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*January 23, 2019*

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OF:**

**APPLICATION NUMBER: 12/489,570**

**FILING DATE: *June 23, 2009***

**PATENT NUMBER: 8081320**

**ISSUE DATE: *December 20, 2011***



Certified by

*Andres Buren*

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for Intellectual Property  
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Patent and Trademark Office

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<b>UTILITY PATENT APPLICATION TRANSMITTAL</b>  (Only for new nonprovisional applications under 37 CFR 1.53(b))	Attorney Docket No.	11042.0098.CPUS02
	First Inventor	Christopher M. Villar
	Title	Tilt Correction System and Method for Rail Seat Abrasion
	Customer No.	23369

<b>APPLICATION ELEMENTS</b> See MPEP chapter 600 concerning utility patent application contents.	<b>ADDRESS TO:</b> Commissioner for Patents P.O. Box 1450 Alexandria VA 22313-1450
<b>1. <input checked="" type="checkbox"/> Fee Transmittal Form</b> (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing) <b>2. <input type="checkbox"/> Applicant claims small entity status.</b> See 37 CFR 1.27. <b>3. <input checked="" type="checkbox"/> Specification</b> [Total Pages <u>40</u> ] Both the claims and abstract must start on a new page (For information on the preferred arrangement, see MPEP 608.01 (a)) <b>4. <input checked="" type="checkbox"/> Drawing(s)</b> (35 U.S.C. 113) [Total Pages <u>12</u> ] <b>5. <input type="checkbox"/> Oath or Declaration</b> [Total Pages <u>  </u> ] a. <input type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> A copy from a prior application (37 CFR 1.63(d)) (for continuation/divisional with Box 18 completed) i. <input type="checkbox"/> <b>DELETION OF INVENTOR(S)</b> Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b). <b>6. <input type="checkbox"/> Application Data Sheet.</b> See 37 CFR 1.76 <b>7. <input type="checkbox"/> CD-ROM or CD-R</b> in duplicate, large table or Computer Program (Appendix) <input type="checkbox"/> Landscape Table on CD <b>8. <input type="checkbox"/> Nucleotide and/or Amino Acid Sequence Submission</b> (if applicable, items a. - c. are required) a. <input type="checkbox"/> Computer Readable Form (CRF) b. <input type="checkbox"/> Specification Sequence Listing on: i. <input type="checkbox"/> CD-ROM or CD-R (2 copies); or ii. <input type="checkbox"/> Paper c. c. <input type="checkbox"/> Statements verifying identity of above copies	<b>ACCOMPANYING APPLICATION PARTS</b> <b>9. <input type="checkbox"/> Assignment Papers</b> (cover sheet & document(s)) Name of Assignee _____ <b>10. <input type="checkbox"/> 37 CFR 3.73(b) Statement</b> (when there is an assignee) <input type="checkbox"/> Power of Attorney <b>11. <input type="checkbox"/> English Translation Document</b> (if applicable) <b>12. <input type="checkbox"/> Information Disclosure Statement</b> (PTO/SB/08 or PTO-1449) <input type="checkbox"/> Copies of citations attached <b>13. <input type="checkbox"/> Preliminary Amendment</b> <b>14. <input type="checkbox"/> Return Receipt Postcard</b> (MPEP 503) (Should be specifically itemized) <b>15. <input type="checkbox"/> Certified Copy of Priority Document(s)</b> (if foreign priority is claimed) <b>16. <input type="checkbox"/> Nonpublication Request</b> under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. <b>17. <input type="checkbox"/> Other:</b> _____
<b>18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:</b> <input type="checkbox"/> Continuation <input type="checkbox"/> Divisional <input checked="" type="checkbox"/> Continuation-in-part (CIP) of prior application No.: <u>11/172,618</u> Prior application information: Examiner <u>Juan D. Valentin</u> Art Unit: <u>2877</u>	
<b>19. CORRESPONDENCE ADDRESS</b>	
<input checked="" type="checkbox"/> The address associated with Customer Number:	<u>23369</u> OR <input type="checkbox"/> Correspondence address below
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Address	
City	State Zip Code
Country	Telephone Email
Signature	Date <u>June 23, 2009</u>
Name (Print/Type) <u>Jade O. Laye</u>	Registration No. (Attorney/ Agent) <u>54,255</u>

This collection of information is required by 37 CFR 1.53(b). 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. 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.

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. Unassigned
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: Herewith	Group: 2877
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 2</i>	

### U.S. Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	5,245,855	9/21/1993	Burgel et al.	73	8	

### Foreign Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1						
	B2						

### Other Art (Including Author, Title, Date Pertinent Pages, Etc.)

Exam. Init.	Ref. Des.	Citation
	C1	
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INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)

DM\_US:22222868\_1



Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		Tilt Correction System and Method for Rail Seat Abrasion		
First Named Inventor/Applicant Name:		Christopher M. Villar		
Filer:		Jade O. Laye		
Attorney Docket Number:		11042.0098.CPUS02		
Filed as Small Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	82	82
Utility Search Fee	2111	1	270	270
Utility Examination Fee	2311	1	110	110
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
<b>Post-Allowance-and-Post-Issuance:</b>				
<b>Extension-of-Time:</b>				
<b>Miscellaneous:</b>				
<b>Total in USD (\$)</b>				<b>462</b>

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	5567203
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Jade O. Laye
<b>Filer Authorized By:</b>	
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	23-JUN-2009
<b>Filing Date:</b>	
<b>Time Stamp:</b>	11:54:29
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$462
RAM confirmation Number	9059
Deposit Account	083038
Authorized User	
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Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)					
<b>File Listing:</b>					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		SpecClaimsAbst.pdf	206795 1c8a0f88437ea2f3823d707e9e14efc2cd94a15e	yes	40
	<b>Multipart Description/PDF files in .zip description</b>				
	<b>Document Description</b>		<b>Start</b>	<b>End</b>	
	Specification		1	34	
	Claims		35	39	
	Abstract		40	40	
<b>Warnings:</b>					
<b>Information:</b>					
2	Drawings-only black and white line drawings	Drawings.pdf	447139 e498f67163c760dfd8db8133c5e3c07ab792b348	no	12
<b>Warnings:</b>					
<b>Information:</b>					
3	Fee Worksheet (PTO-875)	FeeTransmittal.pdf	57779 10d8fc6e88b395b874cdfe7f02e0b72a0c64dbe1	no	1
<b>Warnings:</b>					
<b>Information:</b>					
4	Transmittal of New Application	UtilityTransmittal.pdf	76254 51802f2ba17a7bd12f9495068d894b84fbc1ffe	no	1
<b>Warnings:</b>					
<b>Information:</b>					
5	Information Disclosure Statement (IDS) Filed (SB/08)	IDS.pdf	98035 b746e16d32396b6f2400673837bf76cb9b13f981	no	2
<b>Warnings:</b>					
<b>Information:</b>					
This is not an USPTO supplied IDS fillable form					
6	Fee Worksheet (PTO-875)	fee-info.pdf	32773 d7313525abfac985f0c2481f0572cd8abf68b9f1	no	2
<b>Warnings:</b>					

<b>Information:</b>	
<b>Total Files Size (in bytes):</b>	918775
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**PATENT**  
**11042.0098.CPUS02**

**APPLICATION FOR UNITED STATES LETTERS PATENT**

**for**

**TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION**

**Inventors:**

**Christopher M. Villar**

**John Nagle**

**Steven C. Orrell**

## **CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application is a continuation-in-part of U.S. Application S/N 12/465,473, entitled, "SYSTEM AND METHOD FOR INSPECTING SURFACES USING OPTICAL WAVELENGTH FILTERING, filed May 13, 2009, naming John Nagle, Steven C. Orrell, Christopher Villar, and Charlie Aaron as inventors, which is a continuation-in-part of US Application S/N 11/172,618, entitled, "SYSTEM AND METHOD FOR INSPECTING RAILROAD TRACK, filed June 30, 2005 and naming John Nagle, Christopher Villar and Steven Orrell as inventors, which is a non-provisional application claiming benefit of U.S. Provisional Application S/N 60/584,769, also entitled, "SYSTEM AND METHOD FOR INSPECTING RAILROAD TRACK, filed June 30, 2004, naming John Nagle and Steven C. Orrell as inventors, each being hereby incorporated by reference in their entirety.

## **FIELD OF THE INVENTION**

[0002] The present invention relates generally to systems and methods for inspecting railroad surfaces and, more particularly to systems and methods for determining rail seat abrasion via the utilization of tilt correction algorithms.

## **BACKGROUND OF THE INVENTION**

[0003] Railroads are generally constructed on a base layer of compacted, crushed stone material. A layer of gravel ballast rests on top of this stone layer. Crossties are laid in and on this ballast layer, and two parallel steel rails are attached to the crossties with

fasteners. The majority of crossties in service are made of wood. Various other materials are used such as concrete, steel, and composite or recycled material in the manufacture of crossties.

[0004] The ties are normally paced on top of the track ballast. The remaining  
5 construction differs slightly depending on the type of tie material used. If wood ties are used, tie plates are then placed on top of the ties. Rails are then placed on top of the tie plates. The rails are then fastened to the ties through the use of spikes or bolts driven through holes in the tie plates. When concrete ties are used, rails are placed on top of the ties, with a thin polymer pad preventing direct contact between the steel and the concrete.  
10 Steel clips are often used to fasten the rail to the tie. Additional track ballast is then used to fill spaces between and around the ties to assist in anchoring.

[0005] Normal railroad traffic causes friction between ties and rails, as well as rails and spikes, bolts, screws, or clips, and the surface under the ties. Of particular concern is friction at the point where the rail seats against the tie. Wear at this point, also known as  
15 rail seat abrasion, directly impacts the life of the tie by causing it to loosen from the rail. In spite of the pads used between rails and concrete ties, rail seat abrasion remains a continuing problem with concrete ties.

[0006] When the rail seat wears, it affects the amount of tension on the fastener so that the rail mounting force required to firmly affix it to the tie is not achieved. Should this  
20 happen, the rail can slide against the tie, which increases the rate of abrasion. Rail slide can also cause rail welds to pull apart, either from stress or from temperature misalignments. Another concern with rail seat abrasion is that it increases the exposure of

the surface of the ties to environmental conditions, further accelerating rail seat abrasion and tie degradation. Additional causes or contributing factors to rail seat abrasion can include manufacturing defects, temperature variation patterns, railroad arrangements, such as curvature, grade, and banking, and the state of the pad used between rail and tie.

5           [0007] Measurement has been conducted to monitor the wear of concrete ties, either by direct manual measurement, or through the use of electronic devices installed below individual railroad ties. All previous methods have proved either unreliable, hazardous, labor-intensive, requiring extensive equipment installation, or having a major impact on the availability of railroads to train traffic.

10           [0008] In view of the foregoing, the present invention is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above, thereby providing a system capable of predicting instances of rail track abrasion without the need for hazardous and unreliable manual measurements or costly electronic measurement devices.

## SUMMARY OF THE DISCLOSURE

[0009] Exemplary systems and methods for determining rail seat abrasion of a rail road track are disclosed. Embodiments of the disclosed system includes an inspection system comprising lasers, cameras, and processors adapted to determine whether rail seat abrasion is present along the track. The processor employs a mathematics based algorithm which compensates for tilt encountered as the inspection system moves along the track.

[0010] Exemplary methods of the present invention comprise the steps of moving the inspection system along the track, receiving image data corresponding to the track, determining measurements of the rail seat abrasion for various portions of the track, wherein the measurements adjust for tilt encountered as the inspection system moves along the track.

[0011] By mounting measurement devices on the inspection vehicle that traverses the track, taking precise measurements of the height of the rail and the tie, and adjusting these measurements for any expected tilt encountered, instances of rail track abrasion can be predicted without the need for hazardous raising of rails for unreliable and time-consuming manual measurements, or for costly and labor intensive installation of electronic measurement devices under individual ties.

[0012] The foregoing summary is not intended to summarize each potential embodiment or every aspect of the subject matter of the present disclosure.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0013] The foregoing summary, preferred embodiments, and other aspects of the subject matter of the present disclosure will be best understood with reference to a detailed description of specific embodiments, which follows, when read in conjunction with the accompanying drawings, in which:

[0014] Figure 1 schematically illustrates an embodiment of the disclosed inspection system.

