness. *Graham v. John Deere Co.,* 383 U.S. 1, 86 S. Ct. 684 (1966). The burden is on the Examiner to establish a *prima facie* case of obviousness. *See* MPEP § 2142. Further, if the Examiner does not produce a prima facie case, "the applicant is under no obligation to submit secondary evidence to show nonobviousness." *See id.*

"The determination of obviousness is made with respect to the subject matter as a whole, not separate pieces of the claim." *Apotex*, 550 F.3d 1075 at 1086. (citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007); *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1448 (Fed.Cir.1984)). Accordingly, "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." *See* MPEP § 2143.03 (quoting *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970)). If, considering the claim as a whole, the Examiner deems the claim to be obvious in view of the prior art, the Examiner must provide a "clear articulation of the reason(s) why the claimed invention would have been obvious." *See* MPEP § 2142. The Examiner's

determination of obviousness "cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. 398 at 418 (quoting *In re Kahn*, 441 F.3d 977, 988, (Fed. Cir. 2006)).

In reviewing an Examiner's determination of obviousness, "the Board cannot simply reach conclusions based on its own understanding or experience—or on its assessment of what would be basic knowledge or common sense. Rather, the Board must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 258 F.3d 1379, 1386 (Fed. Cir. 2001). *See also In re Vaidyanathan*, Appeal 2009-1404 at 18-19 (Fed. Cir. May 19, 2010) (nonprecedential) ("If the examiner is able to render a claim obvious simply by saying it is so, neither the Board nor [the Federal Circuit] is capable of reviewing that determination. … If there is neither record evidence nor detailed examiner reasoning, the Board should not conclude that … [the] claims are obvious").

With those principles in mind, and without conceding that any of the references the Examiner cites would qualify as prior art, or that any combination thereof is valid for purposes of 35 U.S.C. § 103, the Applicant respectfully traverses the claim rejections under § 103 for the follow reasons.

I. REJECTION OF DEPENDENT CLAIMS 21-23

The Examiner rejects claims 21-23 under 35 U.S.C. § 103 based on the combination of Soderi and Chung. Office Action at 4-5. The Applicant traverses these rejections, and submits that these claims, as pending when the Office Action was issued, are patentable over the asserted references and any combination thereof.

Based on at least the foregoing, however, the Applicant believes that the rejection of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi has been overcome.

Therefore, at least because these claims depend from independent claim 20, the Applicant submits that claims 21-23 are consequently patentable over the asserted references and combinations thereof at least for the reasons stated above with regard to the rejection of claim 20 under 35 U.S.C. § 102(a)(1).

Accordingly, the Applicant respectfully requests that the rejections of claims 21-23 under 35 U.S.C. § 103 be withdrawn. The Applicant also reserves the right to argue additional reasons beyond those set forth herein, should a need arise in the future.

Final Remarks

In general, the Office Action makes various statements that are now moot in light of the above remarks. Thus, the Applicant will not address such statements at the present time. However, the Applicant expressly reserves the right to challenge such statements in the future should the need arise (*e.g.,* if such statement should become relevant by appearing in a rejection of any current or future claim or be relied upon in any proceeding involving this Application or a corresponding patent).

CONCLUSION

Based on at least the foregoing, the Applicant believes that claims 20-23 and 32-39 are in condition for allowance. If the Examiner has any questions or the Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

A Notice of Allowability is courteously solicited.

Respectfully submitted,

Date: Feb. 20, 2020

/Rami N. Moussa/
Rami N. Moussa
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(312) 775-8000

Electronic Acknowledgement Receipt

EFS ID:	38647094
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	20-FEB-2020
Filing Date:	18-JUL-2019
Time Stamp:	16:55:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		63154US03_OA2_NFOA_Rsp.pdf	93332 cb67325e4d92595e1746a7851807793dcbba5327	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	14
Warnings:			
Information:			
	Total Files Size (in bytes):	93332	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION**
Application Number	16515903
Filing Date	18-Jul-2019
First Named Inventor	Richard Carlson
Attorney Docket Number	63154US03
Title of Invention	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
METROM RAIL, LLC	100%

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

16055905 filed on 08/06/2018

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.	
Applicant claims the following fee status: ◉ Small Entity ○ Micro Entity ○ Regular Undiscounted I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application Registration Number 69528 ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this request	
Signature	/Rami N. Moussa/
Name	Rami N. Moussa

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16515903
Filing Date:	18-Jul-2019
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Filer:	Rami Naim Moussa/Elaine Maxson
Attorney Docket Number:	63154US03

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16515903

Filing Date: 18-Jul-2019

Applicant/Patent under Reexamination: Carlson

Electronic Terminal Disclaimer filed on February 20, 2020

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	38646760
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	20-FEB-2020
Filing Date:	18-JUL-2019
Time Stamp:	16:48:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$160
RAM confirmation Number	E20202JG47590392
Deposit Account	130017
Authorized User	Elaine Maxson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	34036 d5c9d001ccb33cced734d08866b543b0834 9b6fe	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30492 f2aad98f319968fa18c9ef3304adf28069fa0c 77	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	64528		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 03/10/2020

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER
LE, MARK T

ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
03/10/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Office Action Summary	Application No. 16/515,903	Applicant(s) Carlson et al.	
	Examiner MARK T LE	Art Unit 3617	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 20 February 2020.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 20-23 and 32-39 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 20-23 and 32-39 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

1. This communication is responsive to Applicant's response filed February 20, 2020. Applicant's amendment and arguments have been carefully considered.

2. The terminal disclaimer filed February 20, 2020 has been approved.

3. Claims 20-23 and 32-39 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

In claim 20, line 18, "each wayside" is not clear as to whether it refers to each of the wayside units recited in line 3 of the same claim.

Other claims are also indefinite because they depend from the indefinite base claim.

4. Claim(s) 20-22 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Soderi (US 2013/0138276).

Soderi discloses a system that has a configuration usable with a vehicle or a train and having features as recited in the instant claims, comprising wayside units 108 for placement near tracks, such as track 110, a vehicle mount unit 104, 308 configured to communicate with the wayside unit(s) within range and control train functions, wherein the communication includes the use of ultra-wideband based pulses/signals (UWB) (see para [0014]), and wherein such communication is used to estimate stopping distance 118 for controlling vehicle braking to stop at stopping point 106. The vehicle of Soderi is considered to be operable as a locomotive part of a train.

Regarding the added features in claim amended claim 20, consider Soderi (paras [0027], [0024], [0025], [0034]), wherein a determination of the absolute position (i.e. corresponding to stopping distance 118, para [0027]) of the vehicle is based on an absolute positioning information (i.e. the unique signature of a wayside unit 108 - see para [0034]) to obtain the reference distance (i.e. corresponding to the position of the wayside unit 108) and the measured distance (i.e. the ranging information based on UWB based signals). In the structure of Soderi, each wayside unit is considered to also include its communication range as being part of the wayside unit. The structure of Soderi are considered to comprise a combination of features arranged and configured to operate as recited in instant claim 20.

Regarding instant claim 21, the train/vehicle mounted unit of Soderi is also configured to generate at least part of the control information based on other sources, such as the data storage unit for storage of the reference distance (para [0006]) and the device that provides speed information.

Regarding instant claim 22, the determination of a condition (e.g. the distance to a stopping point) and a control action (such as braking of the vehicle) of Soderi are considered to require the train unit to be capable of performing the operation recited in instant claim 22.

5. Claims 21-23 and 32-39 is/are rejected under 35 U.S.C. 103 as being unpatentable over the prior art applied to claim 20 above and further in view of Chung (US 2016/0046308, corresponding to US 9,434,397).

Chung discloses a train control system that is configured to generate control information based on a plurality of sources for controlling braking stopping (e.g. para

[0141]). In view of Chung, it would have been obvious to one of ordinary skill in the art to use multiple sources for detecting the vehicle position or distance to a stopping point, as suggested by Chung, in the structure of Soderi to improve accuracy and reliability (e.g. para [0062] of Chung). The structure of Soderi, as modified, is considered to include the combination of features of claim 21

Regarding instant claim 22, the determination of a condition (e.g. the distance to a stopping point) and a control action (such as braking of the vehicle) of Soderi, as modified, are considered to require the train unit to be capable of performing the operation recited in instant claim 22.

Regarding instant claim 23, consider the description in Chung (e.g. paras [0071], [0072]), it would have been obvious to one of ordinary skill in the art to configure the train control unit of Soderi for performing the operations, similar to that taught by Chung, so as to enhance operational safety by initiating automatic emergency stop when a train operator fails to take action as being alerted and monitored by the train system.

Regarding instant claims 32-37, consider Fig. 3 of Chung, wherein the train mounted unit is configured for operation with various non-UWB based signals 112-116, 130, 142, 162, 310-330, etc…, RFID (e.g. para [0065]), satellite based signals (GPS 132), other systems of the train as shown in Fig. 3 of Chung, operator alert device(s) 210, and input device 140 in the form of a keyboard/touch screen. Regarding instant claim 38, consider the train electrical power described in paragraph [0054] of Chung. Regarding instant claim 39, consider for example the description in paragraph [0063] of Chung, wherein the train mounted unit is configured for communicating with another train/a central location, which are also readable as components in the railway network,

and on the other hand, operator alert device(s) 210 of Chung is also readable as a component(s) communicating with train mounted unit 100. In view of Chung, it would have been obvious to one of ordinary skill in the art to also include the features, similar to that taught in Chung, in the structure of Soderi for performing the expected functions and achieving expected advantages thereof, such as enhancing accuracy, reliability, and safety.

6. The above rejection is made to also include examiner's responses that address (directly/indirectly) applicant's points of arguments.

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to MARK T LE whose telephone number is (571)272-6682. The examiner can normally be reached on Mon-Tue, Thu-Fri 6am-4:30pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an

interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Samuel Morano can be reached on 571-272-6684. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

MARK T. LE
Primary Examiner
Art Unit 3617

/MARK T LE/
Primary Examiner, Art Unit 3617

Notice of References Cited	Application/Control No. 16/515,903	Applicant(s)/Patent Under Reexamination Carlson et al.	
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*	A	US-20160046308-A1	02-2016	Chung; Kevin Kwong-Tai	B61L23/041	701/20
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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	Examiner	Art Unit
	MARK T LE	3617

CPC - Searched*		
Symbol	**Date**	**Examiner**
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CPC Combination Sets - Searched*		
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US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
246	220	10/10/2019	ml

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See EAST Search History (including updated searches)	11/12/2019	ml
Parent Applications 16290576 and 16055905 checked	11/12/2019	ml
Searches updated	02/27/2020	ml

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EAST Search History

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L2	3	(("20130138276") or ("9434397") or ("20160046308")).PN.	US-PGPUB; USPAT	OR	OFF	2020/02/28 11:03
L3	448	((("CARLSON") near3 ("Richard"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/02/28 11:14
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"6570497" | "6571636" | "6584953" |
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		"6591758" | "6604421" | "6609049" | "6612245" | "6612246" | "6615118" | "6615188" | "6631322" | "6634112" | "6647328" | "6647891" | "6665609" | "6668217" | "6676089" | "6681160" | "6691022" | "6694231" | "6698913" | "6701064" | "6712045" | "6725782" | "6728515" | "6728606" | "6728625" | "6732023" | "6732032" | "6742392" | "6748303" | "6748313" | "6763291" | "6778284" | "6782044" | "6789005" | "6799096" | "6804621" | "6810312" | "6812888" | "6814050" | "6814060" | "6823844" | "6833554" | "6853888" | "6853890" | "6854691" | "6863246" | "6865454" | "6893262" | "6895362" | "6903658" | "6904110" | "6910792" | "6915191" | "6945114" | "6947830" | "6948837" | "6951132" | "6953272" | "6957131" | "6973947" | "6976324" | "6980894" | "6996461" | "7007561" | "7023539" | "7031823" | "7036232" | "7036774" | "7047130" | "7050926" | "7051693" | "7053606" | "7054762" | "7072757" | "7081824" | "7082881" | "7082924" | "7096171" | "7131403" | "7140477" | "7152330" | "7161500" | "7164975" | "7181851" | "7188009" | "7197932" | "7200536" | "7201350" | "7219067" | "7226021" | "7228747" | "7234449" | "7263647" | "7263886" | "7290807" | "7296770" | "7305885" | "7309929").PN. OR ("7312607" | "7337766" | "7387029" | "7389694" | "7392117" | "7394553" | "7395141" | "7403296" | "7416262" | "7463348" | "7497201" | "7502670" | "7509193" | "7520415" | "7523893" | "7539596" | "7543670" | "7557748" | "7565867" | "7575201" | "7659972" | "7667611" | "7716010" | "7734387" | "7752913" | "7755660" | "7770847" | "7778747" | "7783397" | "7811089" | "7869909" | "7872736" | "7882742" | "7895135" | "7920984" | "7937246" | "7938370" | "7940389" | "7960855" | "8020446" | "8030871" | "8037763" | "8068975" | "8081320" | "8125219" | "8126601" | "8150568" | "8154227" | "8155811" | "8157218" | "8157219" | "8160832" | "8195364" | "8264330" | "8266092" | "8305567" | "8428798" | "8521345" | "8532842" | "8626366" | "8645047" | "8655518" | "8655519" | "8682514" | "9108640" | "9889869" | "RE35590").PN. OR ("10308265").URPN.				
S9	46	("20030183697" | "20030236598" | "20040111309" | "20050234757" | "20060212183" | "20060212184" | "20070176054" | "20100063656" | "20100063657" | "3819932" | "4122523" | "5398894" | "5420883" | "5437422" | "5463552" | "6135396" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 12:40