[0015] Figure 2 illustrates a portion of an embodiment of a system for inspecting railroad track according to certain teachings of the present disclosure.

[0016] Figure 3 illustrates an example frame of a portion of railroad track obtained with the disclosed inspection system.

[0017] Figures 4A-4C illustrate example frames of railroad track obtained with the disclosed inspection system for determining the spacing between the crossties.

[0018] Figure 5 illustrates an example frame of railroad track obtained with the disclosed inspection system for determining the angle of the crosstie with respect to the rail.

[0019] Figures 6A-6C illustrate example frames of railroad track obtained with the disclosed inspection system for determining a break or separation in the rail.

[0020] Figures 7A-7B illustrate example frames of railroad track obtained with the disclosed inspection system for determining wear of the rail.

[0021] Figure 8 illustrates an example frame of railroad track obtained with the disclosed inspection system for determining defects in the crosstie, spacing of the rail, size of the crossties, and ballast height relative to the crosstie.

[0022] Figure 9 illustrates an example frame of railroad track obtained with the disclosed inspection system for determining a raised spike.

[0023] Figure 10 illustrates an example frame of railroad track obtained with the disclosed inspection system for determining a missing tie plate.

[0024] Figures 11 and 12 illustrate three-dimensional compilations of image data obtained with the disclosed inspection system.

[0025] Figures 13 and 14 illustrate an alternate exemplary embodiment of the present invention.

[0026] Figure 15 illustrates an exemplary embodiment of a camera according to the present invention.

[0027] Figure 16 illustrates a graph plotting the energy of the sun's solar radiation at specific wavelengths according to an exemplary embodiment of the present invention.

[0028] Figure 17 illustrates a profile image of a rail road track tilted according to an exemplary embodiment of the present invention.

[0029] Figure 18 is a flow chart illustrating a method of determining rail seat abrasion according to an exemplary embodiment of the present invention.

[0030] While the disclosed inspection system and associated methods are susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail.

The figures and written description are not intended to limit the scope of the disclosed inventive concepts in any manner. Rather, the figures and written description are provided to illustrate the disclosed inventive concepts to a person skilled in the art by reference to particular embodiments, as required by 35 U.S.C. § 112.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0031] Referring to Figures 1 and 2, an exemplary embodiment of a system 30 for inspecting railroad track according to certain teachings of the present disclosure is illustrated. In Figure 1, the disclosed inspection system 30 is schematically illustrated relative to a railroad track. In Figure 2, a portion of the disclosed inspection system 30 is illustrated in a perspective view relative to railroad track.

[0032] As best shown in Figure 1, the exemplary disclosed inspection system 30 includes a light generator such as a laser 40, a device for receiving light reflected from the area to be inspected such as a camera 50, and a processing device 60. In the implementation shown in Figure 1, the disclosed inspection system 30 is used to survey the track bed of a railroad track. Although the disclosed inspection system and associated methods are described for use in inspecting railroad track, it will be appreciated with the benefit of the present disclosure that the disclosed system and method can be used in other areas and in industries where surfaces or components require inspection. For example, the disclosed inspection system and method can be used to inspect roads, electrical lines, piping, or other networks or systems.

[0033] The track bed includes crossties 10, rails 12, tie plates 14, spikes 16, and ballast 18. Briefly, the laser 40 projects a beam 42 of laser light at the track bed. The beam 42 produces a projected line L, shown in Figure 2, on the track bed that follows the contours of the surfaces and components of the track bed. The light receiver, camera 50, captures an image of the line L of laser light 42 projected on the track bed. The camera 50

sends the captured image to the processing device 60 for processing and analysis as described in more detail below.

[0034] As best shown in exemplary embodiment of Figure 2, pairs of lasers 40 and cameras 50 are positioned above each one of the rails 12 of the track. The lasers 40 and the cameras 50 can be assembled onto a rigid framework 32, which can be mounted on an inspection vehicle (not shown) or other device moving along the track so as to maintain the inspection system 30 in the proper position. Only a portion of the framework 32 is shown in Figure 2 for simplicity. However, it is understood that other known components for the framework 32 may be needed to mount the lasers 40 and the cameras 50 on an inspection vehicle.

[0035] In general, the inspection vehicle can be any suitable vehicle for traveling along the railroad track. For example, a common practice in the art is to equip a normal highway vehicle, such as a pick-up truck, with “hi-rail” gear mounted to the frame of the vehicle. Hi-rail gear typically includes a set of undersized railroad stock wheels that allow the highway vehicle to ride along the rails. In one embodiment, then, the framework 32 of the disclosed inspection system 30 can be mounted in the bed of a pick-up truck having “hi-rail” gear. Alternatively, the inspection vehicle can be maintenance of way (MoW) equipment that is specifically designed for working along the railroad track. In addition, the disclosed inspection system 30 can be mounted on a chassis that is towed by a vehicle or can be mounted on a locomotive or freight car.

[0036] As best shown in Figure 2, the lasers 40 project a beam 42 of light having a predetermined angular spread  $\beta$ . The angular spreads  $\beta$  of the two lasers 40 cover

substantially the entire surface of the track bed. In this way, the lasers 40 produce a projected line L that is substantially straight and extends substantially across the track bed. Each laser 40 preferably produces a beam 42 having an angular spread  $\beta$  of about 60-degrees and covers approximately one half of the track bed. Preferably, the lasers 40 project the beam 42 substantially perpendicular to the surface of the track. Alternatively, a single laser could be used that is positioned such as to create the projected line L across the track bed.

[0037] In addition, the lasers 40 are preferably infrared lasers having 4-watts of optical output and producing light at an infrared wavelength of about 810-nm. The relatively high optical output of the lasers 40 helps reduce effects of ambient light so that shielding is not necessary. A suitable laser for the disclosed inspection system 30 includes a Magnum laser manufactured by Stocker Yale. The parameters described above for the lasers 40 are preferred for inspecting the surface of a railroad track. However, those ordinarily skilled in the art having the benefit of this disclosure realize the present invention may be utilized to inspect a variety of other surfaces. Other implementations of the disclosed inspection system 30 can use an alternate number of light sources as well as different wavelengths, optical outputs, and angular spreads.

[0038] As best shown in Figure 2, the cameras 50 are positioned adjacent the lasers 40. As best shown in Figure 1, the cameras 50 are mounted at an angle  $\theta$  with respect to the beam 42 of light projected from the lasers 40. In one embodiment, the cameras are positioned at an angle  $\theta$  of about 60-degrees. As the disclosed inspection system 30 is moved along the track, the cameras 50 capture an image or frame of the track bed at small,

regular increments. Preferably, the cameras 50 are capable of a substantially high frame rate, such as about 5405 frames per second.

[0039] Each still image or frame captured by the cameras 50 is then filtered and processed to isolate the contoured laser line L projected on the track bed. The cameras 50 are fitted with band-pass filters 52 that allow only the radiant energy substantially at the preferred infrared wavelength of the lasers 40 to pass. Because the wavelength of the lasers 40 is about 810-nm, the band-pass filters 52 of the cameras 50 can eliminate substantially all ambient light so that the camera 50 acquires a substantially clear, still image of the projected line L of light from the lasers 40.

[0040] Each of the two cameras 50 send image data directly to the processing device or computer 60 via wired or wireless transmission lines. Preferably, the camera 50 includes a processor 54 capable of converting or formatting the captured image of the projected line L into a dimensional profile that is sent directly to the processing device or computer 60. The ability of the camera 50 to process or format the captured image in this way can eliminate the need for expensive post processors or high-speed frame grabbers. A suitable camera for the disclosed inspection system 30 having such processing abilities includes a Ranger M50 manufactured by IVP Integrated Vision Products, Inc.

[0041] Among other common components, the processing device or computer 60 includes a microprocessor, inputs, outputs, and a data storage device 62. The data storage device 62 can include a hard drive, a non-volatile storage medium, a flash memory, tape, or CD-ROM. The processing device 60 can further include an input/display 68 for a track inspector to input and review data and to operate the disclosed inspection system 30. The

processing device 60 operates with suitable software programs for storing and analyzing the various data obtained with the disclosed inspection system 30. For example, the processing device 60 can have any suitable image processing software, such as Matrox MIL, Common VisionBlox, Labview, eVision, Halcon, and IVP Ranger. For example, the  
5 processing device 60 can have image processing tools known in the art for analyzing image data from the cameras 50 such as Region of Interest (ROI) tools, filtering tools, blob tools, edge finders, histogram tools, and others.

[0042] To effectively process all of the data obtained with the disclosed inspection system 30, the processing device 60 in a preferred embodiment includes a computer having  
10 a fast processor, such as an Intel Pentium 4 processor capable of running at 2.8 GHz. To effectively store all of the data obtained with the disclosed inspection system 30, the storage device 62 preferably includes two large-capacity hard drives configured to use both read/write mechanisms simultaneously as one drive, which is also known as a Redundant Array of Independent Disks (RAID) system. The fast processor of the processing device  
15 60 and the dual hard drives of the storage device 62 allow for sustained real-time storage of the data obtained with the disclosed inspection system 30. In a preferred embodiment, the power for the disclosed inspection system 30 can be provided by 110 V AC power from a belt driven generator running directly off the engine of the inspection vehicle.

[0043] With the beams 42 projected onto the irregular surface of the track and  
20 viewed at an angle, the projected line L shown in Figure 2 follows the contours of the surface and components of the track bed. An example image or frame showing the projected line L of the track bed is shown in Figure 3. The image data or frame includes a

plurality of pixels given X-Y coordinates and shows a contour of the track bed captured by the cameras 50. Due to filtering and other image processing techniques known in the art, the image includes two pixel values, where the dark pixels represent the contour of the track bed. Every pixel of a given image data is given the same Z-coordinate, which represents the particular position along the length of the track at which the image data was captured. In this manner, a plurality of captured images produce a three-dimensional scan of the track bed in which each image of the scan has X-Y coordinates showing the contour of the track bed and has a Z-coordinate representing the particular position of the contour along the length of rail.

[0044] It is understood that the speed at which an image is captured is limited by the width and height of the scanned area, the distance between the discrete still images, the resolution of the still images, the maximum frame rate of the cameras 50, the processing speed of the computer 60, and the write speed of the data storage device 62. For a railroad application of the disclosed inspection system 30, one preferred example is spacing between still images or frames captured by the cameras 50 of about 0.1-inch, a preferred velocity of the inspection vehicle of about 30-mph, a preferred height of the scanned area of approximately 10 inches, and a preferred width of the scanned area of about 10-feet across the width of the track bed. To satisfy these preferred parameters, a camera system capable of about 5405 frames per second and a computer system capable of processing and recording at about 8.3 MPS is preferred. Each frame or image, such as shown in Figure 3, may require about 1,536 bytes of storage. With a frame captured at about every 0.1-inches

along the length of track, about 633,600 frames would be captured for one mile of track and would require 0.973 gigabytes of storage space.

[0045] Another embodiment and as shown in Figure 1, the disclosed inspection system 30 may further include a Global Position System (GPS) receiver 64 for obtaining geographical locations of the inspection vehicle when inspecting the railroad track. The GPS receiver 64 can include any suitable GPS receiver known in the art for obtaining geographical locations. For example, the GPS receiver 64 can be an independent, commercially available unit mounted on the inspection vehicle and connected to the processing device 60 with a suitable cable connection and input/output interface. The GPS receiver 64 can obtain the geographical location using a differential or non-differential GPS system. Techniques for obtaining substantially accurate location and time data with a GPS receiver 64 are well known in the art and are not discussed further. The geographical locations are sent to the processing device 60 and can be compiled with the image data of the track bed.

[0046] When the image data from the cameras 50 is recorded, the geographical location of the frame can also be recorded. Eliminating a continuous stream of geographical location data from the GPS receiver 64 to the computer 60 can free the processor time available for capturing the image data with the processing device 60. Therefore, the GPS receiver 64 preferably feeds data to an auxiliary module 65. The auxiliary module 65 packages this data and sends the data to the processing device or computer 60 when queried. In addition to obtaining geographical location data, the GPS receiver 64 can obtain time data. Furthermore, the location and time data obtained with the

GPS receiver 64 can be used to determine other variables, such as the speed of the inspection vehicle, which can be used for various purposes disclosed herein. Thus, the disclosed inspection system 30 can use data from the GPS receiver 64 to trigger the cameras 50 to capture a still image of the track bed at about every 0.1-inches along the rail.