		"6154735" | "6459964" | "6694231" | "6799097" | "6853889" | "6915191" | "7089093" | "7092894" | "7099754" | "7139646" | "7201350" | "7269487" | "7386391" | "7558740" | "7706967" | "7715977" | "7725249" | "7734383" | "7797088" | "7813846" | "7869939" | "7937193" | "8082071" | "8126601" | "8140203" | "8224510" | "8234023" | "8290645" | "8321079").PN. OR ("8820685").URPN.				
S10	10	("20090037038" | "5533695" | "6023245" | "6371416" | "6459965" | "6622068" | "6789013" | "7151997" | "7222003").PN. OR ("8224510").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 12:40
S11	128	("3250914" | "3284627" | "3402289" | "3581071" | "3794833" | "3967801" | "4046342" | "4181943" | "4279395" | "4495578" | "4655421" | "4711418" | "4742460" | "4768740" | "5036478" | "5072900" | "5340062").PN. OR ("5533695").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 12:42
S12	10	("20090037038" | "5533695" | "6023245" | "6371416" | "6459965" | "6622068" | "6789013" | "7151997" | "7222003").PN. OR ("8224510").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 12:50
S13	16	("20060212189" | "20070219682" | "20070225878" | "20070260367" | "3963203" | "4066228" | "4553723" | "4582280" | "5340062" | "5398894" | "5452870" | "5533695" | "6400281" | "6459695").PN. OR ("8170732").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 13:56
S14	2	(("20160280240") or ("20110075641")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/09 14:40
S15	115	("20130166114" | "2475578" | "2762913" | "6113037" | "20110152971" | "20160280240" | "6113037" | "5727758" | "5924651" | "5939986" | "6232887" | "8952805" | "5620155" | "6208260" | "20110152971" | "20100102954" | "20110006912" | "2475578" | "8248263" | "5198800" | "5939986" | "6145792" | "6232887" | "6650242" | "8109474" | "20120296562" | "5198800" | "8109474" | "8344877" | "20140045547" | "5554982" | "5727758" | "6145792" | "6208260" | "20100102954" | "5554982" | "5652570" | "8952805" | "20110006912" | "20140045547" | "20130166114" | "20170282944" | "5652570" | "6650242" | "7624952" | "8248263" | "8786428" | "20120296562" | "2762913" | "5924651" | "7167082" | "7624952" | "7167082" | "5620155" | "8786428").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 14:46
S16	2	(("20110075641") or	US-PGPUB;	OR	OFF	2019/10/09

		("20110006912")).PN.	USPAT			15:12
S17	442	((("CARLSON") near3 ("Richard"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/10/09 15:13
S18	15	S17 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:23
S19	500	B61L$.cpc. and solar	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S20	526770	railroad or railway	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S21	409	S19 and S20	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S22	11	(US-20160280240-$ or US-20110006912-$ or US-20070162199-$).did. or (US-10308265-$ or US-9889869-$ or US-9828010-$ or US-9321469-$ or US-8820685-$ or US-8224510-$ or US-6113037-$ or US-5533695-$).did.	US-PGPUB; USPAT	ADJ	ON	2019/10/10 07:05
S23	8213	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 07:08
S24	22	("20100258682" | "20110238242" | "20120325980" | "4596029" | "4601051" | "4654770" | "5050823" | "5533695" | "5815823" | "5823481" | "5950966" | "6032905" | "6034944" | "6122571" | "6308117" | "6392553" | "6400281" | "7148581" | "7364123" | "7823841" | "8032078").PN. OR ("9321469").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 07:17
S25	23	("3361082" | "4005837" | "4015082" | "4556941" | "4742460" | "4854529" | "5403238" | "5440489" | "5527221" | "5583844" | "5590603" | "5623878" | "5681015" | "5815823").PN. OR ("6122571").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 07:17
S26	46	("20030183697" | "20030236598" | "20040111309" | "20050234757" |	US-PGPUB; USPAT;	ADJ	ON	2019/10/10 07:42

		"20060212183" | "20060212184" | "20070176054" | "20100063656" | "20100063657" | "3819932" | "4122523" | "5398894" | "5420883" | "5437422" | "5463552" | "6135396" | "6154735" | "6459964" | "6694231" | "6799097" | "6853889" | "6915191" | "7089093" | "7092894" | "7099754" | "7139646" | "7201350" | "7269487" | "7386391" | "7558740" | "7706967" | "7715977" | "7725249" | "7734383" | "7797088" | "7813846" | "7869939" | "7937193" | "8082071" | "8126601" | "8140203" | "8224510" | "8234023" | "8290645" | "8321079").PN. OR ("8820685").URPN.	USOCR			
S32	526828	railroad or railway	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S33	34723	ultra-wideband	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S34	679	S32 and S33	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S35	15	S34 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S36	56	("1700933" | "1797302" | "1809374" | "1812183" | "1868489" | "1915696" | "2203988" | "2221290" | "2592163" | "3035167" | "3178683" | "3267281" | "3558874" | "3781543" | "3927852" | "3963202" | "4108405" | "4122523" | "4307860" | "4449115" | "4581700" | "4613103" | "4754272" | "4895325" | "4942395" | "5252893" | "5628479" | "5727758" | "5735491" | "5735492" | "5757288" | "5924651").PN. OR ("6113037").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:02
S37	54	("20040073342" | "20050275513" | "20060015224" | "20060116837" | "20070085734" | "20070261894" | "20070274158" | "20100020185" | "20100130873" | "20100163687" | "20110006912" | "20110009814" | "20110030875" | "20110278401" | "20120006946" | "20120218099" | "20140104081" | "20140111356" | "20140210646" | "20140308930" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:02

		"20150091716" | "20170148323" | "3167282" | "4128218" | "4207569" | "5038704" | "5129605" | "5148150" | "5727758" | "5735492" | "5864304" | "5867801" | "5907294" | "5924651" | "5954299" | "6020815" | "6113037" | "6145792" | "6232887" | "6323785" | "6371416" | "7538666" | "7624952" | "7832691" | "8061662" | "8109474" | "8157219" | "8344877" | "8773275" | "8786428" | "8952805" | "9767968" | "9902411").PN. OR ("10106079").URPN.				
S38	10	("20050010338" | "20110006912" | "20120296562" | "20120306664" | "5924651" | "6145792" | "6232887" | "6471162" | "7075427").PN. OR ("9902411").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:05
S39	28	("2762913" | "5303259" | "5415369" | "5461366" | "5554982" | "5572201" | "5620155" | "5727758").PN. OR ("6145792").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:22
S40	17	("5727758" | "6113037" | "6145792").PN. OR ("7624952").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:25
S41	26	("2762913" | "5554982" | "5620155").PN. OR ("5727758").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:27
S42	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/10/10 10:58
S43	24	("3676669" | "3794977" | "3944986" | "3976272" | "4257032" | "4611291" | "4619425" | "5050823" | "5129605" | "5398894" | "5533695" | "5678789" | "5740046" | "5950966" | "6032905" | "6122571").PN. OR ("6556898").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:02
S44	43	("3110885" | "3218452" | "3836768" | "3976272" | "4090173" | "4181849" | "4307463" | "4368534" | "4498650" | "4563762" | "4610206" | "4611291" | "4611775" | "4617662" | "4711418" | "4740972" | "4831521" | "4860977").PN. OR ("5050823").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:09
S45	24	("3676669" | "3794977" | "3944986" | "3976272" | "4257032" | "4611291" | "4619425" | "5050823" | "5129605" | "5398894" | "5533695" | "5678789" | "5740046" | "5950966" | "6032905" | "6122571").PN. OR ("6556898").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:10
S46	133	("2138878" | "3112908" | "3250914" | "3676669" | "3754211" | "3805056").PN. OR ("4711418").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:14

S47	6	(("6113037") or ("20110075641") or ("9283945") or ("20110006912") or ("5415369") or ("5050823")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/10 11:45
S48	8249	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:44
S49	20299	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:44
S50	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/11/05 14:45
S51	24441	S48 or S49 or S50	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:45
S52	261	S51 and @pd>="20191001"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:46
S53	102	("20100327125" | "20120126065" | "20130166114" | "20140214248" | "20140263856" | "20150060608" | "20160339934" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20030214417" | "20110046845" | "20110172856" | "20160046308" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" |	US-PGPUB; USPAT	ADJ	ON	2019/11/08 12:05

		"6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "9002546" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "9128815" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "20140191089" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.				
S55	5	(("20130138276") or ("20120296562") or ("20110234451") or ("4327415") or ("20100063656")).PN.	US-PGPUB; USPAT	OR	OFF	2019/11/08 12:31
S56	89348	(train or locomotive) near4 control$4	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:35
S57	2108	S56 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:35
S58	74261	B61L$.cpc.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:36
S59	1426	S57 and S58	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:36
S60	56230	emergency near4 (stop or stopping or break or breaking)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S61	2736299	operator	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S62	3694	S60 with S61	US-PGPUB; USPAT; FPRS; EPO; JPO;	ADJ	ON	2019/11/08 13:24

			DERWENT; IBM_TDB			
S63	52	S58 and S62	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:24
S64	1053209	train or locomotive	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S65	325442	position near (sensing or detecting)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S66	983251	redundan$3	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:08
S67	393	S65 with S66	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:08
S68	50	S64 and S67	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:09
S69	74311	B61L$.cpc.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:09
S71	308	S64 and S65 and S69	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:10
S72	4808	speed with odometer	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:14
S73	59	S69 and S72	US-PGPUB; USPAT; FPRS; EPO; JPO;	ADJ	ON	2019/11/12 09:14

			DERWENT; IBM_TDB			
S74	106	("5415369" | "5452870" | "5620155" | "5699986").PN. OR ("5978718").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/11/12 09:16
S75	1	("20160046308").PN.	US-PGPUB	OR	OFF	2019/11/12 09:46
S76	471	((("CARLSON") near3 ("Richard")) OR (("GUNTHER") near3 ("Kurt")) OR (("WOITEL") near3 ("Sara") near3 ("Jo")) OR (("CYGNUS") near3 ("Marc"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/11/12 10:16
S77	8	S76 and decentral$4	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 10:16
S79	102	("20120126065" | "20140214248" | "20140263856" | "20160339934" | "20100327125" | "20130166114" | "20150060608" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "9128815" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20110172856" | "20030214417" | "20110046845" | "20160046308" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "9002546" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "20140191089" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "7167082" |	US-PGPUB; USPAT	ADJ	ON	2019/11/12 11:01

		"8478463" | "6666411" | "5420883" | "7725252").PN.				
S80	102	("20120126065" | "20140214248" | "20140263856" | "20160339934" | "20100327125" | "20130166114" | "20150060608" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20110172856" | "20030214417" | "20110046845" | "20160046308" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "9002546" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "9128815" | "20140191089" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.	US-PGPUB; USPAT	ADJ	ON	2019/11/12 11:03
S81	102	S79 or S80	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 11:04
S82	2	(("20130138276") or ("9434397")).PN.	US-PGPUB; USPAT	OR	OFF	2019/11/15 08:21
S85	9472	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42

S86	24347	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S87	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/02/27 14:42
S88	29038	S85 or S86 or S87	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S89	1328	S88 and @pd>="20191101"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S90	64	S89 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:47
S91	1	"16515903"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:08
S92	4782	absolute with ranging	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:30
S93	3033	absolute near7 ranging	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:30
S94	166	S93 with (position or location)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:31
S95	125	S92 and (railroad or railway)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:51

S96	736	train with (location or position) with wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:57
S97	44	S96 and ranging	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:58
S98	2885	B61L27/0038.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 16:22
S99	858	wayside with position	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 16:23
S100	1	"20160046308"	US-PGPUB	ADJ	ON	2020/02/28 08:33
S101	1	"16515903"	US-PGPUB	ADJ	ON	2020/02/28 09:31
S102	1	"16515905"	US-PGPUB	ADJ	ON	2020/02/28 09:32

EAST Search History (Interference)

<This search history is empty>

2/28/2020 11:19:49 AM
C:\Users\mle1\Documents\EAST\Workspaces\16515903.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Richard C. Carlson
Art Unit	3617
Examiner Name	LE, MARK T
Attorney Docket Number	63154US03

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	1							

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	LE, MARK T
	Attorney Docket Number	63154US03

	1	International Preliminary Report on Patentability for PCT/US2018/049062, date of completion - October 26, 2018, 8 pages.