5           [0047] In an alternative exemplary embodiment and as shown in Figure 1, the disclosed inspection system 30 can include a distance device 66 for obtaining geographical locations of the inspection vehicle when inspecting the rail. The distance device 66 can be an encoder that counts wheel revolutions or partial revolutions as the inspection vehicle moves along the rail or can be the existing odometer sensor on the inspection vehicle. The  
10 distance device 66 can provide location data to the processing device 60. Using the distance device 66, the disclosed inspection system 30 can trigger the cameras 50 to capture a still image of the track bed at about every 0.1-inches along the rail.

          [0048] In another exemplary embodiment, the disclosed inspection system 30 can capture still images of the track bed at or near the maximum frame rate of the cameras 50  
15 without being triggered by the GPS receiver 64 or distance device 66. For example, the cameras 50 and processing device 60 can operate at or near the maximum frame rate while the inspection vehicle travels along the track. Using the known average width of a crosstie 10 or tie plate 14, the disclosed inspection system 30 can calculate the velocity of the inspection vehicle. The disclosed system can then delete any extra frames to reduce data  
20 storage so that the retained frames would have an approximate spacing of 0.1-inch. It is understood that exact spacing of 0.1-inch may not always be possible, but the spacing will be known and may be between 0.05" and 0.1". In this embodiment, the same number of

frames must be discarded between each retained frame on a given tie so that frame spacing remains uniform. For example, if the tie plates are known to be 8-inches wide and 244 frames are captured for a specific tie plate, then two frames can be discarded between each retained frame. If the entire set of frames were numbered 1 through 244, then the retained frames would be those numbered: 1, 4, 7, 10, ... 241, 244. The retained 82 frames would have a calculated spacing of 0.098-inch.

[0049] Alternatively, the disclosed system could interpolate between any two captured frames to create a new third frame at any desired location along the track. Some frames could then be discarded to achieve the exact frame spacing desired.

[0050] After the disclosed inspection system 30 completes a survey of railroad track, computer analysis of the image data is performed. The computer analysis can be performed by the processing device or computer 60 located in the inspection vehicle. Alternatively, the computer analysis can be performed by another computer system having image processing software known in the art. The computer analysis searches the image data and determines or detects locations along the track where defects occur or where allowable tolerances of the railroad track are not maintained. For a particular implementation, the computer analysis can be customized or changed. The geographic locations of defects or unallowable tolerances can be provided so that appropriate repairs can be made or maintenance work can be scheduled.

[0051] A number of measurable aspects of the railroad track can be determined or detected from the image data of the track bed obtained with the disclosed inspection system and associated methods. In examples that follow, a number of such measurable

aspects are discussed, and various techniques for analyzing the measurable aspects are disclosed. It will be appreciated that these and other measurable aspects of the railroad track can be determined or detected from the image data of the track bed obtained with the disclosed inspection system. In addition, it will be appreciated that other techniques  
5 known in the art for analyzing the image data can be used with the disclosed inspection system and associated methods, and that surfaces other than railroad components may be inspected. Accordingly, the disclosed inspection system and associated methods are not intended to be limited to railroad inspection or the measurable aspects and particular techniques described herein.

10 [0052] For clarity, Figures 11 and 12 illustrate example compilations of image data obtained with the disclosed inspection system and associated methods. Figure 11 has a plurality of compiled image data showing a portion of a crosstie, tie plate, and rail in a perspective view. Figure 12 has a plurality of compiled image data showing a more detailed perspective view. As can be seen in Figures 11-12, the compiled image data  
15 forms a three-dimensional representation (X, Y, and Z) of the area of the track bed. The representation has substantial detail, and various aspects of the components of the track bed can be measured. In Figures 11-12, for example, cracks or splits in the crosstie 10 are visible. Also, the height of the crosstie 10 with respect to the ballast layer 18 is visible. The orientation and heights of the tie plate 14 and rail 12 are visible. These and other  
20 details can be obtained with the disclosed inspection system and associated methods as described in more detail below.

[0053] In one example, the spacing between crossties can be determined from the plurality of image data. Referring to Figures 4A-4C, example frames of the track bed obtained with the disclosed inspection system 30 are illustrated that can be used to determine the spacing between the crossties 10. Figure 4A shows an end frame F1 having a contour of a first crosstie 10 that is at position Z1 along the track. This end frame F1 may designate the last frame showing this crosstie 10. Figure 4B shows an intermediate frame F2 captured some time after the end frame F1 and at a further position Z2 along the track. This intermediate frame F2 lacks a crosstie because it designates a location between crossties of the track. It is understood that a plurality of such intermediate frames will follow the end frame F1 of Figure 4A. Figure 4C shows an end frame F3 having another crosstie 10' that is at further position Z3 along the track. Computer analysis can determine the spacing between crossties 10 and 10' by, for example, first counting the number of such intermediate frames F2 lacking a crosstie. This number of intermediate frames F2 can then be multiplied by the known spacing between frames (*e.g.*, 0.1-inch) to calculate the distance between crossties 10 and 10'. In this way, a substantially accurate measurement between crossties of the track bed can be obtained without the need for a track inspector to physically inspect the crossties. Instead, the image data that forms the three-dimensional scan of the track bed is used.

[0054] Determining whether a frame has a crosstie or not can be performed by imaging techniques known in the art. For example and as shown in Figure 4A-4C, the contour of a crosstie 10 is expected in a region of interest R of the frames F1-F3. Computer analysis can search the region of interest R of a frame for pixels indicating the

presence of a crosstie. This can be done, for example, by averaging or summing the value of pixels in the region of interest R. Because the contour of the crosstie is composed of dark pixels, the region of interest R in a frame F1 having a crosstie 10 will have a greater average or sum than the region R in an intermediate frame F2 lacking a crosstie.

5            [0055] In another example, the angles of the crossties with respect to the rail can be determined from the image data. Referring to Figure 5, an example frame of railroad track obtained with the disclosed inspection system is illustrated. The angular orientation of the heads of the rails 12 can be represented by a line L1. The line L1 can be estimated, for example, by best fit or curve fitting techniques known in the art. Similarly, the angular  
10 orientation of the crosstie 10 can be represented by a line L2. The line L2 can also be estimated, for example, by best fit or curve fitting techniques known in the art. These lines L1 and L2 can be averaged from several of the frames along the Z-axis near the crosstie 10. Computer analysis can then determine the angular relation between these lines L1-L2 to determine the angles of the ties with respect to rail. This condition would indicate either  
15 worn rail or a plate cut condition on a wooden crosstie.

          [0056] In another example, a break in the rail can be determined from the image data. Referring to Figures 6A-6C, example frames F1-F3 of railroad track obtained with the disclosed inspection system are illustrated that can be used to determine the separation of rail 12. Figure 6A shows an end frame F1 having an end of a first rail 12 that is at  
20 position Z1 along the track. This end frame F1 designates the last frame showing this rail 12. Figure 6B shows an intermediate frame F2 captured some time after the end frame F1 and at a further position Z2 along the track. This intermediate frame F2 lacks a rail

because it represents a location between rails of the track. It is understood that a plurality of such intermediate frames F2 may follow the end frame F1 of Figure 6A. Figure 6C shows another end frame F3 having another rail 12' that is at further position Z3 along the track. Computer analysis can determine the spacing between the rails 12 and 12', for example, by first counting the number of intermediate frames F2 lacking a rail. This number of intermediate frames F2 can then be multiplied by the known spacing between frames (e.g., 0.1-inch) to calculate the distance between the rails 12 and 12'.

[0057] Determining whether a frame has a rail 12 or not can be performed by imaging techniques known in the art. For example and as shown in Figure 6A-6C, the contour of a rail 12 is expected in a region of interest R of the frames F1-F3. Computer analysis can search the region of interest R of a frame for pixels indicating the presence of a rail contour. This can be done by averaging or summing the value of pixels in the region of interest, for example. Because the contour of the rail is composed of dark pixels, the region of interest R in a frame F1 having a rail 12 will have a greater average or sum than the region R in a frame F2 lacking a cross tie.

[0058] In another example, the wear of the rails can be determined from the image data. Referring to Figures 7A-7B, example frames F1-F2, of railroad track obtained with the disclosed inspection system, are illustrated and can be used to determine wear of the rail 12. Computer analysis can determine if a rail 12 has wear, for example, by determining whether the distance between the contour of the rail 12 and a reference point in a frame is less than the same distance in a prior frame. Figure 7A shows a frame F1 having rail 12 that is at a position Z1 along the track. The contour of the rail 12 lies within

a region of interest R and at a level L along the Y-axis of the frame F1. The contour of rail 12 is above a reference level L2, which may be the height of a tie plate, a measurable distance LD. As would be apparent to one of ordinary skill in the art having benefit of this disclosure, reference L2 may be located at a number of reference points such as tie plates 14, spikes 16, or crossties 10, for example. Figure 7B shows another frame F2 at another position Z2 along the track. At position Z2, the distance LD is less between the contour of the rail 12 and level L2 than at position Z1. Thus, frame F2 may indicate wear of the rail 12 at the position Z2 along the track. As would be apparent to one of ordinary skill in the art having benefit of this disclosure, rail wear could also be determined comparing frames taken at different times, but at the same position along a track bed.

[0059] In another example, the defects in the crossties 10 can be determined from the image data. As shown in Figure 8, an example frame of railroad track obtained with the disclosed inspection system is shown. Defects D and D' are shown in the crosstie 10. Computer analysis can detect if the crosstie 10 has a defect, for example, by determining whether portions D of the contour of the cross tie lie outside a region of interest R or whether portions D' of the contour are absent within the region R. As is known, defects in a crosstie can include cracks, splits, or breaks in the ties. Using the plurality of image data near such a defect, computer analysis can determine the width and length of the defect. For example and as seen in Figures 11-12, the plurality of image data can be used to estimate the width W and length L of the crack shown in the edge of the crosstie. In some instances, the computer analysis can determine the depth of the defect, for example, when the orientation of the defect allows light from the laser to be projected within the defect

and to be captured by the camera. In one embodiment, the angle between the laser and the camera can be relatively small so that the light projecting into a recessed defect can still be captured by the camera positioned almost parallel to the beam of laser light.

[0060] In another example, the spacing or gage of the rail or length of the crossties can be determined from the image data. In Figure 8, an edge detecting technique known in the art can be used to find edges of the rail contours 12 in the frame, and the distance W1 between the edges can be calculated to estimate the spacing of the rails 12. Similarly, an edge detecting technique known in the art can be used to find edges of the crosstie contour 10 in the frame, and the distance W1 between the edges can be calculated to estimate the width W2 of the crosstie 10.

[0061] In another example, the height of ballast 18 relative to the crosstie 10 can be determined from the image data. In Figure 8, a line fitting technique can determine the level of the ballast 18 and the level of the crosstie 10, and the difference between these levels can estimate the height  $H_B$  of the ballast 18 relative to the crosstie 10. In another example, the scans of the railroad track can be used to determine the size of stones in the ballast 18. This can be done by analyzing a region of interest having ballast 18 and estimating sizes of the ballast stone using curvatures in the contour of the ballast 18.

[0062] In another example, raised spikes can be detected from the image data. Referring to Figure 9, an example frame of railroad track obtained with the disclosed inspection system is illustrated. To determine whether there is a raised spike, a region of interest R can be analyzed to determine whether a portion of the contour representing a raised spike 16 occur within the region R.

[0063] In other examples, missing tie plates, misaligned tie plates, or sunken tie plates can be detected from the image data. Referring to Figure 10, an example frame of railroad track obtained with the disclosed inspection system is illustrated. The missing or sunken tie plate can be detected, for example, by analyzing a region of interest R and  
5 determining whether a portion of the contour representing a tie plate occurs or does not occur within the region R. A misaligned tie plate can be determined by line fitting the portion of the contour of the tie plate and comparing the orientation of the line to that of the crosstie, for example.

[0064] In regards to Figure 13, an alternative exemplary embodiment of inspection  
10 system 30 will now be described. In this embodiment, inspection system 30 may be constructed and operated in the same way as described in relation to the previous embodiments. However, in this embodiment, the present invention has been adapted to allow more efficient daylight operation. Inspection system 30 utilizes three line-generating lasers 40 mounted above the surface to be inspected. Center laser 40 is mounted in the  
15 center of framework 32 and scans the surface area within its angular spread  $\beta$ , while the outer two lasers 40 scan the outer periphery of the inspected surface within their angular spread  $\beta$ . If, for example, a railroad track were being inspected, center laser 40 could scan the full 9-foot tie, while the outer lasers would scan the rails.

[0065] In this exemplary embodiment, the two outer lasers 40 are each tilted  
20 outwardly away from the center laser at an approximate angle  $\gamma$  of 10 degrees. The two outer lasers 40 are tilted in this embodiment in order to allow the inspection system 30 to be stowed into a truck bed, for example, while still being capable of scanning a 9 foot tie

of a railroad track bed. By tilting lasers 40 outward, the present invention achieves the scanning width required to inspect the ties, while still physically fitting within the trucks limit. However, since the present invention can also be used to inspect other surfaces, the two outer lasers 40 may not be tilted whatsoever dependent upon the practical requirements of that application.

[0066] Further referring to the exemplary embodiment of Figure 13, lasers 40 are 7-watts lasers, each having a 45 degree angular spread  $\beta$ . However, angular spread  $\beta$  could be more or less depending upon the distance between lasers 40 and the inspected surface as understood by those skilled in the art having the benefit of this disclosure. The intensity of the laser line L (i.e., laser beam L) projected by lasers 40 onto the inspected surface is at least 0.15 watts per inch of the width of laser line L projected onto the surface. In the most preferred embodiment, the intensity is 0.18 watts per inch of the width of laser line L projected onto the surface. The number of lasers 40 utilized may be more or less than three, as long as the number utilized can provide the necessary wattage per inch of laser line L. Accordingly, those ordinarily skilled in this art having the benefit of this disclosure realize there are a variety of laser combinations which could provide this minimum wattage.

[0067] Further referring to the exemplary embodiment of Figure 13, the combined use of the three lasers 40 provides a higher light intensity, thereby producing a line of light at a specific wavelength which is more intense than the solar radiation at that same wavelength. In this exemplary embodiment, lasers 40 are each 808nm +/- 2nm wavelength lasers as understood in the art. This choice of laser wavelength corresponds to a dip in the

solar spectrum at approximately 808nm caused by the sunlight penetrating the earth's atmosphere, as illustrated in the graph of Figure 16. Here, the solar spectrum is shown at sea level ranging from roughly 400nm to above 2400nm, which includes UV, visible and infrared wavelengths. At approximately 808nm, there is a sharp dip in sun's solar energy.

5 Thus, the 808nm lasers utilized in the present invention were specifically chosen because their wavelengths at approximately 808nm are more intense than the solar radiation at the same wavelength, thereby allowing their radiated light to be detected in sunlight via cameras 50. Those ordinarily skilled in the art having the benefit of this disclosure realize other laser wavelengths may be utilized to take advantage of other dips in solar radiation,  
10 in accordance with the present invention.

[0068] Referring to Figures 14 and 15, an exemplary alternative embodiment of cameras 50 of the present invention will now be described. As previously discussed, cameras 50 are mounted to framework 32 and send image data of the inspected surface (in this example, a railroad track) to the processing device or computer 60 via wired or  
15 wireless transmission lines. However, in this exemplary embodiment, cameras 50 each include a housing 70 having a lens 72. Within housing 70 is a charge coupled device 74, or CCD, which is an analog shift register that enables transmission of analog signals through successive stages controlled by a clock signal. CCD 74 can be used as a form of memory or for delaying samples of analog signals, as understood in the art. In the  
20 alternative, however, a CMOS sensor as understood in the art may be utilized to capture images as well. Those ordinarily skilled in the art having the benefit of this disclosure realize there are a variety of cameras which may be utilized with the present invention.

[0069] As illustrated in Figure 15, CCD 74 is placed adjacent an optical bandpass filter 76. In this exemplary embodiment, bandpass filter 76 was chosen to pass a band of the laser 40's wavelength -2nm and +1nm, while filtering at least OD4 for the remainder of camera 50's response range from 300nm to 1100nm, excluding the ramp-up and ramp-down areas that exist near the band pass region as understood by those ordinarily skilled in the art having the benefit of this disclosure. Therefore, by utilizing 808nm lasers, bandpass filter 76 passes a wavelength approximately 806-810nm, while filtering out the remaining solar radiation. Since there is a dip in the sun's radiation at this wavelength, the line generated by lasers 40 is readily detectable in the sunlight.

[0070] In order to reduce the blue shift associated with light passing through a filter at an angle, bandpass filter 76 is mounted between lens 72 and CCD 74. Typically, when light passes through a filter at extreme angles, in order to get the same wavelength of light at many different angles, you must have a filter with a wide passband. If a filter were placed on the exterior of the lens, light would come in at an extreme angle. However, by moving the filter behind the lens, the light is much more parallel and the blue shift effect is dramatically decreased. This reduction in the blue shift results in a much tighter filter bandpass, which is necessary to filter out as much solar radiation as possible. Accordingly, bandpass filter 76 is mounted behind lens 72.

[0071] A spacer 78 is positioned on the other side of bandpass filter 76 opposite CCD 74. Spacer 76 comprises an opening 80 which allows image data to be collected from lens 72. In this embodiment, bandpass filter 76 screens out as much nonlaser-generated light as possible, thereby enabling daytime inspection. Also, this embodiment

results in a slight increase in focal length due to the light passing through filter 76. This phenomenon is compensated for by mounting CCD 74 slightly further from lens 72 via the use of spacer 78 located between lens 72 and camera housing 70. Spacer 78 changes the orientation of the lens 72 relative to CCD 74. Spacer 78 may be, for example, a precision shim washer. In the alternative, however, spacer 78 would not be necessary in embodiments utilizing a camera lens which has a sufficiently wide focusing range. Accordingly, those ordinarily skilled in the art having the benefit of this disclosure realize there are a variety of spacers which could be utilized with the present invention, and that the need for spacer 78 may be negated through lens choice.

[0072] In yet another exemplary embodiment of the present invention, rail seat abrasion may be predicted with a high level of accuracy. This embodiment utilizes the image data previously described and the application of algorithms that adjust for vehicle tilt. As inspection system 30 moves along the track, it may encounter curves or bends in the track which result in a suspension lean of the system 30 as it moves through the curve. This lean results in the railroad track itself leaning either to the left or right in the field of the cameras 50 view. The resulting measurement data is used to target which ties should be physically inspected for rail abrasion. However, the leaning, or tilt, must be taken into account when identifying ties to be inspected for rail seat abrasion, as will be described below.

[0073] The tilt phenomena is more clearly described in reference to the profile image depicted in Figure 17. Although this image would be three dimensional as previously described, it is illustrated here as a profile for simplicity. In this exemplary

embodiment, left and right rails 12 are illustrated laying atop concrete tie 10. Line L3 represents level ground. Although not shown, it is envisioned this section of the track is within a curve, and an inspection system of the present invention is moving along the track resulting in an angular tilt of cross ties 10 represented by line L4. As such, the track is tilting slightly to the left. In order to determine whether rail seat abrasion is present, height measurements of the each rail must be taken in accordance with the methods previously described. However, in this example, the height of right rail 12 would appear taller than left rail 12, resulting in skewed data measurements. Accordingly, during significant empirical and mathematical research for the present invention, a standard tilt correction factor of 0.12 was determined. This tilt correction factor is incorporated into algorithms of the present invention in order to adjust for tilt caused by variations in vehicle suspension, rail height placement standards, and other factors unrelated to rail seat abrasion.

[0074] In further reference to the exemplary embodiment of Figure 17 and the exemplary flow chart of Figure 18, a tilt correction algorithm for the present invention is now described. Based on the three-dimensional image data received from cameras 50 as previously described, at step 100, a measurement is taken of the rail base height of each rail, left ( $H^{L_{rail}}$ ) and right ( $H^{R_{rail}}$ ), as well as each tie, left ( $H^{L_{tie}}$ ) and right ( $H^{R_{tie}}$ ). The rail base and tie heights are the heights of the rails and ties relative to line L5, representing the top of the three-dimensional image. Once the dimensional images have been captured, the rail base heights and tie heights are determined based upon the vertical pixel count of  $H^{L_{rail}}$ ,  $H^{R_{rail}}$ ,  $H^{L_{tie}}$  and  $H^{R_{tie}}$ , which is then normalized based upon a 0-255 measurement index. In operation, the laser light reflected by the track structure that passes through the

camera lens is projected onto the camera CCD, as previously described. The dimensions of each CCD, in an exemplary embodiment, are 256 pixels by 1536 pixels. In this exemplary embodiment, there are two cameras placed roughly side by side. Accordingly, the total field of view for the two cameras combined has a field of view of 256 pixels by 3072 pixels – hence the 0-255 index. Those ordinarily skilled in the art having the benefit of this disclosure realized there are a variety of methods to determine the heights.

[0075] Thereafter, at step 102, inspection system 30 records the uncorrected  $H^{Lrail}$ ,  $H^{Rrail}$ ,  $H^{Ltie}$ , and  $H^{Rtie}$  height measurements of rails 12 and tie 10 based upon the pixel value of each. Then, at step 104, the processor of inspection system 30 derives the tilt correction factor (TC) based upon the following equation:

$$TC = (H^{Lrail} - H^{Rrail})(.12)$$

[0076] Thereafter, at step 106, the actual  $\Delta$  (i.e., the distance/difference between two points) is determined for both the right and left rail bases based upon the following equation:

$$\Delta^{leftRail} = (H^{Lrail} - H^{Ltie}) - TC$$

$$\Delta^{rightRail} = (H^{Rrail} - H^{Rtie}) + TC$$

The result is the actual  $\Delta$  between the rail base height and tie elevation for both the right and left rails. Please note the foregoing equations take into account the lean, or tilt, of the truck, whether left or right.

[0077] Then, at step 108, the rail seat abrasion value (“RSA”) for the right and left rail bases is determined based upon the following formula:

$$RSA^{Lrail} = (32/54) - (\Delta^{leftRail} / 50)$$

$$RSA^{Rail} = (32/54) - (\Delta^{rightRail} / 50)$$

The “32/54” is the expected  $\Delta$  between the rail base and tie elevation, signifying no rail seat abrasion. The “50” represents the rate of collection in height, 50 pixels per inch. Those ordinarily skilled in the art realize the 50 pixels inch rate of collection could vary  
5 based upon the geometry of the camera and laser setup.

[0078] Thereafter, at step 110, the RSA values are outputted in a form suitable for further analysis. At step 112, the next frame image is then analyzed and the algorithm begins again. The RSA data provides accurate measurements of rail seat abrasion and allows for effective, accurate identification of potential safety hazards and wear points  
10 requiring monitoring or corrective action to ensure track safety.

[0079] An exemplary system for determining rail seat abrasion of a rail road track comprises at least one light generator positioned adjacent the rail road track, the light generator adapted to project a beam of light across the rail road track; at least one camera positioned adjacent the rail road track for receiving at least a portion of the light reflected  
15 from the rail road track and for generating at least one image representative of a profile of at least a portion of the rail road track, and at least one processor adapted to perform the steps comprising: analyzing the at least one image; and determining whether rail seat abrasion is present along the rail road track, wherein, when determining whether rail seat abrasion is present, the at least one processor compensates for a tilt of the rail road track.

20 [0080] In other exemplary embodiments, the processor compensates for the tilt of the rail road track by the steps comprising: determining a height of a left rail base, right rail base, left crosstie and right crosstie; determining a tilt correction factor; determining an

actual delta for the right and left rail bases; and determining a rail seat abrasion value for the right and left rail bases. In yet another exemplary embodiment, the step of determining the heights further comprises the steps of: determining vertical pixel counts for each of the heights of the left rail base, right rail base, left crosstie and right crosstie; and normalizing the vertical pixel counts based upon a measurement index.