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	LE, MARK T
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2020-04-15
Name/Print	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 61997WO01	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2018/049062	International filing date *(day/month/year)* 31 August 2018 (31.08.2018)	Priority date *(day/month/year)* 01 September 2017 (01.09.2017)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant METROM RAIL, LLC		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 03 March 2020 (03.03.2020)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Miki Kobayashi e-mail: pct.team8@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: RAMI N. MOUSSA
MCANDREWS, HELD & MALLOY LTD.
500 WEST MADISON STREET
34TH FLOOR
CHICAGO, IL 60661

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	09 NOV 2018
Applicant's or agent's file reference 61997WO01	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/049062	31 August 2018	01 September 2017

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - B61L 27/00; B61L 25/02; B61L 15/00; B61L 23/16 (2018.01)
CPC - B61L 27/0005; B61L 15/0027; B61L 27/0038; B61L 27/0077; B61L 15/0018 (2018.08)

Applicant METROM RAIL, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	26 October 2018	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/049062

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:
   - [X] the international application in the language in which it was filed.
   - [ ] a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. [ ] With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing:
   - a. [ ] forming part of the international application as filed:
     - [ ] in the form of an Annex C/ST.25 text file.
     - [ ] on paper or in the form of an image file.
   - b. [ ] furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
   - c. [ ] furnished subsequent to the international filing date for the purposes of international search only:
     - [ ] in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
     - [ ] on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/049062

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-18	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-18	NO
Industrial applicability (IA)	Claims	1-18	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 2, 4-7, 9, and 14-18 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Siriwongpairat).

Regarding claim 1, Metrom'240 discloses a system for wireless train communications (railway systems, para.0002; the train 101 may be equipped with the VAD 120, which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. train communications], para.0037; VAD include circuitry for wireless communications, para.0064; WDU include circuitry for wireless communications, para.0076 [thus interpreted as wireless train communications]), the system comprises:
a plurality of wayside communication units, configured for placement on or near path of trains, wherein each wayside communication unit (wayside detection units (WDU), configured for placement on or near paths of the vehicles [i.e. trains], Abstract; The WDU 130 is configured to operate as stand-alone device, placed on or near the path of the object being detected. For example, the WDU is temporarily placed near the track 103. The WDU 130 broadcasts a signal when a train or vehicle passes, para.0019) comprises:
a power component configured for generating and/or obtaining power for powering components of the wayside communication unit (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27);
a communication component configured for transmitting and/or receiving wireless signals (WDU 400 includes a communication subsystem 454 that may comprise suitable circuitry operable to communicate signals from and/or to the electronic device, via wireless connections, para.0076; wayside detection unit comprising a communication component, comprising one or more antennas, configured for transmitting and/or receiving wireless signals, claim 27); and
one or more circuits operable to: process signals and data, and perform one or more applications or functions relating to operations of the wayside communication unit (the WDU 400 may comprise suitable circuitry for performing various operations in support of its functions. For example, the WDU 400 may comprise one or more main processors 450. Each main processor 450 may comprise suitable circuitry operable to process data, and/or control and/or manage operations of the WDU 400, and/or tasks and/or applications performed therein, para.0073, 0074; wayside detection unit comprises one or more circuits operable to process signals and data, and to perform one or more applications or functions relating to operations of the wayside detection unit, claim 27);
wherein the wayside communication unit is configured to communicate signals and/or messages with each train-based device that moves within communication range of the wayside communication unit (the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 [i.e. wayside communication unit] as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. VAD or train based device approaching or moving within specified distance i.e. communication range of the WDU], para.0037; the WDU is temporarily placed near the track 103. The WDU 130 broadcasts a signal when a train or vehicle passes, para.0019).
Metrom'240 lacks the teaching of wireless train communications configured for operation in conjunction with legacy train control systems, and wherein a wayside communication unit is configured to communicate signals and/or messages with one or more local control devices within a legacy train control system.
Metrom'240 further teaches using wireless train communication in existing systems (system 100 [i.e. wireless train communication system] may be configured to provide backward compatibility with existing protection solutions and/or protocols. Further, it may be particularly designed and implemented such that it may be integrated into future communications based train control systems [i.e. CBTC based systems], para.0030).
Siriwongpairat discloses railroad communication system (Abstract) and teaches wireless train communications configured for operation in conjunction with legacy train control systems (central office 101 receive the status messages through at least one of the base stations 103. Wired communication links between the base stations 103 and central office 101 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to wayside units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0339; system 100 supports wireless communications between a central office 101 and locomotives 102 and other railroad vehicles located at various points around a rail system [i.e. wireless train communications in conjunction with legacy train control system formed by central office 101 and base stations 103a and 103b], para.0048, Fig.1), and a wayside communication unit is configured to communicate signals and/or messages with one or more local control devices within a legacy train control system (wayside status updates are forwarded to central office 101 from wayside units 104, para.0054, Fig.1; locomotives 102 and base stations 103 can receive status messages from multiple wayside monitoring subsystems 104 [i.e. wayside communication units] simultaneously, para.0057; central office 101 must receive the wayside interface unit (WIU) status messages through at least one of the base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 that receive messages via wayside units 120 i.e. local control devices, see PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus base stations 103a and 103b in wired connection with central office 101 are interpreted as local control devices within

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the legacy train control system that receive status messages from wayside communication units 104a and 104b], para.0339, Fig.1).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for operating wireless train communications in conjunction with legacy train control systems in the invention of Metrom'240.
The motivation would have been for solving the constraints of dispersing devices over large geographical areas by providing wireless communication links and thereby maintaining a reliable and efficient communication handling different types of data (para.0003, 0004, Siriwongpairat).

Regarding claim 2, Metrom lacks the teaching that legacy train control systems comprise communication-based train control (CBTC) based systems.
Metrom furthermore teaches communication based train control based systems (system 100 may be configured to provide backward compatibility with existing protection solutions and/or protocols. Further, it may be particularly designed and implemented such that it may be integrated into future communications based train control systems [i.e. CBTC based systems], para.0030).
Siriwongpairat teaches legacy train control system comprising communication based train control based system (central office 101 receive the status messages through at least one of the base stations 103. Wired communication links between the base stations 103 and central office 101 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to wayside units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0339; communications in positive train control systems, para.0005; supporting railroad communications including interoperability positive train control systems [i.e. train control systems supporting communications i.e. communication based train control systems], para.0007).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for incorporating legacy train control systems comprising communication based train control systems in the invention of Metrom.
The motivation would have been for providing centralized control of locomotives or trains based on communications through central office i.e. communication based train control (para.0054, Siriwongpairat).

Regarding claim 4, modified Metrom'240 teaches the wayside communication unit obtaining information relating to trains associated with train-based devices that move within communication range of the wayside communication unit and providing the obtained information to other devices (the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 [i.e. wayside communication unit] as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. VAD or train based device approaching or moving within specified distance i.e. communication range of the WDU]. The WDU 130 may send proximity warnings (trigger alarms) to all local PADs 110 [i.e. WDU sending alarms to other devices based on information received from VAD i.e. train based devices], para.0037) but lacks the teaching of providing the obtained information to the legacy train control system, via the one or more local control devices.
Siriwongpairat teaches wayside communication unit providing information to the legacy train control system, via the one or more local control devices (wayside monitoring systems communicating monitored information to central office through base stations, para.0049; central office 101 must receive the wayside interface unit (WIU) status messages through at least one of the base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 that receive messages via wayside units 120 i.e. local control devices, see PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus base stations 103a and 103b in wired connection with central office 101 are interpreted as local control devices within the legacy train control system that receive status messages from wayside communication units 104a and 104b], para.0339).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for providing information to legacy train control system in the invention of Metrom'240.
The motivation would have been for providing central office with status updates thereby supporting signal system health and centralized control of control points (para.0054, Siriwongpairat).

Regarding claim 5, modified Metrom'240 teaches that each of plurality of wayside communication units is configured for detecting, monitoring, and/or tracking trains (wayside detection unit comprising one or more sensory components, for detecting, monitoring, and/or tracking vehicles, claim 27; the wayside devices monitor for and detect approaching vehicles (e.g., the train 101), broadcast alarms (or signals triggering alarms) when a vehicle is in proximity (e.g., determined when at particular distance from the wayside device and/or moving at particular speed), para.0036).

Regarding claim 6, modified Metrom'240 teaches that each of plurality of wayside communication units is configured for detecting, monitoring, and/or tracking trains, based on interactions with train-based devices associated with the trains (the wayside devices monitor for and detect approaching vehicles and broadcast alarms when a vehicle is in proximity, para.0036; the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit interacting with train-based devices], such as when the train 101 is at a specified distance. In response, the WDU 130 may send proximity warnings (trigger alarms) to all local PADs 110, para.0037).

Regarding claim 7, modified Metrom'240 teaches that at least one of plurality of wayside communication units is configured for obtaining ranging related information for trains, based on interactions with train-based devices associated with the trains (the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit interacting with train-based devices], such as when the train 101 is at a specified distance [distance relating to ranging information], para.0037; the WDU 400 may have sensory elements, such as a train detector 430. The train detector 430 may be operable to monitor, detect, and track approaching vehicle, using one or more suitable technologies (e.g., visual, infrared, laser ranging, etc.), and/or to enable generating corresponding data (distance, relative speed, etc.) [i.e. obtaining ranging related information such as distance], para.0072).

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Regarding claim 9, modified Metrom'240 teaches that at least one of plurality of wayside communication units is configured for directly interacting with trains based on communications with train-based devices associated with the trains (the train 101 may be equipped with the VAD 120 [i.e. train based devices], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit (WDU) directly interacting with trains through train-based devices], such as when the train 101 is at a specified distance, para.0037).

Regarding claim 14, Metrom'240 lacks the teaching that at least one of plurality of wayside communication units is configured for interacting with one or more other wayside devices.
Siriwongpairat teaches wayside communication units configured for interacting with one or more other wayside devices (wayside monitoring subsystem 104a [i.e. wayside communication unit] is shown monitoring a switch 105 and a signal 106 [switch is interpreted as the wayside device, see PCT Application claim 15], and wayside monitoring subsystem 104b [i.e. wayside communication unit] is shown monitoring a hand-throw switch 107 [switch is interpreted as the wayside device], para.0050).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for interacting with wayside devices in the invention of Metrom'240.
The motivation would have been for controlling railroad systems by providing status updates of monitored devices such as switches (para.0054, 0050, Siriwongpairat).

Regarding claim 15, Metrom'240 lacks the teaching wherein one or more other wayside devices comprise track switches and/or signals.
Siriwongpairat teaches wayside devices comprising track switching and/or signals (wayside monitoring subsystem 104a is shown monitoring a switch 105 and a signal 106 [i.e. wayside devices], and wayside monitoring subsystem 104b is shown monitoring a hand-throw switch 107 [i.e. wayside device], para.0050).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for implementing wayside device comprising track switching and signals in the invention of Metrom'240.
The motivation would have been for controlling railroad systems by providing status updates of monitored devices such as switches (para.0054, 0050, Siriwongpairat).

Regarding claim 16, Metrom'240 lacks the teaching wherein the at least one of plurality of wayside communication units forwards control data from the legacy train control system to the one or more wayside devices.
Siriwongpairat teaches wayside communication units forwarding control data from legacy train control system to wayside devices (system 100 supports wireless communications between a central office (Communications system 100 includes a series of wayside monitoring subsystems [i.e. wayside communication units], which monitor wayside systems such as signals, switches, and track circuits [i.e. wayside devices] and communicate the monitored information directly to central office 101, though base stations 103 [As per PCT Application, legacy train control system is a conventional train control system such as CBTC system 100 comprising back office installation 110 with wired connections to wayside units 120, shown in PCT Application Figs.1, 2, para.0036, 0037, 0057, claim 2. Thus central office 101 in wired connections with base stations 103a and 103 b can be interpreted as back office installation 110 in wired connection with wayside units 120 forming legacy train control system], para.0050, Fig.1; central office 101 provides centralized control [i.e. control data] of control points through communication path between waysides 104 and central office [Fig.1 shows that wayside units 104 communicating control data from central office to wayside devices 105, 106 and 107], para.0054, Fig.1).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Siriwongpairat for forwarding control data from legacy system to wayside device through wayside communication units in the invention of Metrom'240.
The motivation would have been for controlling switch positons of the devices through control data for preventing train-to-train collisions, and over-speed derailments (para.0316, 0005, Siriwongpairat).

Regarding claim 17, modified Metrom'240 teaches that each wayside communication unit comprises a housing for enclosing components of the wayside communication unit (the wayside detection unit comprising: a housing for enclosing components of the wayside detection unit, claim 27; the WDU 400 may comprise a housing 410 for enclosing various components of the WDU 400 and/or allowing attachment to certain external elements or structures, para.0072).

Regarding claim 18, modified Metrom'240 teaches that each wayside communication unit comprises a support structure for holding and supporting the wayside communication unit when placed on or near train tracks (the wayside detection unit comprising a support structure for holding and supporting the wayside detection unit when placed on or near the path, claim 27; The WDU 400 typically would also comprise a support structure 420, such as a rigid tripod, to enable placement of the WDU 400, such as near train tracks, para.0072).

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Claims 3, 8, 10, and 11 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Sir|wongpairat) and Metrom Rail, Llc (hereinafter Metrom'608).

Regarding claim 3, modified Metrom'240 teaches communication component in communications with train-based devices (WDU 400 includes a communication subsystem 454 that may comprise suitable circuitry operable to communicate signals from and/or to the electronic device, via wireless connections, para.0076; the train 101 may be equipped with the VAD 120 [thus VAD is interpreted as the train based device], which may communicate directly with the WDU 120 as the train 101 approaches it, such as when the train 101 is at a specified distance [i.e. communication with train based device], para.0037) but lacks the teaching wherein the communication component is configured for utilizing ultra-wideband (UWB) based communications with one or both of the one or more local device and train-based devices.
Metrom'608 discloses vehicle management system (Abstract) and teaches communication component configured for utilizing UWB based communications with train based devices (A system for vehicle management includes a control signal interface subsystem and a vehicle-mounted subsystem [i.e. vehicle mounted subsystem is interpreted as train based device]. Each of these subsystems includes an ultra-wideband (UWB) communications component. The subsystems communicate with each other through the UWB components, Abstract; communication between the UWB communications component of the control signal interface subsystem and the UWB communications component of the vehicle-mounted subsystem, para.0013).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for implementing UWB based communications with train based devices in the invention of Metrom'240.
The motivation would have been for combining ranging technology such as UWB for measuring distance and assist in controlling and enforcing separation between rail vehicles on a rail track (para.0038, 0132, Metrom'608).

Regarding claim 8, modified Metrom'240 teaches that the at least one of plurality of wayside communication units is configured for obtaining ranging (the WDU 400 [i.e. wayside communication unit] may have sensory elements, such as a train detector 430. The train detector 430 may be operable to monitor, detect, and track approaching vehicle, using one or more suitable technologies (e.g., visual, infrared, laser ranging, etc.), and/or to enable generating corresponding data (distance, relative speed, etc.) [i.e. obtaining ranging related information such as distance], para.0072) but lacks the teaching of obtaining ranging based on ultra-wideband (UWB) signaling.
Metrom'608 teaches obtaining ranging based on UWB signaling (determining speed by distance ranging over time for example, using the UWB time-of-flight data over time, para.0090; UWB may provide a wide bandwidth distance measurement signal that can be used to measure distance, para.0132).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for obtaining ranging data based on UWB signaling in the invention of Metrom'240.
The motivation would have been for combining ranging technology such as UWB for measuring distance and assist in controlling and enforcing separation between rail vehicles on a rail track (para.0038, 0132, Metrom'608).

Regarding claim 10, modified Metrom'240 teaches at least one of plurality of wayside communication units directly interaction with systems on the train (the train 101 may be equipped with the VAD 120 [i.e. system on the train], which may communicate directly with the WDU 120 as the train 101 approaches it [i.e. wayside communication unit (WDU) directly interacting with VAD i.e. train system], such as when the train 101 is at a specified distance, para.0037) but lacks the teaching of controlling one or more systems within the trains.
Metrom'608 teaches directly interacting and controlling one or more systems with the train (When the collision avoidance system 100 determines that the signals provided by the signal control point 40 are not being followed by the rail vehicle operator, the processor 150 can operate one or more other functions of the collision avoidance system 100. For example, the processor may use the auto-braking system 130 to initiate an auto-braking feature to automatically brake or otherwise reduce the speed of the rail vehicle [i.e. controlling auto-braking system within the train] or otherwise reduce the speed of the rail vehicle, para.0076; the auto-braking system 130 can be adapted to automatically brake a rail vehicle based on the distance between the vehicle and a signal control point 40, depending on the signal indicated by the signal control point 40. For example, the collision avoidance system 100 can automatically brake the rail vehicle when the collision avoidance system 100 detects that the rail vehicle is not observing a stop signal communicated by the signal control point, para.0077).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for controlling systems within the train in the invention of Metrom'240.
The motivation would have been for controlling and enforcing sufficient vehicle separation thereby avoiding disastrous collisions and accidents (para.0008, 0005, Metrom'608).

Regarding claim 11, Metrom'240 lacks the teaching wherein the one or more systems within the trains comprise automated braking, speed sensors, or operator displays.
Metrom'608 teaches that systems within the trains comprise automated braking or speed sensors (the auto-braking system 130 can be adapted to automatically brake a rail vehicle based on the distance between the vehicle and a signal control point 40, depending on the signal indicated by the signal control point 40. For example, the collision avoidance system 100 can automatically brake the rail vehicle when the collision avoidance system 100 detects that the rail vehicle is not observing a stop signal communicated by the signal control point, para.0077).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Metrom'608 for controlling systems such as automated braking within the train in the invention of Metrom'240.
The motivation would have been for controlling and enforcing sufficient vehicle separation thereby avoiding disastrous collisions and accidents (para.0008, 0005, Metrom'608).

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Claims 12 and 13 lack an inventive step under PCT Article 33(3) as being obvious over Metrom Rail, Llc (hereinafter Metrom'240) in view of Siriwongpairat et al. (hereinafter Siriwongpairat) and Milan.

Regarding claim 12, modified Metrom'240 teaches the power component configured to obtain power (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27) but lacks the teaching of obtaining power using one or more power harvesting techniques.
Milan discloses wireless railroad monitoring system (Abstract) and teaches obtaining power using power harvesting techniques (a power harvesting component configured to generate power from motion of a rail vehicle and provide sufficient power to operate the sensor node without access to any additional power sources, para.0008, 0019).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Milan for implementing power harvesting techniques for obtaining power in the invention of Metrom'240.
The motivation would have been for providing power for rail operation without requiring access to any additional power sources such as connection to an external electrical grid (para.0019, Milan).

Regarding claim 13, modified Metrom'240 teaches the power component is configured to obtain power (The WDU 130 may be powered using integrated power supply (e.g., batteries or similar power sources), which may be rechargeable, para.0026; wayside detection unit comprising a power supply for powering components of the wayside detection unit, claim 27) but lacks the teaching of obtaining power by harvesting solar energy.
Milan teaches obtaining power by harvesting solar energy (The set of power harvesting components 12 can include one or more power harvesting components 12 configured to generate power from an ambient condition of the operating environment, e.g., solar power generators, para.0020; sensor node 10 can include a power harvesting component 12 comprising a solar cell, which can be configured to generate power from sunlight, para.0029).
It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Milan for obtaining power by harvesting solar energy in the invention of Metrom'240.
The motivation would have been for providing power for rail operation without requiring access to any additional power sources such as connection to an external electrical grid (para.0019, Milan).

Claims 1-18 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

Electronic Patent Application Fee Transmittal

Application Number:	16515903
Filing Date:	18-Jul-2019
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Filer:	Rami Naim Moussa/Elaine Maxson
Attorney Docket Number:	63154US03

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	120	120
		Total in USD ($)		**120**

Electronic Acknowledgement Receipt	
EFS ID:	39164039
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
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Receipt Date:	15-APR-2020
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Deposit Account	130017
Authorized User	Elaine Maxson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	63154US03_SB08a.pdf	1006983 f2ffe5b0c93b6535c84b96e9a8b5cc546e58d746	no	4
Warnings:					
Information:					
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2	Non Patent Literature	IPRP_for_PCTUS2018049062.pdf	1578746 051f0781c9111a0e27df9706219166a7b8182eef	no	8
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: A.NE.AFCP
Document Description: After Final Consideration Pilot Program Request

PTO/SB/434 (05-13)

CERTIFICATION AND REQUEST FOR CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0

Practitioner Docket No.:	Application No.:	Filing Date:
63154US03	16/515,903	07/18/2019
First Named Inventor:	**Title:**	
Richard C. Carlson	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL	

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS CONSIDERATION UNDER THE AFTER FINAL CONSIDERATION PILOT PROGRAM 2.0 (AFCP 2.0) OF THE ACCOMPANYING RESPONSE UNDER 37 CFR 1.116.

1. The above-identified application is (i) an original utility, plant, or design nonprovisional application filed under 35 U.S.C. 111(a) [a continuing application (*e.g.*, a continuation or divisional application) is filed under 35 U.S.C. 111(a) and is eligible under (i)], or (ii) an international application that has entered the national stage in compliance with 35 U.S.C. 371(c).
2. The above-identified application contains an outstanding final rejection.
3. Submitted herewith is a response under 37 CFR 1.116 to the outstanding final rejection. The response includes an amendment to at least one independent claim, and the amendment does not broaden the scope of the independent claim in any aspect.
4. This certification and request for consideration under AFCP 2.0 is the only AFCP 2.0 certification and request filed in response to the outstanding final rejection.
5. Applicant is willing and available to participate in any interview requested by the examiner concerning the present response.
6. This certification and request is being filed electronically using the Office's electronic filing system (EFS-Web).
7. Any fees that would be necessary consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, extension of time fees, are being concurrently filed herewith. [There is no additional fee required to request consideration under AFCP 2.0.]
8. By filing this certification and request, applicant acknowledges the following:

- Reissue applications and reexamination proceedings are not eligible to participate in AFCP 2.0.
- The examiner will verify that the AFCP 2.0 submission is compliant, *i.e.*, that the requirements of the program have been met (see items 1 to 7 above). For compliant submissions:
  - The examiner will review the response under 37 CFR 1.116 to determine if additional search and/or consideration (i) is necessitated by the amendment and (ii) could be completed within the time allotted under AFCP 2.0. If additional search and/or consideration is required but cannot be completed within the allotted time, the examiner will process the submission consistent with current practice concerning responses after final rejection under 37 CFR 1.116, *e.g.*, by mailing an advisory action.
  - If the examiner determines that the amendment does not necessitate additional search and/or consideration, or if the examiner determines that additional search and/or consideration is required and could be completed within the allotted time, then the examiner will consider whether the amendment places the application in condition for allowance (after completing the additional search and/or consideration, if required). If the examiner determines that the amendment does not place the application in condition for allowance, then the examiner will contact the applicant and request an interview.
    - The interview will be conducted by the examiner, and if the examiner does not have negotiation authority, a primary examiner and/or supervisory patent examiner will also participate.
    - If the applicant declines the interview, or if the interview cannot be scheduled within ten (10) calendar days from the date that the examiner first contacts the applicant, then the examiner will proceed consistent with current practice concerning responses after final rejection under 37 CFR 1.116.

Signature	Date
/Rami N. Moussa/	May 11, 2020
Name (Print/Typed) Rami N. Moussa	**Practitioner Registration No.** 69,528

***Note**: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.*

[✓] * Total of 1 forms are submitted.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: May 11, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.116

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the final office action of Mar. 10, 2020 ("Office Action") in the above-identified application ("Application"). Applicant respectfully requests entry of the following amendments and consideration of the following remarks, and hereby requests to participate in the After Final Consideration Pilot 2.0 ("AFCP 2.0") program. The required form is attached with this response. Applicant's representative is available to participate in any interview initiated by the Examiner concerning the response.

Listing of the Claims begins on page 2 of this paper.

Remarks and Arguments begin on page 6 of this paper.

LISTING OF THE CLAIMS

1-19. (Canceled)

20. (Currently amended) A system for providing decentralized control operations in a railway network, the system comprises:

a plurality of wayside units, each configured for placement on or near tracks in the railway network; and

one or more train-mounted units, each configured for deployment on a train operating in the railway network;

wherein each train-mounted unit is configured to:

communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and

generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network,

wherein generating the control information comprises or is based on obtaining ranging measurements ~~substantially continually determining absolute position of the train~~, and

wherein obtaining the ranging measurements ~~determining the absolute position of the train~~ comprises:

~~determining absolute positioning information based on information obtained from each wayside as the train passes the wayside unit,~~

broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit, the UWB based signals comprising information identifying the train-mounted unit;

selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and

determining ranging information corresponding to each of the one or more wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units~~, and~~

~~determining the absolute position of the train based on the absolute positioning information and the ranging information~~.