[0081] In other exemplary embodiments, the step of determining the tilt correction factor is accomplished based upon the left and right rail base heights and a standard tilt correction factor. In yet another exemplary embodiment, the step of determining the actual delta is accomplished based upon the tilt correction factor. Also, other embodiments provide for the step of determining the rail seat abrasion value to be accomplished based upon the actual delta.

[0082] Exemplary methods of the present invention provide a method for determining rail seat abrasion of a rail road track, the method comprising the steps of: determining a height of a left rail base, right rail base, left crosstie and right crosstie; recording the heights of the left rail base, right rail base, left crosstie and right crosstie; determining a tilt correction factor; determining an actual delta for the right and left rail bases; and determining a rail seat abrasion value for the right and left rail bases. Another exemplary method provides a method the step of determining the heights further comprises the steps of: determining vertical pixel counts for each of the heights of the left rail base, right rail base, left crosstie and right crosstie; and normalizing the vertical pixel counts based upon a measurement index.

[0083] Further exemplary methods provide methods wherein the step of determining the tilt correction factor is accomplished based upon the left and right rail base heights and a standard tilt correction factor. In other examples, the step of determining the actual delta is accomplished based upon the tilt correction factor. In other examples, the  
5 step of determining the rail seat abrasion is accomplished based upon the actual delta for the right and left rail bases.

[0084] In yet another exemplary method of the present invention, a method for determining rail seat abrasion of a rail road track is provided, the method comprising the steps of: moving an inspection system along the track; receiving image data corresponding  
10 to at least a portion of the track; determining a measurement of the rail seat abrasion for the portion of the track, wherein the measurement are adjusted for tilt encountered as the inspection system moves along the track; and determining whether rail seat abrasion exists based upon the adjusted measurement. In another exemplary method, the step of determining a measurement of the rail seat abrasion further comprises the steps of:  
15 determining a height of a left rail base, right rail base, left crosstie and right crosstie; determining a tilt correction factor; determining an actual delta for the right and left rail bases; and determining a rail seat abrasion value.

[0085] In other exemplary methods, the step of determining the heights further comprises the steps of: determining vertical pixel counts for each of the heights of the left  
20 rail base, right rail base, left crosstie and right crosstie; and normalizing the vertical pixel counts based upon a measurement index. In another exemplary method, the step of determining the tilt correction factor is accomplished based upon the left and right rail base

heights and a standard tilt correction factor. In yet another method, the step of determining the actual delta is accomplished based upon the tilt correction factor. In another method, the step of determining the rail seat abrasion value is accomplished based upon the actual delta.

5           [0086] Although various embodiments have been shown and described, the present invention is not so limited and will be understood to include all such modifications and variations as would be apparent to one skilled in the art. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents.

## **CLAIMS**

WE CLAIM:

1. A system for determining rail seat abrasion of a rail road track, the system  
5 comprising:

at least one light generator positioned adjacent the rail road track, the light  
generator adapted to project a beam of light across the rail road track;

at least one camera positioned adjacent the rail road track for receiving at least a  
portion of the light reflected from the rail road track and for generating at  
10 least one image representative of a profile of at least a portion of the rail  
road track, and

at least one processor adapted to perform the steps comprising:

analyzing the at least one image; and

determining whether rail seat abrasion is present along the rail road track,

15 wherein, when determining whether rail seat abrasion is present, the at least one  
processor compensates for a tilt of the rail road track.

2. A system as defined in claim 1, wherein the processor compensates for the tilt of  
the rail road track by the steps comprising:

20 determining a height of a left rail base, right rail base, left crosstie and right  
crosstie;

determining a tilt correction factor;

determining an actual delta for the right and left rail bases; and  
determining a rail seat abrasion value for the right and left rail bases.

3. A system as defined in claim 2, wherein the step of determining the heights further  
5 comprises the steps of:

determining vertical pixel counts for each of the heights of the left rail base, right  
rail base, left crosstie and right crosstie; and  
normalizing the vertical pixel counts based upon a measurement index.

10 4. A system as defined in claim 2, wherein the step of determining the tilt correction  
factor is accomplished based upon the left and right rail base heights and a standard tilt  
correction factor.

5. A system as defined in claim 2, wherein the step of determining the actual delta is  
15 accomplished based upon the tilt correction factor.

6. A system as defined in claim 2, wherein the step of determining the rail seat  
abrasion value is accomplished based upon the actual delta.

20

7. A method for determining rail seat abrasion of a rail road track, the method comprising the steps of:

- (a) determining a height of a left rail base, right rail base, left crosstie and right crosstie;
- 5 (b) recording the heights of the left rail base, right rail base, left crosstie and right crosstie;
- (c) determining a tilt correction factor;
- (d) determining an actual delta for the right and left rail bases; and
- (e) determining a rail seat abrasion value for the right and left rail bases.

10

8. A method as defined in claim 7, wherein step (a) further comprises the steps of:  
determining vertical pixel counts for each of the heights of the left rail base, right  
rail base, left crosstie and right crosstie; and  
normalizing the vertical pixel counts based upon a measurement index.

15

9. A method as defined in claim 7, wherein the step (c) is accomplished based upon the left and right rail base heights and a standard tilt correction factor.

10. A method as defined in claim 7, wherein step (d) is accomplished based upon the  
20 tilt correction factor.

11. A method as defined in claim 7, wherein step (e) is accomplished based upon the actual delta for the right and left rail bases.

12. A method for determining rail seat abrasion of a rail road track, the method  
5 comprising the steps of:

- (a) moving an inspection system along the track;
- (b) receiving image data corresponding to at least a portion of the track;
- (c) determining a measurement of the rail seat abrasion for the portion of the  
10 track, wherein the measurement are adjusted for tilt encountered as the  
inspection system moves along the track; and
- (d) determining whether rail seat abrasion exists based upon the adjusted  
measurement.

13. A method as defined in claim 12, wherein step (c) further comprises the steps of:  
15 determining a height of a left rail base, right rail base, left crosstie and right  
crosstie;  
determining a tilt correction factor;  
determining an actual delta for the right and left rail bases; and  
determining a rail seat abrasion value.

14. A method as defined in claim 13, wherein the step of determining the heights  
further comprises the steps of:

determining vertical pixel counts for each of the heights of the left rail base, right rail base, left crosstie and right crosstie; and  
normalizing the vertical pixel counts based upon a measurement index.

5      15.      A method as defined in claim 13, wherein the step of determining the tilt correction factor is accomplished based upon the left and right rail base heights and a standard tilt correction factor.

16.      A method as defined in claim 13, wherein the step of determining the actual delta is  
10      accomplished based upon the tilt correction factor.

17.      A method as defined in claim 13, wherein the step of determining the rail seat abrasion value is accomplished based upon the actual delta.

15

## **ABSTRACT**

A system and method for determining rail seat abrasion of a rail road track is disclosed. An inspection system comprises lasers, cameras, and processors adapted to  
5 determine whether rail seat abrasion is present along the track. The processor employs a mathematics based algorithm which compensates for tilt encountered as the inspection system moves along the track.

10

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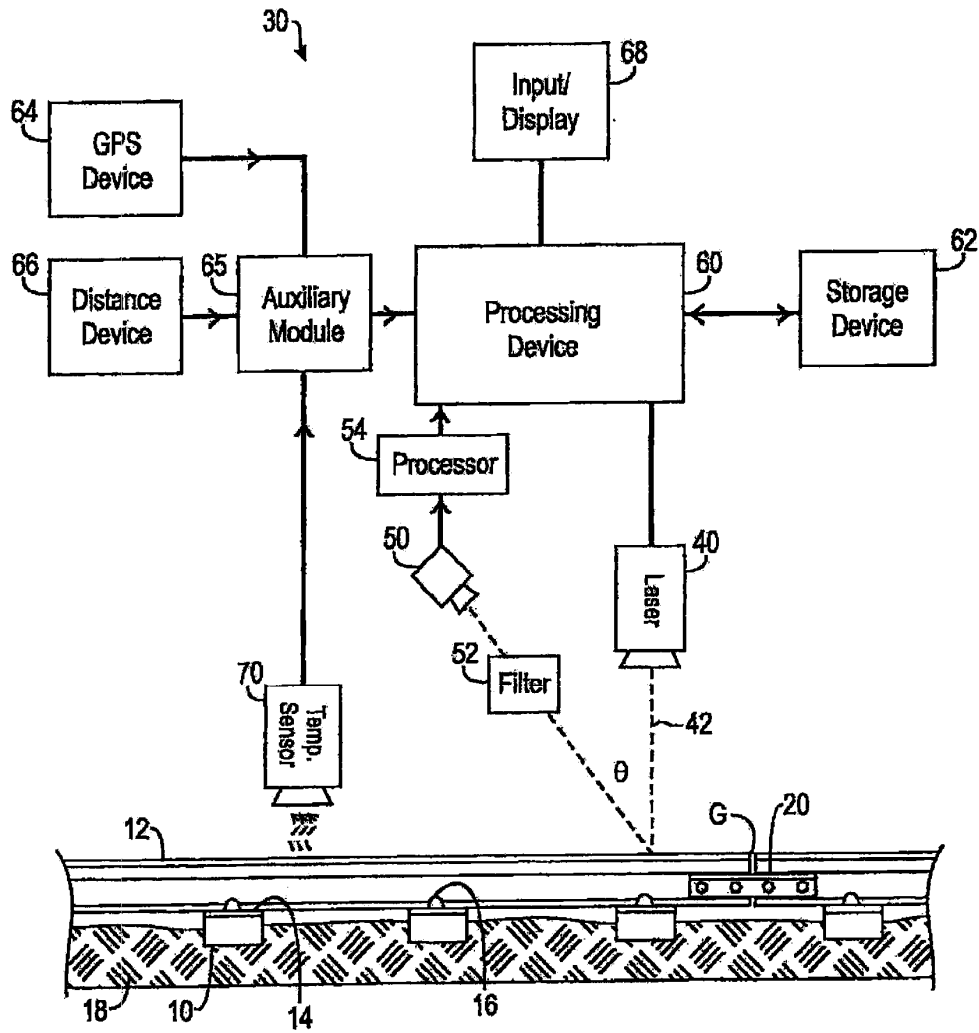
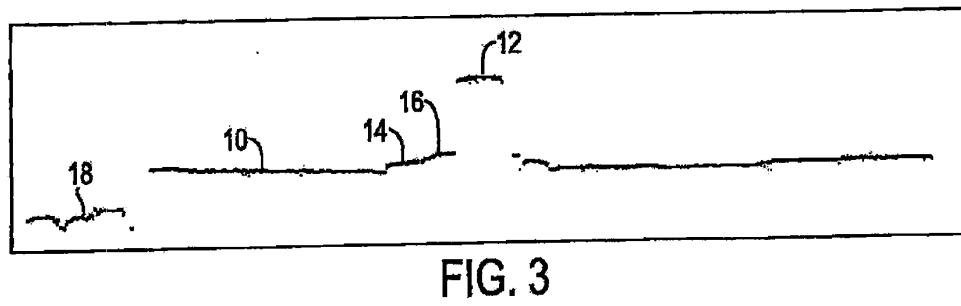
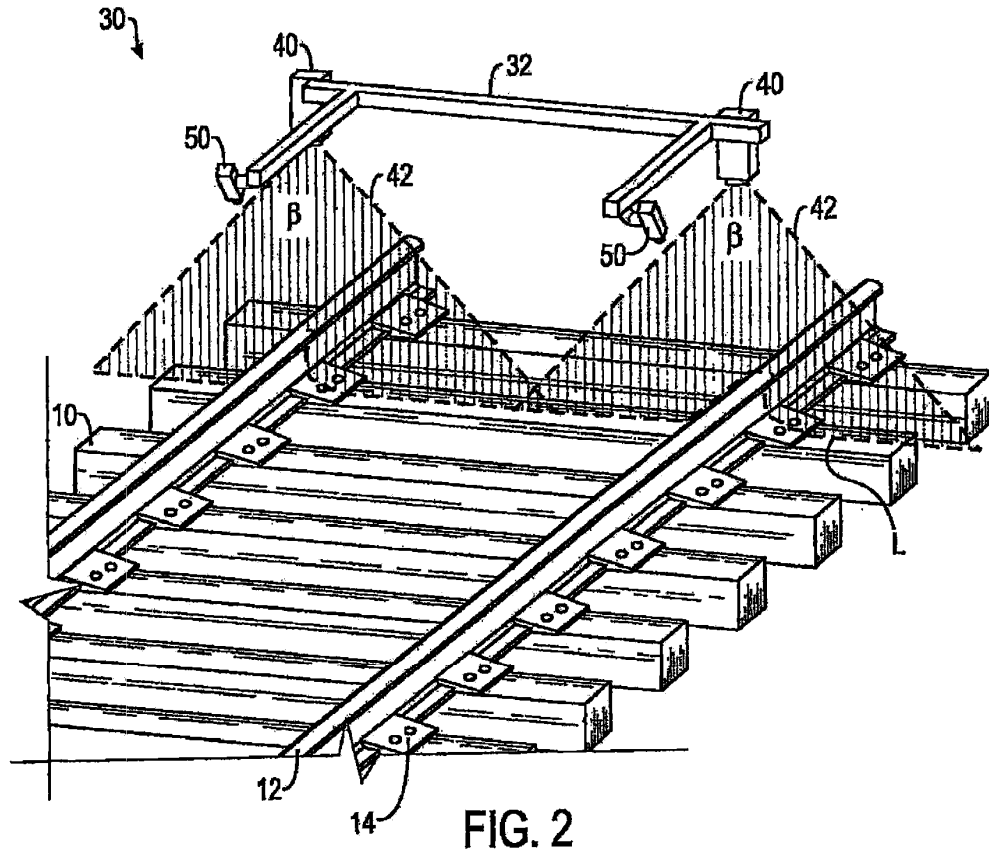


FIG. 1

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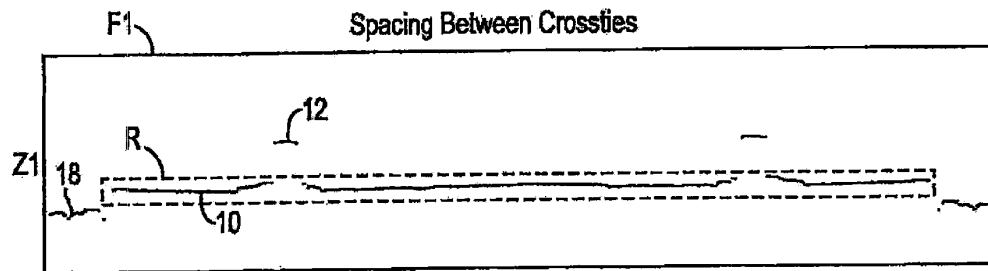


FIG. 4A

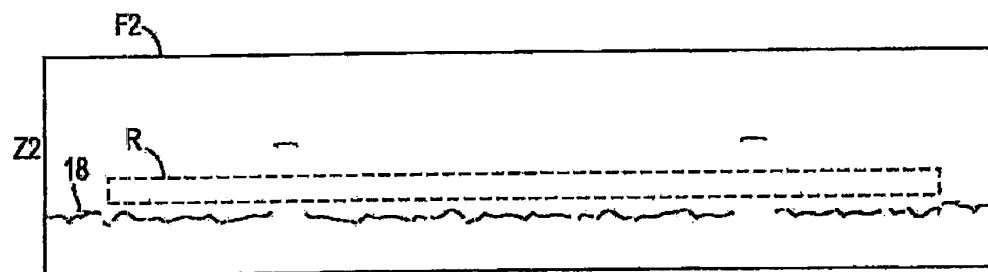


FIG. 4B

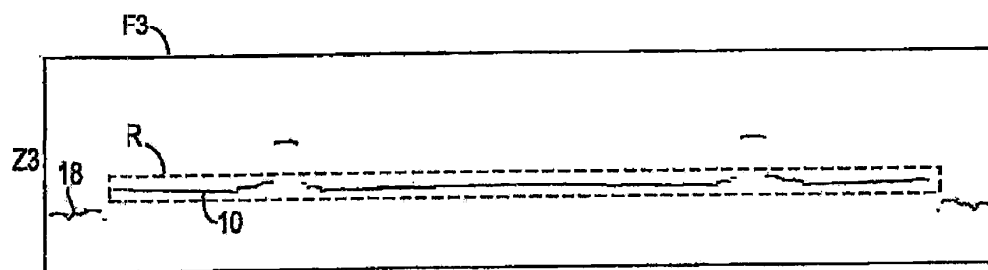


FIG. 4C

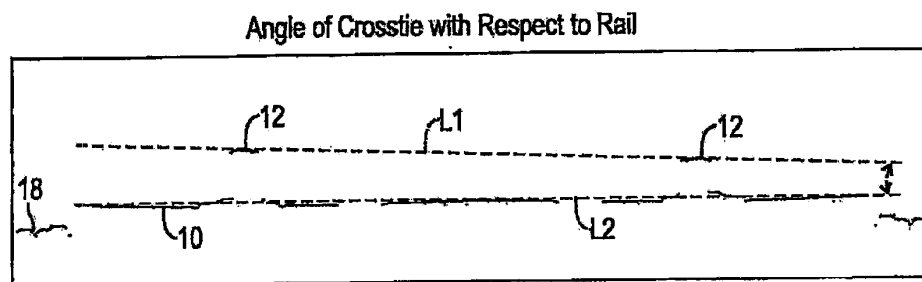


FIG. 5

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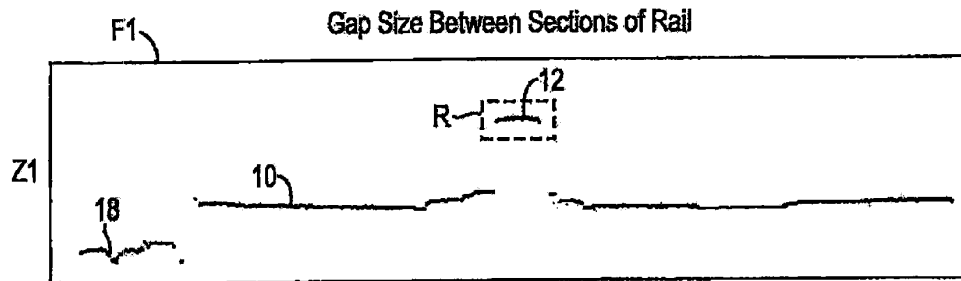


FIG. 6A

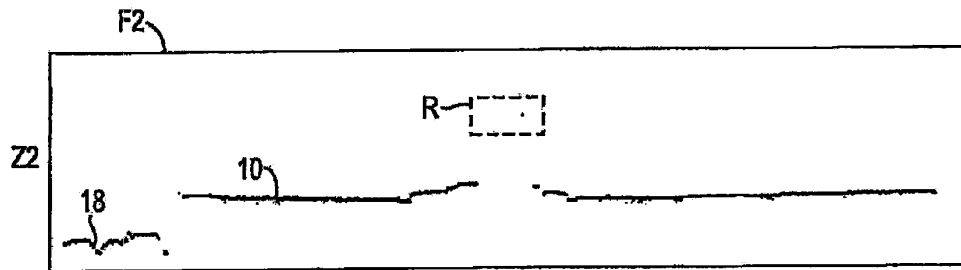


FIG. 6B

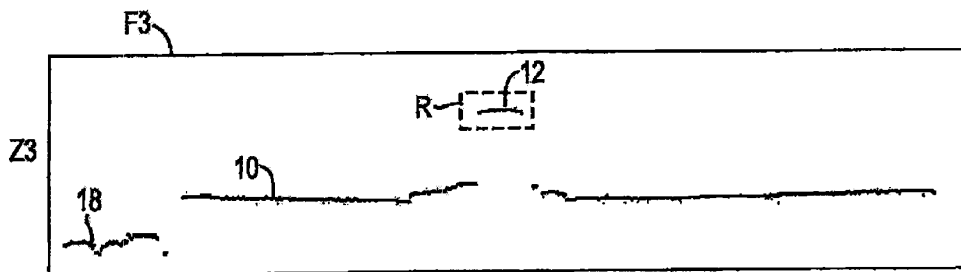
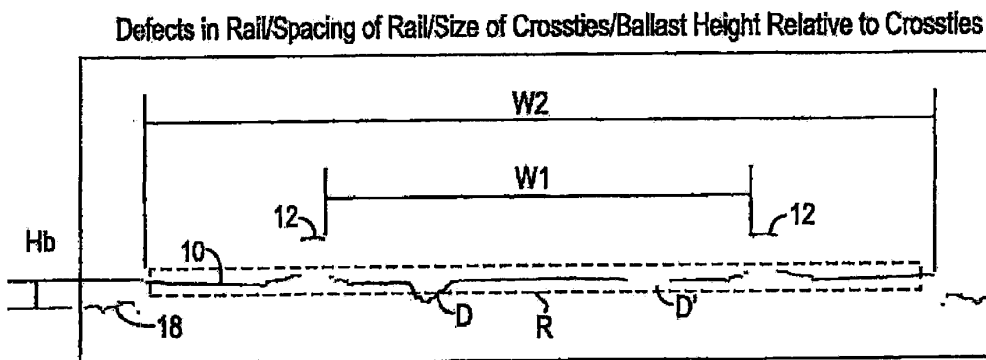
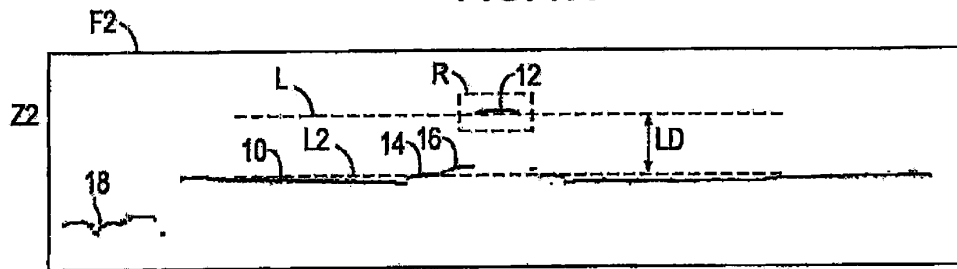
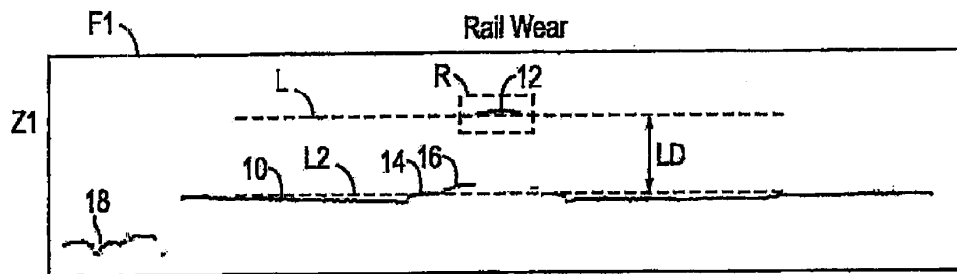


FIG. 6C

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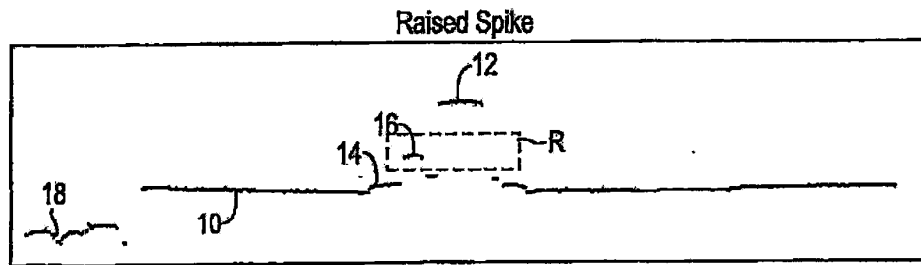