21. (Currently amended) The system of claim 20, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than [[the]] processing of the ultra-wideband (UWB) based signals.

22. (Currently amended) The system of claim 21, wherein the train-mounted unit is configured to:

assess based on ~~the processing of~~ the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

when at least one condition meets one or more particular criteria, determine one or more responsive actions; and

perform or cause performing each of the one or more responsive actions.

23. (Previously presented) The system of claim 22, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:

monitor actions of the train operator;

assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

24. (Canceled)

25. (Canceled)

26. (Canceled)

27. (Canceled)

28. (Canceled)

29. (Canceled)

30. (Canceled)

31. (Canceled)

32. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.

33. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

34. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for handling satellite based signals.

35. (Previously presented) The system of claim 34, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

36. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.

37. (Previously presented) The system of claim 20, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.

38. (Previously presented) The system of claim 20, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.

39. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.

40. (New) The system of claim 20, wherein the train-mounted unit is configured to substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units.

41. (New) The system of claim 40, wherein the train-mounted unit is configured to determine the absolute position of the train based on the ranging information and positioning information obtained without ranging to wayside units.

42. (New) The system of claim 41, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from each wayside unit as the train passes the wayside unit.

43. (New) The system of claim 42, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from at least one wayside unit passes that wayside unit using non-UWB communications.

REMARKS AND ARGUMENTS

The Examiner notes that this Application is being examined under the first inventor to file provisions of the AIA (America Invents Act). Office Action at 2. Initially, Applicant notes that a goal of patent examination is to provide a prompt and complete examination of a patent application:

> It is essential that patent applicants obtain a prompt yet complete examination of their applications. Under the principles of compact prosecution, each claim should be reviewed for compliance with every statutory requirement for patentability in the initial review of the application, even if one or more claims are found to be deficient with respect to some statutory requirement. Thus, USPTO personnel should state all reasons and bases for rejecting claims in the first Office action. Deficiencies should be explained clearly, particularly when they serve as a basis for a rejection. Whenever practicable, USPTO personnel should indicate how rejections may be overcome and how problems may be resolved. A failure to follow this approach can lead to unnecessary delays in the prosecution of the application.

See Manual of Patent Examining Procedure (MPEP) § 2103(I). As such, Applicant assumes, based on the goals of patent examination noted above, that the present Office Action has set forth "all reasons and bases" for rejecting the claims.

Claims 20-23 and 32-39 are pending in this Application, of which claim 20 is an independent claims, and claims 21-23 and 32-39 are dependent claims, depending from independent claim 20. Claims 1-19 and 24-31 were previously canceled. In this correspondence, claims 20-22 are amended, and new claims 40-43 are added. In this regard, claims 21 and 22 are amended to correct typographical errors therein, without adding or otherwise changing the claimed subject matter therein.

All of claims, as pending when the Office Action was issued, stand finally rejected. In particular, claims 20-22 stand rejected under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi et al. (U.S. Patent Publication No. 2013/0138276; hereinafter "Soderi"). Claims 21-23 and 32-39 stand rejected under 35 U.S.C. § 103 for

allegedly being unpatentable over Soderi in view of Chung et al. (U.S. Patent No. 9,434,397; hereinafter "Chung").

Applicant respectfully traverses these rejections at least based on the following remarks. In addition, Applicant also reserves the right to argue additional reasons beyond those set forth herein to support allowability of the claims, should a need arise in the future.

Claim Rejections under 35 U.S.C. § 102

With respect to the claim rejections on anticipation grounds under 35 U.S.C. § 102, Applicant notes that "[a] claim is anticipated only if ***each and every element*** as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *See* MPEP § 2131 (internal citation omitted). Furthermore, "[t]he identical invention must be shown in as complete detail as is contained in the … claim." *See id.* (internal citation omitted).

With those principles in mind, and without conceding that Soderi would qualify as prior art under 35 U.S.C. § 102(a)(1), Applicant respectfully traverses the claim rejections under § 102 for the follow reasons.

I. REJECTION OF INDEPENDENT CLAIM 20

With regard to the rejection of the independent claim 20 under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi, Applicant traverses the rejection, and maintains that claim 20 as pending when the Office Action are not anticipated by Soderi. Nonetheless, Applicant submits that in order to advance prosecution, claim 20 is amended, rendering the rejection moot.

In particular, claim 20 is amended such that it now recites: "[a] system for providing decentralized control operations in a railway network, the system comprises: a plurality of wayside units, each configured for placement on or near tracks in the railway

network; and one or more train-mounted units, each configured for deployment on a train operating in the railway network; wherein each train-mounted unit is configured to: communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network, *wherein generating the control information comprises or is based on obtaining ranging measurements, and wherein obtaining the ranging measurements comprises: broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit, the UWB based signals comprising information identifying the train-mounted unit; selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and determining ranging information corresponding to each of the one or more wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units*." (Emphasis added).

Applicant submits that Soderi does not teach or disclose all the limitations of claim 20, particularly in view of amendments made hereto. In particular, the Applicant submits that Soderi does not teach, with respect to train-mounted unit disclosed thereby (presumably ranging unit (RU) 104), that the train-mounted unit may be configured generate based on communication of signals with wayside units, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network, specifically where generating the control information includes or is based on obtaining ranging measurements, and where obtaining the ranging measurements specifically includes broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit, with the UWB based signals comprising information identifying the train-mounted unit, selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units, and determining ranging information corresponding to each of the one or more

wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units.

Therefore, Applicant believes that claim 20 is/are not anticipated by Soderi, at least in view of the amendments made hereto.

Accordingly, Applicant respectfully requests that the rejections of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi be withdrawn. Applicant also reserves the right to argue additional reasons beyond those set forth herein, should such a need arise.

II. REJECTION OF DEPENDENT CLAIMS 21 AND 22

The Examiner rejects claims 21 and 22 under 35 U.S.C. § 102(a)(1) for allegedly being anticipated by Soderi. Office Action at 3. Applicant traverses these rejections, and submits that these claims, as pending when the Office Action was issued, are not anticipated by Soderi.

Based on at least the foregoing, however, Applicant believes that the rejection of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi has been overcome. Therefore, because claims 21 and 22 depend from independent claim 20, Applicant submit that claims 21 and 22 are consequently not anticipated by Soderi at least for the reasons stated above with regard to the rejections of claim 20.

Accordingly, Applicant respectfully requests that the rejections of claims 21 and 22 under 35 U.S.C. § 102(a)(1) based on Soderi be withdrawn. Applicant also reserves the right to argue additional reasons beyond those set forth herein, should a need arise in the future.

Claim Rejections under 35 U.S.C. § 103

With respect to the claim rejections on obviousness grounds under 35 U.S.C. § 103, Applicant notes that the determination of obviousness is a legal conclusion based

on underlying findings fact. *Sanofi-Synthelabo v. Apotex, Inc.*, 550 F.3d 1075, 1085 (Fed. Cir. 2008). The factual inquiries include: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the relevant art, and (4) any objective indicia of non-obviousness. *Graham v. John Deere Co.,* 383 U.S. 1, 86 S. Ct. 684 (1966). The burden is on the Examiner to establish a *prima facie* case of obviousness. *See* MPEP § 2142. Further, if the Examiner does not produce a prima facie case, "Applicant is under no obligation to submit secondary evidence to show nonobviousness." *See id*.

"The determination of obviousness is made with respect to the subject matter as a whole, not separate pieces of the claim." *Apotex*, 550 F.3d 1075 at 1086. (citing *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007); *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1448 (Fed.Cir.1984)). Accordingly, "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." *See* MPEP § 2143.03 (quoting *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970)). If, considering the claim as a whole, the Examiner deems the claim to be obvious in view of the prior art, the Examiner must provide a "clear articulation of the reason(s) why the claimed invention would have been obvious." *See* MPEP § 2142. The Examiner's determination of obviousness "cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *KSR*, 550 U.S. 398 at 418 (quoting *In re Kahn*, 441 F.3d 977, 988, (Fed. Cir. 2006)).

In reviewing an Examiner's determination of obviousness, "the Board cannot simply reach conclusions based on its own understanding or experience—or on its assessment of what would be basic knowledge or common sense. Rather, the Board must point to some concrete evidence in the record in support of these findings." *In re Zurko*, 258 F.3d 1379, 1386 (Fed. Cir. 2001). *See also In re Vaidyanathan*, Appeal 2009-1404 at 18-19 (Fed. Cir. May 19, 2010) (nonprecedential) ("If the examiner is able to render a claim obvious simply by saying it is so, neither the Board nor [the Federal Circuit] is capable of reviewing that determination. … If there is neither record evidence

nor detailed examiner reasoning, the Board should not conclude that … [the] claims are obvious").

With those principles in mind, and without conceding that any of the references the Examiner cites would qualify as prior art, or that any combination thereof is valid for purposes of 35 U.S.C. § 103, Applicant respectfully traverses the claim rejections under § 103 for the follow reasons.

I. REJECTION OF DEPENDENT CLAIMS 21-23 AND 32-39

The Examiner rejects claims 21-23 and 32-39 under 35 U.S.C. § 103 based on the combination of Soderi and Chung. Office Action at 3-5. Applicant traverses these rejections, and submits that these claims, as pending when the Office Action was issued, are patentable over the asserted references and any combination thereof.

Based on at least the foregoing, however, Applicant believes that the rejection of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi has been overcome. Therefore, because the Examiner does not assert any additional grounds or make any additional arguments for rejecting independent claim 20 based on Chung, and because claims 21-23 and 32-39 depend from independent claim 20, Applicant submits that claims 21-23 and 32-39 are consequently patentable over the combination of Soderi and Chung at least for the reasons stated above with regard to the rejection of independent claim 20 under 35 U.S.C. § 102(a)(1) based on Soderi.

Accordingly, Applicant respectfully requests that the rejections of claims 21-23 and 32-39 under 35 U.S.C. § 103 be withdrawn. Applicant also reserves the right to argue additional reasons beyond those set forth herein, should such a need arise.

Final Remarks

In general, the Office Action makes various statements that are now moot in light of the above remarks. Thus, Applicant will not address such statements at the present

time. However, Applicant expressly reserves the right to challenge such statements in the future should the need arise (*e.g.,* should these statements become relevant or are relied upon in any proceeding involving this Application or a corresponding patent).

CONCLUSION

Based on at least the foregoing, Applicant believes that all pending claims are in condition for allowance. If the Examiner has any questions or Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

A Notice of Allowability is courteously solicited.

Respectfully submitted,

Date: May 11, 2020

/Rami N. Moussa/
Rami N. Moussa
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Electronic Acknowledgement Receipt

EFS ID:	39407068
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	11-MAY-2020
Filing Date:	18-JUL-2019
Time Stamp:	16:29:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	After Final Consideration Program Request	63154US03_AFCP_20.pdf	227855 812722ef281f4ce8e27393b0f6cd3c923c5197b8	no	2

Warnings:

Information:					
2		63154US03_OA3_FOA_Rsp_AAF.pdf	87983 9023a3206bf43a54aca3f63c1b762f3bd8ddf874	yes	13

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response After Final Action	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	13

Warnings:	
Information:	
Total Files Size (in bytes):	315838

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/515,903	Filing Date 07/18/2019	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	05/11/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/FELICIA R FARMER/
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The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 05/20/2020

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EXAMINER
LE, MARK T

ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
05/20/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 16/515,903	**Applicant(s)** Carlson et al.	
	Examiner MARK T LE	**Art Unit** 3617	**AIA (FITF) Status** Yes

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 11 May 2020 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☑ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☑ The period for reply expires 3 months from the mailing date of the final rejection.
   b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection.The current period for reply expires ____ months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANTS FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37CFR 41.37(a).

AMENDMENTS

3. ☑ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☑ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☑ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: See Continuation Sheet (See 37CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicants reply has overcome the following rejection(s): _____
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☑ For purposes of appeal, the proposed amendment(s):(a) ☑ will not be entered, or (b) ☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☐ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
13. ☑ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). 4/15/20
14. ☑ Other: See PTOL-2323.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
    Claim(s) allowed:_____.
    Claim(s) objected to:_____.
    Claim(s) rejected:20-23 and 32-39.
    Claim(s) withdrawn from consideration:_____.

/MARK T LE/ Primary Examiner, Art Unit 3617	Attachments: PTOL-2323, and IDS

Continuation of 3. NOTE: The proposed amended base claim 20 and the proposed new claims 40-43 would require further searches and considerations

AFCP 2.0 Decision

Application No.	Applicant(s)	
16/515,903	Carlson et al.	
Examiner	**Art Unit**	**AIA (FITF) Status**
MARK T LE	3617	Yes

This is in response to the After Final Consideration Pilot request filed 11 May 2020.

1. **Improper Request** – The AFCP 2.0 request is improper for the following reason(s) and the after final amendment submitted with the request will be treated under pre-pilot procedure.

   ☐ An AFCP 2.0 request form PTO/SB/434 (or equivalent document) was not submitted.

   ☐ A non-broadening amendment to at least one independent claim was not submitted.

   ☐ The request is not the first proper AFCP 2.0 request submitted in response to the most recent final rejection.

   ☐ Other: _____

2. **Proper Request**

   A. After final amendment submitted with the request will not be treated under AFCP 2.0.
   The after final amendment cannot be reviewed and a search conducted within the guidelines of the pilot program.

   ☑ The after final amendment will be treated under pre-pilot procedure.

   B. Updated search and/or completed additional consideration.
   The examiner performed an updated search and/or completed additional consideration of the after final amendment within the time authorized for the pilot program. The result(s) of the updated search and/or completed additional consideration are:

   ☐ 1. All of the rejections in the most recent final Office action are overcome and a Notice of Allowance is issued herewith.

   ☐ 2. The after final amendment would not overcome all of the rejections in the most recent final Office action . See attached interview summary for further details.

   ☐ 3. The after final amendment was reviewed, and it raises a new issue(s). See attached interview summary for further details.

   ☐ 4. The after final amendment raises new issues, but would overcome all of the rejections in the most recent final Office action. A decision on determining allowability could not be made within the guidelines of the pilot. See attached interview summary for further details, including any newly discovered prior art.

   ☐ 5. Other: _____

   Examiner Note: Please attach an interview summary when necessary as described above.

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16515903
Filing Date	2019-07-18
First Named Inventor	Richard C. Carlson
Art Unit	3617
Examiner Name	LE, MARK T
Attorney Docket Number	63154US03

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.T.L/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	LE, MARK T
	Attorney Docket Number	63154US03

	1	International Preliminary Report on Patentability for PCT/US2018/049062, date of completion - October 26, 2018, 8 pages.

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/MARK T LE/	Date Considered	05/15/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.T.L/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16515903
	Filing Date	2019-07-18
	First Named Inventor	Richard C. Carlson
	Art Unit	3617
	Examiner Name	LE, MARK T
	Attorney Docket Number	63154US03

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

☒ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2020-04-15
Name/Print	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.T.L/

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.T.L/

DO NOT ENTER: /M.T.L/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: May 11, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.116

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the final office action of Mar. 10, 2020 ("Office Action") in the above-identified application ("Application"). Applicant respectfully requests entry of the following amendments and consideration of the following remarks, and hereby requests to participate in the After Final Consideration Pilot 2.0 ("AFCP 2.0") program. The required form is attached with this response. Applicant's representative is available to participate in any interview initiated by the Examiner concerning the response.

Listing of the Claims begins on page 2 of this paper.

Remarks and Arguments begin on page 6 of this paper.

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	16515903	Filing Date	2019-07-18	Docket Number (if applicable)	63154US03	Art Unit	3617
First Named Inventor	Richard C. Carlson			Examiner Name	LE, MARK T		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☒ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

☒ Other Response to Final Office Action filed May 11, 2020

☐ Enclosed

☐ Amendment/Reply

☐ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____
(Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 130017

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

X Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Rami N. Moussa/	Date (YYYY-MM-DD)	2020-06-09
Name	Rami N. Moussa	Registration Number	69528

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16515903
Filing Date:	18-Jul-2019
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Filer:	Rami Naim Moussa/Elaine Maxson
Attorney Docket Number:	63154US03

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
RCE- 1ST REQUEST	2801	1	650	650
		Total in USD ($)		**650**

Electronic Acknowledgement Receipt	
EFS ID:	39664050
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	09-JUN-2020
Filing Date:	18-JUL-2019
Time Stamp:	11:09:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$650
RAM confirmation Number	E202069B09468215
Deposit Account	130017
Authorized User	Elaine Maxson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	63154US03_RCE.pdf	1350217 0f23ca14cbd4c35287ed9eee75770953fa227c94	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30561 33b0e1d5384dfcc24919b1e5d7eb4a986782d3b6	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1380778		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

23446 7590 07/20/2020

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER	
LE, MARK T	
ART UNIT	PAPER NUMBER
3617	

DATE MAILED: 07/20/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

TITLE OF INVENTION: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	10/20/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23446 7590 07/20/2020
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

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APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	10/20/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LE, MARK T	3617	246-193000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____
2_____
3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/515,903	Applicant(s) Carlson et al.	
	Examiner MARK T LE	Art Unit 3617	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to Applicant's response filed June 9, 2020.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 20-23 and 32-43 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MARK T LE/
Primary Examiner, Art Unit 3617

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	**Art Unit**
	MARK T LE	3617

CPC						
Symbol					**Type**	**Version**
H04J	/	11	/	0079	F	2013-01-01
B61L	/	27	/	0005	I	2013-01-01
B61L	/	3	/	006	I	2013-01-01
B61L	/	27	/	04	I	2013-01-01
H04W	/	4	/	40	I	2018-02-01
B61L	/	3	/	125	I	2013-01-01
B61L	/	15	/	0027	I	2013-01-01
B61L	/	2201	/	00	A	2013-01-01
B61L	/	25	/	025	A	2013-01-01
B61L	/	23	/	34	A	2013-01-01
B61L	/	23	/	06	A	2013-01-01
B61L	/	27	/	0038	A	2013-01-01
B61L	/	25	/	021	A	2013-01-01
B61L	/	2205	/	00	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	16	
/MARK T LE/ Primary Examiner, Art Unit 3617	23 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	20	8

U.S. Patent and Trademark Office — Part of Paper No.: 20200623

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	**Art Unit**
	MARK T LE	3617

INTERNATIONAL CLASSIFICATION				
CLAIMED				
B61L	/	27	/	04
B61L	/	23	/	06
B61L	/	23	/	34

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	16	
/MARK T LE/ Primary Examiner, Art Unit 3617	23 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	20	8

U.S. Patent and Trademark Office — Part of Paper No.: 20200623

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	**Art Unit**
	MARK T LE	3617

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	16	
/MARK T LE/ Primary Examiner, Art Unit 3617	23 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	20	8

U.S. Patent and Trademark Office — Part of Paper No.: 20200623

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	Art Unit
	MARK T LE	3617

CPC - Searched*		
Symbol	**Date**	**Examiner**
(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	10/09/2019	ml
(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	10/10/2019	ml

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
246	220	10/10/2019	ml

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See EAST Search History (including updated searches)	11/12/2019	ml
Parent Applications 16290576 and 16055905 checked	11/12/2019	ml
Searches updated	02/27/2020	ml
Searches updated	06/22/2020	ml

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/515,903	Carlson et al.
	Examiner	Art Unit
	MARK T LE	3617

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	See EAST Search History	06/23/2020	ml

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L8	155	("20020189336" | "20030025626" | "20030071754" | "20040168512" | "20050164643" | "20060074546" | "20060125683" | "20060170587" | "20060212344" | "20070024488" | "20070159378" | "20070177704" | "20070192391" | "20070200749" | "20070210955" | "20070276600" | "20080048905" | "20080077327" | "20090033539" | "20090135044" | "20090303100" | "20100073221" | "20100214157" | "20100214158" | "20100245161" | "20110221624" | "20130099943" | "2709252" | "2921301" | "3126540" | "3174146" | "3182312" | "3241106" | "3582620" | "3626413" | "3838421" | "3976999" | "4167735" | "4190882" | "4620192" | "4901083" | "5075680" | "5189425" | "5274271" | "5337082" | "5345471" | "5361070" | "5374932" | "5422607" | "5457394" | "5461384" | "5465094" | "5471162" | "5479120" | "5497100" | "5510800" | "5512834" | "5517198" | "5519342" | "5519400" | "5519618" | "5521600" | "5523760" | "5563605" | "5573012" | "5576627" | "5581256" | "5589838" | "5609059" | "5661490" | "5682164" | "5686921" | "5754144" | "5757320" | "5764189" | "5766208" | "5767953" | "5774091" | "5804921" | "5805110" | "5883591" | "5966090" | "5986600" | "6031421" | "6031504" | "6055287" | "6060915" | "6072427" | "6137438" | "6191724" | "6266005" | "6278965" | "6317076" | "6359583" | "6373428" | "6404381" | "6414627" | "6426716" | "6452467" | "6456231" | "6462697" | "6462705" | "6466168" | "6486825" | "6492933" | "6531977" | "6535161" | "6600103" |	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/23 05:47

		"6642854" | "6644114" | "6662099" | "6747599" | "6750787" | "6856276" | "6888494" | "6909396").PN. OR ("6914552" | "7057550" | "7068210" | "7148791" | "7180428" | "7187321" | "7224944" | "7271761" | "7345623" | "7379016" | "7446695" | "7446699" | "7508337" | "7551703" | "7592944" | "7786927" | "7817080" | "7864100" | "7952515" | "7994968" | "8115673" | "8264401" | "8466831").PN. OR ("8872674").URPN.				
L10	93,034	ultra near (wide or wideband)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 06:43
L11	7,786,631	distance	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 06:43
L12	3,215	10 with 11	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 06:43
L13	566,428	railroad or railway	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 06:43
L14	145	12 and 13	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 06:43
L15	450	((("CARLSON") near3 ("Richard"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 07:11
L16	25	15 and (uwb or ultra)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/06/23 07:12

S1	1	"16118941"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 09:23
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S13	16	("20060212189" | "20070219682" | "20070225878" | "20070260367" | "3963203" | "4066228" | "4553723" | "4582280" | "5340062" | "5398894" | "5452870" | "5533695" | "6400281" | "6459695").PN. OR ("8170732").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/09 13:56
S14	2	(("20160280240") or ("20110075641")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/09 14:40
S15	115	("20130166114" | "2475578" | "2762913" | "6113037" | "20110152971" | "20160280240" | "6113037" | "5727758" | "5924651" | "5939986" | "6232887" | "8952805" | "5620155" | "6208260" | "20110152971" | "20100102954" | "20110006912" | "2475578" | "8248263" | "5198800" | "5939986" | "6145792" | "6232887" | "6650242" | "8109474" | "20120296562" | "5198800" | "8109474" | "8344877" | "20140045547" | "5554982" | "5727758" | "6145792" | "6208260" | "20100102954" | "5554982" | "5652570" | "8952805" | "20110006912" | "20140045547" | "20130166114" | "20170282944" | "5652570" | "6650242" | "7624952" | "8248263" | "8786428" | "20120296562" | "2762913" | "5924651" | "7167082" | "7624952" | "7167082" | "5620155" | "8786428").PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 14:46

S16	2	(("20110075641") or ("20110006912")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/09 15:12
S17	442	((("CARLSON") near3 ("Richard"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/10/09 15:13
S18	15	S17 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:23
S19	500	B61L$.cpc. and solar	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S20	526,770	railroad or railway	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S21	409	S19 and S20	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/09 15:44
S22	11	(US-20160280240-$ or US-20110006912-$ or US-20070162199-$).did. or (US-10308265-$ or US-9889869-$ or US-9828010-$ or US-9321469-$ or US-8820685-$ or US-8224510-$ or US-6113037-$ or US-5533695-$).did.	US-PGPUB; USPAT	ADJ	ON	2019/10/10 07:05
S23	8,213	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 07:08
S24	22	("20100258682" | "20110238242" | "20120325980" | "4596029" | "4601051" | "4654770" | "5050823" | "5533695" | "5815823" | "5823481" | "5950966" | "6032905"	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 07:17

		| "6034944" | "6122571" | "6308117" | "6392553" | "6400281" | "7148581" | "7364123" | "7823841" | "8032078").PN. OR ("9321469").URPN.				
S25	23	("3361082" | "4005837" | "4015082" | "4556941" | "4742460" | "4854529" | "5403238" | "5440489" | "5527221" | "5583844" | "5590603" | "5623878" | "5681015" | "5815823").PN. OR ("6122571").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 07:17
S26	46	("20030183697" | "20030236598" | "20040111309" | "20050234757" | "20060212183" | "20060212184" | "20070176054" | "20100063656" | "20100063657" | "3819932" | "4122523" | "5398894" | "5420883" | "5437422" | "5463552" | "6135396" | "6154735" | "6459964" | "6694231" | "6799097" | "6853889" | "6915191" | "7089093" | "7092894" | "7099754" | "7139646" | "7201350" | "7269487" | "7386391" | "7558740" | "7706967" | "7715977" | "7725249" | "7734383" | "7797088" | "7813846" | "7869939" | "7937193" | "8082071" | "8126601" | "8140203" | "8224510" | "8234023" | "8290645" | "8321079").PN. OR ("8820685").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 07:42
S32	526,828	railroad or railway	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S33	34,723	ultra-wideband	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S34	679	S32 and S33	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50