FIG. 9

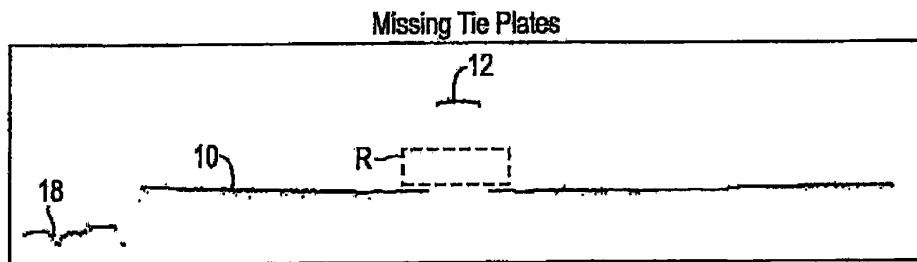


FIG. 10

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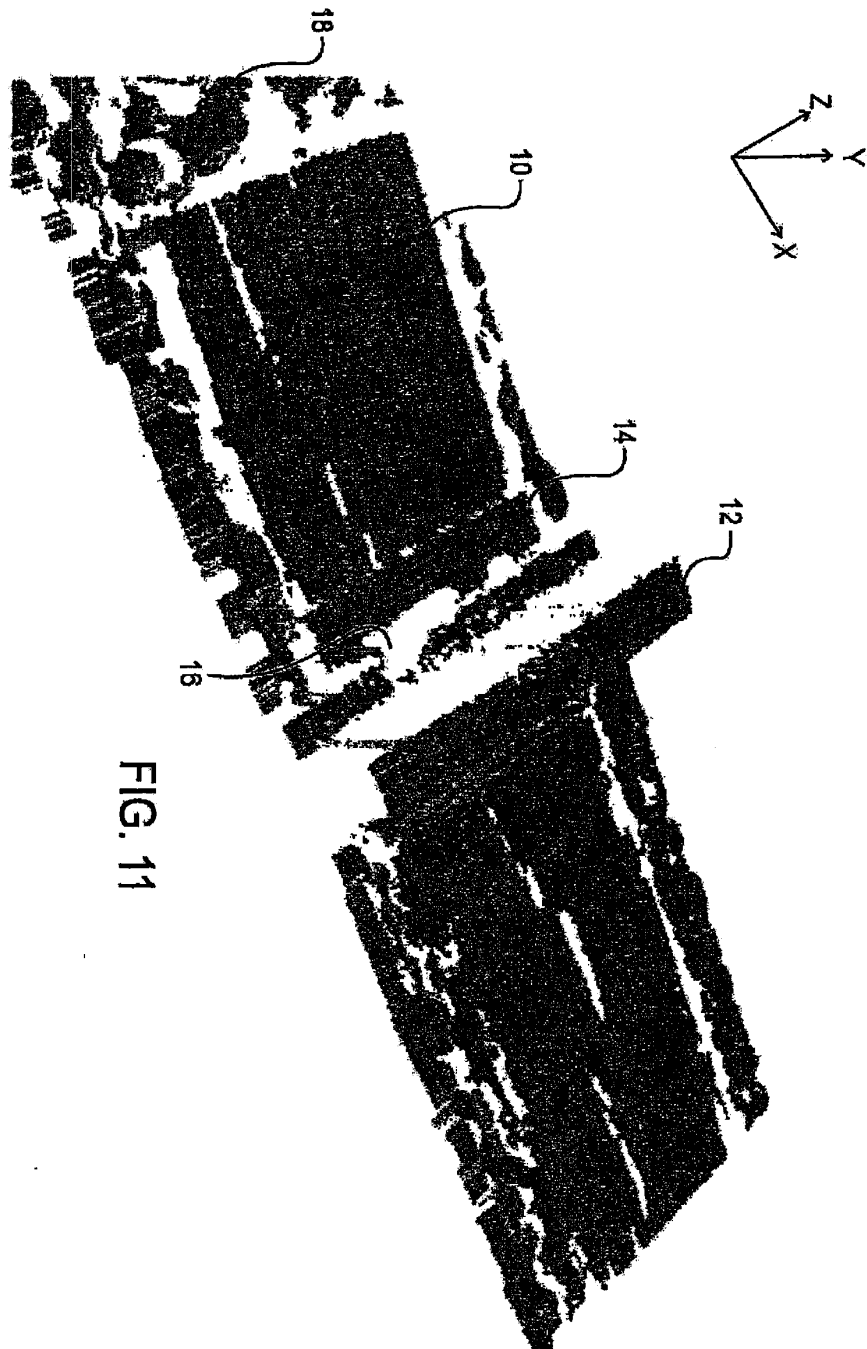
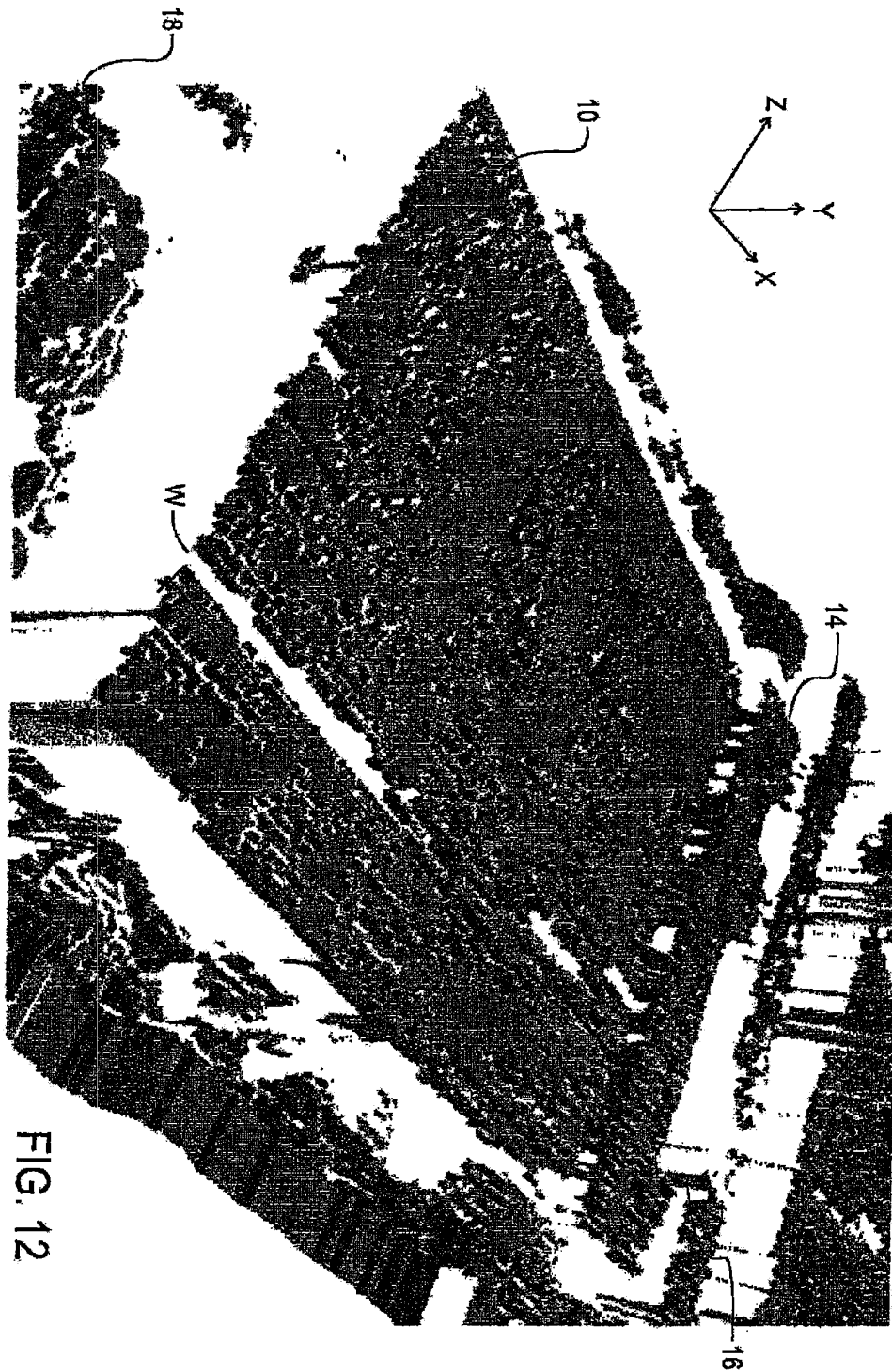
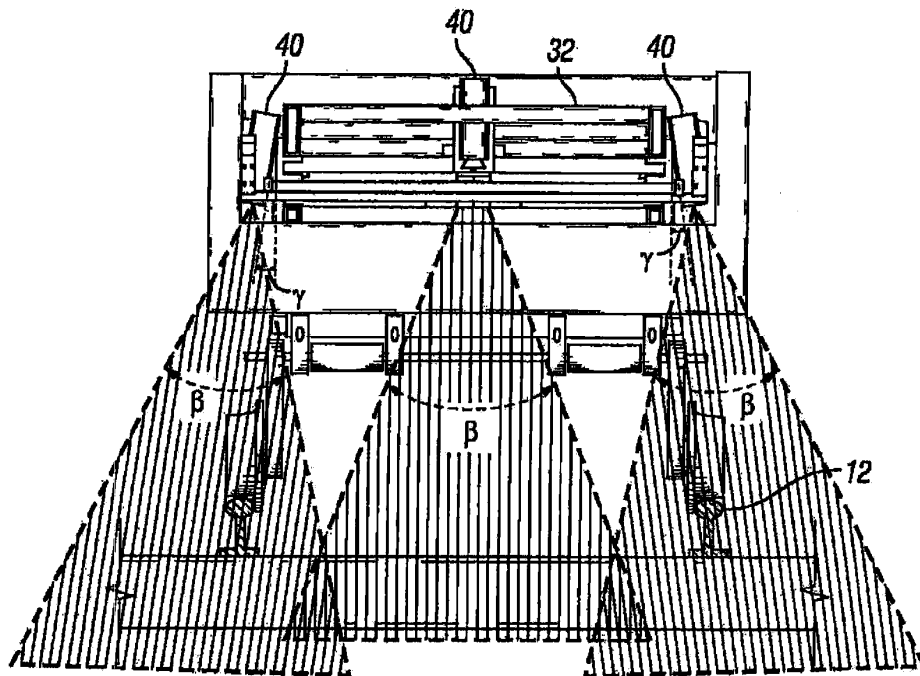


FIG. 11

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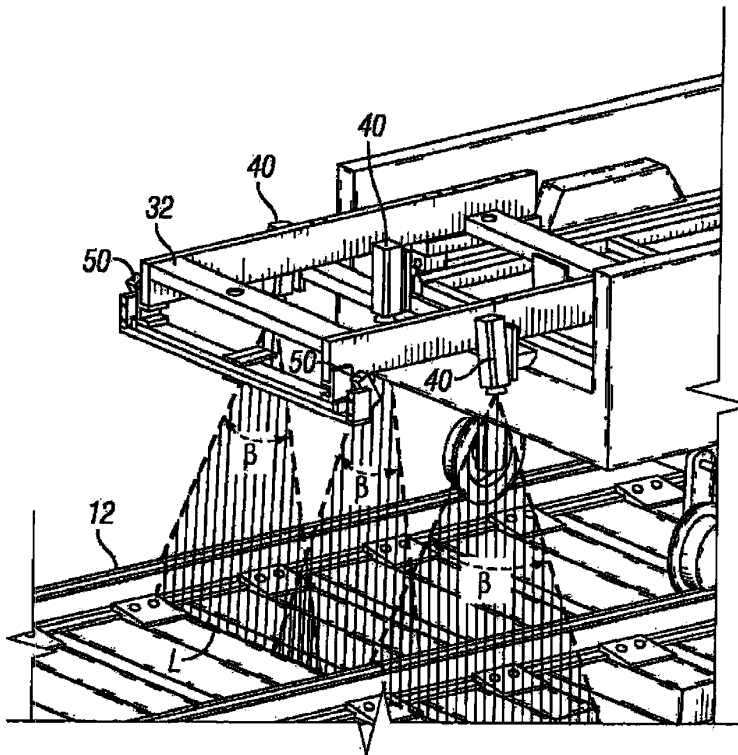