S35	15	S34 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/10/10 09:50
S36	56	("1700933" | "1797302" | "1809374" | "1812183" | "1868489" | "1915696" | "2203988" | "2221290" | "2592163" | "3035167" | "3178683" | "3267281" | "3558874" | "3781543" | "3927852" | "3963202" | "4108405" | "4122523" | "4307860" | "4449115" | "4581700" | "4613103" | "4754272" | "4895325" | "4942395" | "5252893" | "5628479" | "5727758" | "5735491" | "5735492" | "5757288" | "5924651").PN. OR ("6113037").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:02
S37	54	("20040073342" | "20050275513" | "20060015224" | "20060116837" | "20070085734" | "20070261894" | "20070274158" | "20100020185" | "20100130873" | "20100163687" | "20110006912" | "20110009814" | "20110030875" | "20110278401" | "20120006946" | "20120218099" | "20140104081" | "20140111356" | "20140210646" | "20140308930" | "20150091716" | "20170148323" | "3167282" | "4128218" | "4207569" | "5038704" | "5129605" | "5148150" | "5727758" | "5735492" | "5864304" | "5867801" | "5907294" | "5924651" | "5954299" | "6020815" | "6113037" | "6145792" | "6232887" | "6323785" | "6371416" | "7538666" | "7624952" | "7832691" | "8061662" | "8109474" | "8157219" | "8344877" | "8773275" | "8786428" | "8952805" | "9767968" | "9902411").PN. OR ("10106079").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:02
S38	10	("20050010338" | "20110006912" | "20120296562" | "20120306664" | "5924651" | "6145792" | "6232887" | "6471162" | "7075427").PN. OR ("9902411").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:05

S39	28	("2762913" | "5303259" | "5415369" | "5461366" | "5554982" | "5572201" | "5620155" | "5727758").PN. OR ("6145792").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:22
S40	17	("5727758" | "6113037" | "6145792").PN. OR ("7624952").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:25
S41	26	("2762913" | "5554982" | "5620155").PN. OR ("5727758").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 10:27
S42	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/10/10 10:58
S43	24	("3676669" | "3794977" | "3944986" | "3976272" | "4257032" | "4611291" | "4619425" | "5050823" | "5129605" | "5398894" | "5533695" | "5678789" | "5740046" | "5950966" | "6032905" | "6122571").PN. OR ("6556898").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:02
S44	43	("3110885" | "3218452" | "3836768" | "3976272" | "4090173" | "4181849" | "4307463" | "4368534" | "4498650" | "4563762" | "4610206" | "4611291" | "4611775" | "4617662" | "4711418" | "4740972" | "4831521" | "4860977").PN. OR ("5050823").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:09
S45	24	("3676669" | "3794977" | "3944986" | "3976272" | "4257032" | "4611291" | "4619425" | "5050823" | "5129605" | "5398894" | "5533695" | "5678789" | "5740046" | "5950966" | "6032905" | "6122571").PN. OR ("6556898").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:10
S46	133	("2138878" | "3112908" | "3250914" | "3676669" | "3754211" | "3805056").PN. OR ("4711418").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/10/10 11:14
S47	6	(("6113037") or ("20110075641") or ("9283945") or ("20110006912") or ("5415369") or ("5050823")).PN.	US-PGPUB; USPAT	OR	OFF	2019/10/10 11:45

S48	8,249	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:44
S49	20,299	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:44
S50	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/11/05 14:45
S51	24,441	S48 or S49 or S50	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:45
S52	261	S51 and @pd>="20191001"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/05 14:46
S53	102	("20100327125" | "20120126065" | "20130166114" | "20140214248" | "20140263856" | "20150060608" | "20160339934" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20030214417" | "20110046845" | "20110172856" | "20160046308" |	US-PGPUB; USPAT	ADJ	ON	2019/11/08 12:05

		"4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "9002546" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "9128815" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "20140191089" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.				
S55	5	(("20130138276") or ("20120296562") or ("20110234451") or ("4327415") or ("20100063656")).PN.	US-PGPUB; USPAT	OR	OFF	2019/11/08 12:31
S56	89,348	(train or locomotive) near4 control$4	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:35
S57	2,108	S56 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:35
S58	74,261	B61L$.cpc.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 12:36
S59	1,426	S57 and S58	US-PGPUB; USPAT; FPRS; EPO;	ADJ	ON	2019/11/08 12:36

			JPO; DERWENT; IBM_TDB			
S60	56,230	emergency near4 (stop or stopping or break or breaking)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S61	2,736,299	operator	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:23
S62	3,694	S60 with S61	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:24
S63	52	S58 and S62	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/08 13:24
S64	1,053,209	train or locomotive	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S65	325,442	position near (sensing or detecting)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:07
S66	983,251	redundan$3	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:08
S67	393	S65 with S66	US-PGPUB; USPAT; FPRS; EPO; JPO;	ADJ	ON	2019/11/12 09:08

			DERWENT; IBM_TDB			
S68	50	S64 and S67	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:09
S69	74,311	B61L$.cpc.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:09
S71	308	S64 and S65 and S69	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:10
S72	4,808	speed with odometer	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:14
S73	59	S69 and S72	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 09:14
S74	106	("5415369" | "5452870" | "5620155" | "5699986").PN. OR ("5978718").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2019/11/12 09:16
S75	1	("20160046308").PN.	US-PGPUB	OR	OFF	2019/11/12 09:46
S76	471	((("CARLSON") near3 ("Richard")) OR (("GUNTHER") near3 ("Kurt")) OR (("WOITEL") near3 ("Sara") near3 ("Jo")) OR (("CYGNUS") near3 ("Marc"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2019/11/12 10:16
S77	8	S76 and decentral$4	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 10:16

S79	102	("20120126065" | "20140214248" | "20140263856" | "20160339934" | "20100327125" | "20130166114" | "20150060608" | "2475578" | "2762913" | "4302811" | "4538228" | "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "9128815" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20110172856" | "20030214417" | "20110046845" | "20160046308" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "9002546" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "20140191089" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.	US-PGPUB; USPAT	ADJ	ON	2019/11/12 11:01
S80	102	("20120126065" | "20140214248" | "20140263856" | "20160339934" | "20100327125" | "20130166114" | "20150060608" | "2475578" | "2762913" | "4302811" | "4538228"	US-PGPUB; USPAT	ADJ	ON	2019/11/12 11:03

		| "6113037" | "6435459" | "9022325" | "20040155760" | "20110075641" | "20120286563" | "20140046514" | "20140214247" | "20150344048" | "20190054942" | "4495578" | "5727758" | "5924651" | "8200380" | "8650242" | "8651433" | "9008854" | "9134411" | "6732023" | "20170245192" | "20110152971" | "20140229096" | "20150032302" | "20150367822" | "20160280240" | "20170282944" | "5620155" | "5675190" | "6208260" | "20110172856" | "20030214417" | "20110046845" | "20160046308" | "4459668" | "5198800" | "5939986" | "6145792" | "6232887" | "8109474" | "20120123617" | "8126035" | "8423240" | "8998149" | "20050010338" | "20060151672" | "20090326746" | "20110234451" | "20120296567" | "20130046420" | "4869557" | "8344877" | "5995881" | "6135396" | "8245983" | "20030028323" | "20100063656" | "20100102954" | "20100225527" | "20110006912" | "20110184621" | "20120296562" | "20130024054" | "20140045547" | "20160200327" | "20170101116" | "5554982" | "5652570" | "8952805" | "9002546" | "20080040023" | "20080114519" | "20150329130" | "20160221592" | "20170113707" | "4327415" | "7624952" | "8248263" | "8786428" | "20090212168" | "9128815" | "20140191089" | "20050110628" | "20060015224" | "20100268466" | "20120029740" | "20130138276" | "7167082" | "8478463" | "6666411" | "5420883" | "7725252").PN.				
S81	102	S79 or S80	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2019/11/12 11:04
S82	2	(("20130138276") or ("9434397")).PN.	US-PGPUB; USPAT	OR	OFF	2019/11/15 08:21
S85	9,472	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR	US-PGPUB; USPAT;	ADJ	ON	2020/02/27 14:42

		B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S86	24,347	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S87	237	(246/220).CCLS.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/02/27 14:42
S88	29,038	S85 or S86 or S87	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S89	1,328	S88 and @pd>="20191101"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:42
S90	64	S89 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 14:47
S91	1	"16515903"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:08
S92	4,782	absolute with ranging	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:30
S93	3,033	absolute near7 ranging	US-PGPUB; USPAT;	ADJ	ON	2020/02/27 15:30

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S94	166	S93 with (position or location)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:31
S95	125	S92 and (railroad or railway)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:51
S96	736	train with (location or position) with wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:57
S97	44	S96 and ranging	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 15:58
S98	2,885	B61L27/0038.CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 16:22
S99	858	wayside with position	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/27 16:23
S100	1	"20160046308"	US-PGPUB	ADJ	ON	2020/02/28 08:33
S101	1	"16515903"	US-PGPUB	ADJ	ON	2020/02/28 09:31
S102	1	"16515905"	US-PGPUB	ADJ	ON	2020/02/28 09:32
S103	2	(("20130138276") or ("9434397")).PN.	US-PGPUB; USPAT	OR	OFF	2020/02/28 10:48

S104	3	(("20130138276") or ("9434397") or ("20160046308")).PN.	US-PGPUB; USPAT	OR	OFF	2020/02/28 11:03
S105	448	((("CARLSON") near3 ("Richard"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	ADJ	ON	2020/02/28 11:14
S106	18	S105 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/02/28 11:14
S107	9,996	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 13:10
S108	26,754	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 13:10
S112	31,430	S107 or S108	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 13:11
S113	1,661	S112 and @pd>="20200227"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 13:12
S115	628	S113 and (rang$4 or distance)	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 13:29
S116	23	S115 and wayside	US-PGPUB; USPAT; FPRS; EPO; JPO;	ADJ	ON	2020/06/22 13:29

			DERWENT; IBM_TDB			
S121	2	(("20160280240") or ("20110075641")).PN.	US-PGPUB	OR	OFF	2020/06/22 13:46
S122	10	"8224510"	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 14:10
S123	1	("20070139191").PN.	US-PGPUB	OR	OFF	2020/06/22 14:21
S124	1	("20120296562").PN.	US-PGPUB	OR	OFF	2020/06/22 14:23
S126	18	("7148791" | "20080150786" | "20100225527" | "20100207787" | "6295019" | "20130279393" | "5904210" | "6917284" | "20030028323" | "20130279392" | "20130279491" | "6473028" | "6922166" | "7089099" | "7725252" | "20060025897" | "6674396" | "20100207787" | "8231270" | "20080150786").PN.	US-PGPUB; USPAT	ADJ	ON	2020/06/22 15:43
S127	11	S126 and ultra	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 15:43
S128	40	(US-20070162199-$ or US-20160280240-$ or US-20110006912-$ or US-20050010338-$ or US-20050145753-$ or US-20050137760-$ or US-20130138276-$ or US-20190323807-$ or US-20150346332-$ or US-20150351067-$ or US-20150198712-$ or US-20140257748-$ or US-20140209755-$ or US-20120173055-$ or US-20030105560-$ or US-20200172134-$ or US-20120296562-$ or US-20100225527-$).did. or (US-10308265-$ or US-8820685-$ or US-8224510-$ or US-5533695-$ or US-9889869-$ or US-9828010-$ or US-9321469-$ or US-6113037-$ or US-9902411-$ or US-6471162-$ or US-6145792-$ or US-8344877-$ or US-5924651-$ or US-5415369-$ or US-7729818-$ or US-	US-PGPUB; USPAT; FPRS	ADJ	ON	2020/06/22 15:57

		5947423-$ or US-4066877-$ or US-5995881-$ or US-7725252-$ or US-7148791-$).did. or (CA-2850287-$).did.				
S130	10	S128 and ultra	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2020/06/22 15:58
S131	101	("6031862" | "6300903" | "6430208" | "6469628" | "6489893" | "6492906" | "6501393" | "6504483" | "6759948" | "6917284").PN. OR ("7148791").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2020/06/22 16:12

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L17	2,014	(B61L23/06 OR B61L23/044 OR B61L27/0088 OR B61L25/02 OR B61L25/021 OR B61L27/0094 OR B61L29/24 OR B61L29/32).CPC.	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:15
L18	6,830	(B61L15/0027 OR B61L2027/005 OR B61L2201/00 OR B61L2205/00 OR B61L23/20 OR B61L25/021 OR B61L25/025 OR B61L27/0005 OR B61L27/0038 OR B61L27/04 OR H02S99/00 OR H04W4/42 OR H04W4/44).CPC.	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:15
L19	7,760	17 or 18	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:15
L20	5,311	19 and @py>="2015"	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:16
L21	579	20 and (uwb or ultra)	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:17
L23	53,715	railroad or raiway	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:18
L24	94	21 and 23	US-PGPUB; USPAT	ADJ	ON	2020/06/23 07:18

6/23/2020 8:12:22 AM
C:\Users\mle1\Documents\EAST\Workspaces\16515903.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: Jul. 24, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.312

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the notice of allowance of Jul. 20, 2020 ("Notice") in the above-identified application ("Application"). Applicant respectfully requests entry of the following amendments in this Application and consideration of the following remarks.

Listing of the Claims begins on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

LISTING OF THE CLAIMS

1-19. (Canceled)

20. (Previously presented) A system for providing decentralized control operations in a railway network, the system comprises:

a plurality of wayside units, each configured for placement on or near tracks in the railway network; and

one or more train-mounted units, each configured for deployment on a train operating in the railway network;

wherein each train-mounted unit is configured to:

communicate with any wayside unit or other train-mounted unit that comes within communication range of the train-mounted unit, wherein the communicating comprises use of ultra-wideband (UWB) based signals; and

generate based on the communication, control information configured for use in controlling one or more functions of the train in conjunction with operation in the railway network,

wherein generating the control information comprises or is based on obtaining ranging measurements, and

wherein obtaining the ranging measurements comprises:

broadcasting ultra-wideband (UWB) based signals within a wireless range of the train-mounted unit, the UWB based signals comprising information identifying the train-mounted unit;

selecting based on received responses to the broadcast UWB based signals, one or more of the plurality of wayside units; and

determining ranging information corresponding to each of the one or more wayside units, based on ultra-wideband (UWB) based signals communicated respectively with each of the one or more of the plurality of wayside units.

21. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured to generate at least part of the control information based on sources other than processing of the ultra-wideband (UWB) based signals.

22. (Previously presented) The system of claim 21, wherein the train-mounted unit is configured to:

assess based on the processing of the ultra-wideband (UWB) based signals, one or more conditions relating to operation of the train within the railway network;

when at least one condition meets one or more particular criteria, determine one or more responsive actions; and

perform or cause performing each of the one or more responsive actions.

23. (Previously presented) The system of claim 22, wherein, when the one or more responsive actions comprise providing indication or feedback, relating to the at least one condition, to a train operator, the train-mounted unit is configured to:

monitor actions of the train operator;

assess based on the monitoring, the train operator's compliance with at least one expected subsequent responsive action; and

when the train operator fails to do so, directly perform the at least one expected subsequent responsive action or perform an alternative action.

24. (Canceled)

25. (Canceled)

26. (Canceled)

27. (Canceled)

28. (Canceled)

29. (Canceled)

30. (Canceled)

31. (Canceled)

32. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for utilizing non-UWB based signals for communicating at least some data with the wayside unit and/or another train-mounted unit.

33. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for handling radio-frequency identification (RFID) based signals with RFID devices used within the railway network.

34. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for handling satellite based signals.

35. (Previously presented) The system of claim 34, wherein the train-mounted unit is configured for obtaining from received satellite based signals information, and generating or adjusting the control information based on the obtained information.

36. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for connecting to and/or interfacing with other systems of the train.

37. (Previously presented) The system of claim 20, comprising one or more input/output (I/O) components, for receiving input from an operator of the train and/or for providing output to the operator of the train.

38. (Previously presented) The system of claim 20, comprising a power component for supplying and/or obtaining power for components of the train-mounted unit.

39. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured for communicating, directly or via at least one of the wayside unit and another train-mounted unit, with one or more other components or devices in the railway network, the one or more other components or devices in the railway network not being part of decentralized train control system.

40. (Previously presented) The system of claim 20, wherein the train-mounted unit is configured to substantially continually determine absolute position of the train, based on the ranging information obtained from ranging with wayside units.

41. (Previously presented) The system of claim 40, wherein the train-mounted unit is configured to determine the absolute position of the train based on the ranging information and positioning information obtained without ranging to wayside units.

42. (Previously presented) The system of claim 41, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from each wayside unit as the train passes the wayside unit.

43. (Currently amended) The system of claim 42, wherein the train-mounted unit is configured to obtain at least portion of the positioning information from at least one wayside unit <u>as the train</u> passes that wayside unit using non-UWB communications.

REMARKS

Claims 20-23 and 32-43 are pending in this Application, of which claim 20 is an independent claims, and claims 21-23 and 32-43 are dependent claims, depending from independent claim 20. Claims 1-19 and 24-31 were previously canceled. All of claims 20-23 and 32-43 are allowed in the Notice.

Upon receipt of the Notice, Applicant reviewed the claims and noted certain minor changes that may be needed in some of the claims. Applicant is making these changes in this correspondence, and the Examiner is kindly requested to enter the claim amendments prior to issuance of the patent for this Application. In this regard, Applicant respectfully requests entry of these claim amendments pursuant to Manual of Patent Examining Procedure (MPEP) § 714.16, submitting that the amendments to the claims address formal matters without changing the scope thereof. Applicant submits that the claim amendments require no substantial amount of additional work on the part of the USPTO as these changes do not add to or otherwise change the scope of the allowed subject matter(s).

Specifically, claim 43 is amended for clarification, consistency, and to ensure consistency with its base claim (claim 42). In this regard, claim 43 is amended to correct typographical error therein, such that claim 43 now recites "wherein the train-mounted unit is configured to obtain at least portion of the positioning information from at least one wayside unit ***as the train*** passes that wayside unit using non-UWB communications." (Emphasis added). Applicant submits, again, that as these changes do not add to or otherwise change the scope of the allowed subject matter(s).

CONCLUSION

Based on at least the foregoing, Applicant believes that all pending claims remain in condition for allowance. Should there be any questions or if Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

Respectfully submitted,

Date: Jul. 24, 2020

/Rami N. Moussa/
Rami N. Moussa
Attorney for Applicant
Registration No. 69,528

MCANDREWS, HELD & MALLOY, LTD.
500 WEST MADISON STREET, 34TH FLOOR
CHICAGO, ILLINOIS 60661
(312) 775-8000

Electronic Patent Application Fee Transmittal

Application Number:	16515903
Filing Date:	18-Jul-2019
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Filer:	Rami Naim Moussa/Elaine Maxson
Attorney Docket Number:	63154US03

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**500**

Electronic Acknowledgement Receipt	
EFS ID:	40096829
Application Number:	16515903
International Application Number:	
Confirmation Number:	2880
Title of Invention:	METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL
First Named Inventor/Applicant Name:	Richard C. Carlson
Customer Number:	23446
Filer:	Rami Naim Moussa/Elaine Maxson
Filer Authorized By:	Rami Naim Moussa
Attorney Docket Number:	63154US03
Receipt Date:	24-JUL-2020
Filing Date:	18-JUL-2019
Time Stamp:	15:30:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$500
RAM confirmation Number	E20207NF31191270
Deposit Account	130017
Authorized User	Elaine Maxson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.21 (Miscellaneous fees and charges) 37 CFR 1.20 (Post Issuance fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.16 (National application filing, search, and examination fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	63154US03_Issue_Fee_transmittal.pdf	1360429 bfa1823c9d44097211b33d6a79096727a067ffcb	no	1
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	63154US03_Allowance_Comments.pdf	31170 bb265fbeaa26220fc98aa650b2cceb0cedf82b5b	no	3
Warnings:					
Information:					
3		63154US03_CFR_1-312_Amendment.pdf	49702 22e3796d20c954b5ee69b93a87a1eed46072c109	yes	7

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment after Notice of Allowance (Rule 312)	1	1
Claims	2	5
Applicant Arguments/Remarks Made in an Amendment	6	7

Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30371 83132ac8ecad25b83ce33d5fa132340435cda0fb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1471672		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23446 7590 07/20/2020
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Rami N. Moussa	(Typed or printed name)
/Rami N. Moussa/	(Signature)
July 24, 2020	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

TITLE OF INVENTION: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	10/20/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
LE, MARK T	3617	246-193000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

McAndrews, Held & Malloy, Ltd.
1 500 West Madison Street
2 Suite 3400
3 Chicago, IL 60661

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
METROM RAIL, LLC	CRYSTAL LAKE, ILLINOIS

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 130017

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Rami N. Moussa/ Date July 24, 2020

Typed or printed name Rami N. Moussa Registration No. 69,528

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: Jul. 24, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the notice of allowance of Jul. 20, 2020 ("Notice") in the above-identified application ("Application"). Applicant respectfully requests entry of the following remarks in the record.

REMARKS

Claims 20-23 and 32-43 are pending in this Application, of which claim 20 is an independent claims, and claims 21-23 and 32-43 are dependent claims, depending from independent claim 20. Claims 1-19 and 24-31 were previously canceled.

As indicated in the Notice, all of claims 20-23 and 32-43 are allowed. In this regard, the Notice indicates that the allowance is responsive to the office action response submitted on Jun. 9, 2020, without providing specific reasons for the allowance of the claims. Nonetheless, various statements and/or arguments regarding the claims and/or the disclosure in general (e.g., made during examination of the Application and/or any other related application(s)) may also be construed as reasons for allowing the claims.

Applicant thanks the Examiner for the positive consideration of the claims. However, with respect to the reasons for allowing the claims, Applicant does not agree or disagree with any reasons the United States Patent and Trademark Office ("Patent Office") may have had for allowing the claims, and respectfully submits that the allowability of the claims is based upon the features of the claims and the totality of the record. Further, with respect to the dependent claims, Applicant submits that each dependent claim stands on its own and is allowable based on its own elements and/or in combination with one or more elements recited in its base claim(s).

Upon receipt of the Notice, Applicant reviewed the claims and noted that certain minor corrections were needed in certain claims, which Applicant is making by submitting, along with this correspondence, an amendment in accordance with 37 C.F.R. § 1.312. Applicant submits that the changes being made do not change the scope of the claims, and as such do not require reopening the examination of this Application. Thus, Applicant presumes that this Application will remain in condition of allowance after entry of these changes.

Applicant also reserves the right to traverse the stated reasons and/or to argue other reasons to support allowance of the claims, should the need arise in the future.

CONCLUSION

The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

Respectfully submitted,

Date: Jul. 24, 2020

/Rami N. Moussa/
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	07/18/2019	Richard C. Carlson	63154US03	2880

23446 7590 08/18/2020

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER
LE, MARK T

ART UNIT	PAPER NUMBER
3617	

NOTIFICATION DATE	DELIVERY MODE
08/18/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/515,903	Carlson et al.	
	Examiner	Art Unit	AIA (FITF) Status
	MARK T LE	3617	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 24 July 2020 under 37 CFR 1.312 has been considered, and has been:

a) ☐ entered.

b) ☑ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/MARK T LE/
Primary Examiner, Art Unit 3617

APPROVED: /M.T.L/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

(Attorney Docket № 63154US03)

In the Application of:

Richard Carlson et al.

Serial No. 16/515,903

Filed: Jul. 18, 2019

For: METHODS AND SYSTEMS FOR DECENTRALIZED RAIL SIGNALING AND POSITIVE TRAIN CONTROL

Examiner: LE, Mark T

Group Art Unit: 3617

Confirmation No.: 2880

Customer No.: 23446

CERTIFICATE OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via EFS-Web to the United States Patent and Trademark Office on: Jul. 24, 2020.

/Rami N. Moussa/
Rami N. Moussa
Reg. No. 69,528

RESPONSE UNDER 37 C.F.R. § 1.312

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

This paper responds to the notice of allowance of Jul. 20, 2020 ("Notice") in the above-identified application ("Application"). Applicant respectfully requests entry of the following amendments in this Application and consideration of the following remarks.

Listing of the Claims begins on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/515,903	09/15/2020	10778363	63154US03	2880

23446 7590 08/26/2020

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CHICAGO, IL 60661

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Metrom Rail, LLC, Crystal Lake, IL;
Richard C. Carlson, Palatine, IL;
Kurt Alan Gunther, Woodstock, IL;
Sara Jo Woitel, Lake Zurich, IL;
Marc Wayne Cygnus, Mundelein, IL;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court District of Delaware on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	1/13/2022	District of Delaware

PLAINTIFF	DEFENDANT
Metrom Rail, LLC	Siemens Mobility, Inc., Thales Transport & Security, Inc., Thales USA., Inc., Humatics Corp., and Piper Networks, Inc,

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 10,778,363 B2	9/15/2020	Metrom Rail, LLC
2	US 8,812,227 B2	8/19/2014	Metrom Rail, LLC
3	US 9,043,131 B2	5/26/2015	Metrom Rail, LLC
4	US 10,737,709 B2	8/11/2020	Metrom Rail, LLC
5	US 10,179,595 B2	1/15/2019	Metrom Rail, LLC

In the above---entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above---entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1---Upon initiation of action, mail this copy to Director Copy 3---Upon termination of action, mail this copy to Director
Copy 2---Upon filing document adding patent(s), mail this copy to Director Copy 4---Case file copy