9/12



**FIG. 13**

10/12



**FIG. 14**

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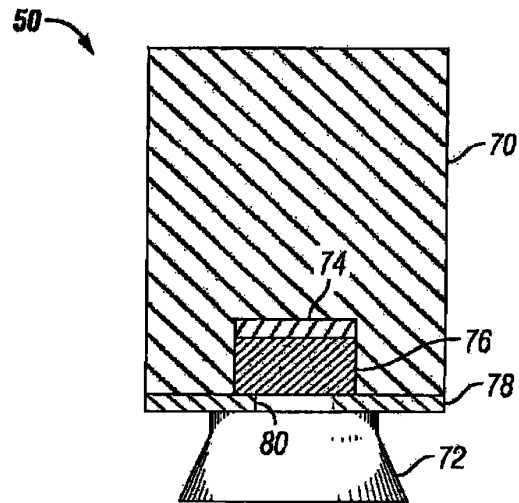


FIG. 15

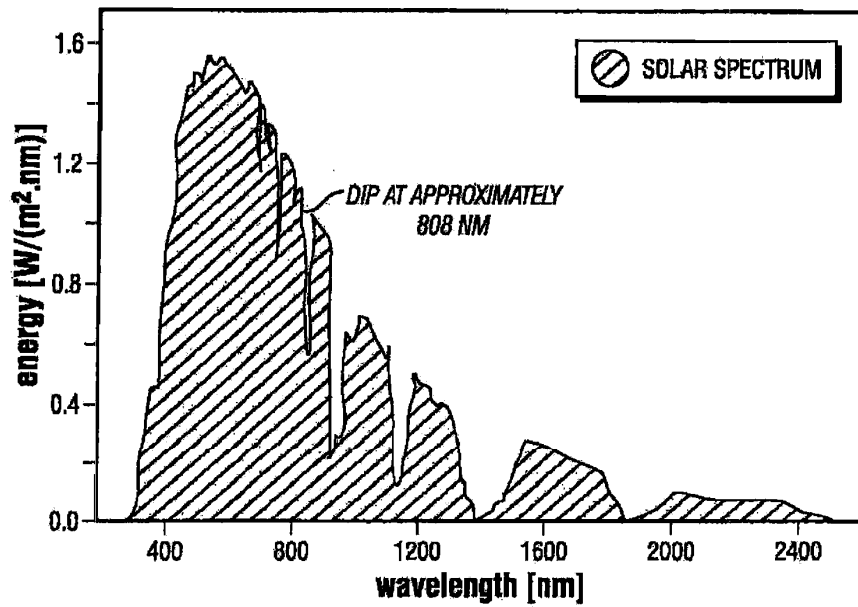


FIG. 16

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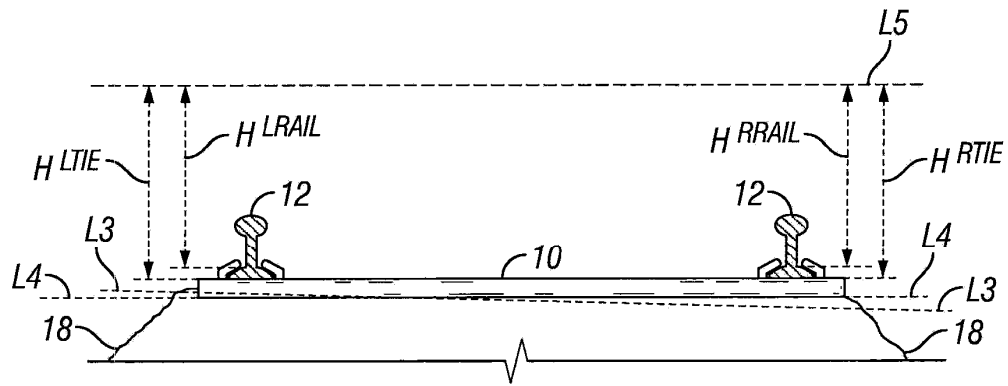


FIG. 17

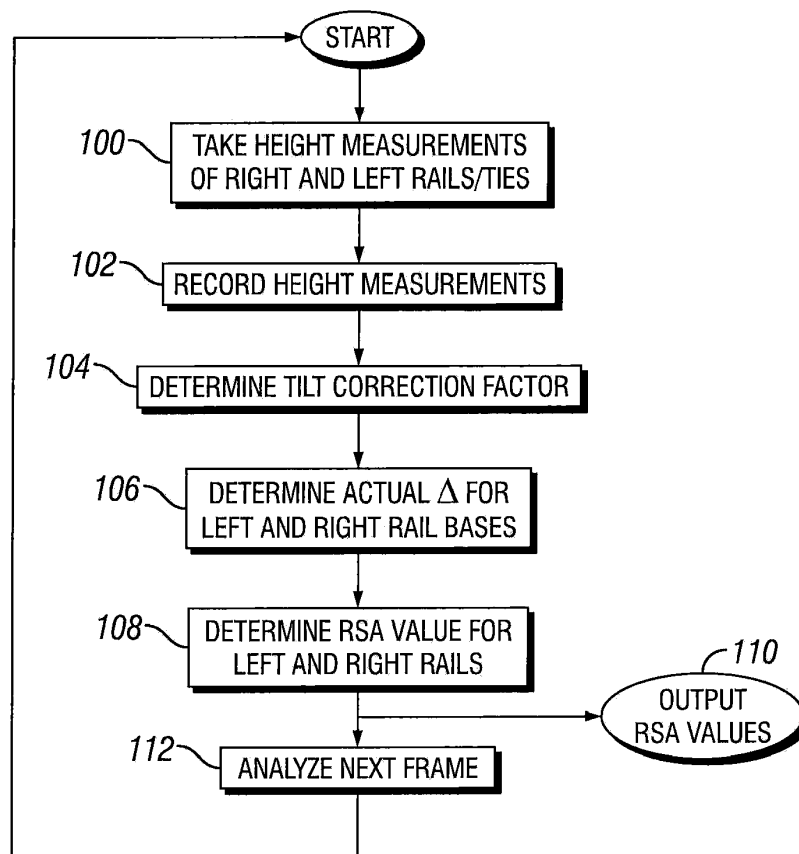


FIG. 18

<p><small>Effective on 12/08/2004. Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).</small></p> <p><b>FEE TRANSMITTAL For FY 2005</b></p> <p><input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27</p> <p><b>TOTAL AMOUNT OF PAYMENT</b> (\$) 462.00</p>	<p><b>Complete if Known</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Application Number</td><td>Unassigned</td></tr> <tr><td>Filing Date</td><td>Herewith</td></tr> <tr><td>First Named Inventor</td><td>Christopher M. Villar</td></tr> <tr><td>Examiner Name</td><td>Juan D. Valentin</td></tr> <tr><td>Art Unit</td><td>2877</td></tr> <tr><td>Attorney Docket No.</td><td>11042.0098.CPUS02</td></tr> </table>	Application Number	Unassigned	Filing Date	Herewith	First Named Inventor	Christopher M. Villar	Examiner Name	Juan D. Valentin	Art Unit	2877	Attorney Docket No.	11042.0098.CPUS02
Application Number	Unassigned												
Filing Date	Herewith												
First Named Inventor	Christopher M. Villar												
Examiner Name	Juan D. Valentin												
Art Unit	2877												
Attorney Docket No.	11042.0098.CPUS02												

**METHOD OF PAYMENT (check all that apply)**

- ☐ Check 
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 ☐ Money Order 
 ☐ None 
 ☐ Other (please identify): \_\_\_\_\_
- ☒ Deposit Account 
 Deposit Account Number: 08-3038 (11042.0098.CPUS02) 
 Deposit Account Name: Howrey LLP
- For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)
- ☒ Charge fee(s) indicated below 
 ☐ Charge fee(s) indicated below, except for the filing fee
- ☒ Charge any additional fee(s) or underpayments of fee(s) 
 ☒ Credit any overpayments
- under 37 CFR 1.16 and 1.17

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**FEE CALCULATION**

**1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	
Utility	330	165	540	270	220	110	\$462.00
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

**2. EXCESS CLAIM FEES**

**Fee Description**

Each claim over 20 (including Reissues)

Each independent claim over 3 (including Reissues)

Multiple dependent claims

Total Claims	Extra Claims	Fee (\$)	Fee Paid (\$)	Multiple Dependent Claims Fee (\$)	Fee Paid (\$)
17	- 20 or HP	0	X 26 = 0		

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims	Extra Claims	Fee (\$)	Fee Paid (\$)
3	- 3 or HP =	0	x 110 = \$0

**3. APPLICATION SIZE FEE**

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is \$260 (\$130 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).


Total Sheets Extra Sheets Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
55 - 100 = 0 / 50 = 0 (round up to a whole number) x \$0 =	\$0	\$0

**4. OTHER FEE(S)**

Non-English Specification,

Other (e.g., late filing surcharge):

**SUBMITTED BY**

Signature 	Registration No. (Attorney/Agent) 54,255	Telephone 713-787-1400
Name (Print/Type) Jade O. Lave	Date June 23, 2009	

Filing Date: 06/23/09

Approved for use through 7/31/2006. 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 <b>12/489,570</b>	
APPLICATION AS FILED – PART I						
(Column 1)			(Column 2)		SMALL ENTITY	
FOR			NUMBER FILED		NUMBER EXTRA	
BASIC FEE (37 CFR 1.16(a), (b), or (c))			N/A		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))			N/A		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))			N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))			17 minus 20 =		x\$26	
INDEPENDENT CLAIMS (37 CFR 1.16(h))			3 minus 3 = *		x\$110	
APPLICATION SIZE FEE (37 CFR 1.16(s))			If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$260 (\$130 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					195	
					TOTAL <b>462</b>	
* If the difference in column 1 is less than zero, enter "0" in column 2.						
APPLICATION AS AMENDED – PART II						
(Column 1)			(Column 2)		(Column 3)	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA	
	Total (37 CFR 1.16(i))	*	Minus	**	=	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	
	Application Size Fee (37 CFR 1.16(s))					
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
					TOTAL ADD'T FEE	
(Column 1)			(Column 2)		(Column 3)	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA	
	Total (37 CFR 1.16(i))	*	Minus	**	=	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	
	Application Size Fee (37 CFR 1.16(s))					
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
					TOTAL ADD'T 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 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.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/489,570	06/23/2009	Christopher M. Villar	11042.0098.CPUS02

**CONFIRMATION NO. 1864**

**FORMALITIES LETTER**

23369  
HOWREY LLP-HN  
C/O IP DOCKETING DEPARTMENT  
2941 FAIRVIEW PARK DRIVE, SUITE 200  
FALLS CHURCH, VA 22042-7195



Date Mailed: 07/07/2009

**NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION**

**FILED UNDER 37 CFR 1.53(b)**

***Filing Date Granted***

**Items Required To Avoid Abandonment:**

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.  
*A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.*  
*Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.*

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings submitted to the Office are not electronically reproducible because portions of figures 11,12 are missing and/or blurry.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of **\$65** for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this notice.

**SUMMARY OF FEES DUE:**

Total additional fee(s) required for this application is **\$65** for a small entity  
• **\$65** Surcharge.

Replies should be mailed to:

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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
12/489,570	06/23/2009	3617	462	11042.0098.CPUS02	17	3

CONFIRMATION NO. 1864

23369  
HOWREY LLP-HN  
C/O IP DOCKETING DEPARTMENT  
2941 FAIRVIEW PARK DRIVE, SUITE 200  
FALLS CHURCH, VA 22042-7195

## FILING RECEIPT



0000000036769046

Date Mailed: 07/07/2009

Receipt is acknowledged of this non-provisional 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 APPLICANT, 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 Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections 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**

### Applicant(s)

Christopher M. Villar, Residence Not Provided;

### Power of Attorney: None

### Domestic Priority data as claimed by applicant

This application is a CIP of 12/465,473 05/13/2009  
which is a CIP of 11/172,618 06/30/2005  
which claims benefit of 60/584,769 06/30/2004

### Foreign Applications

**If Required, Foreign Filing License Granted:** 07/01/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/489,570**

**Projected Publication Date:** To Be Determined - pending completion of Missing Parts

**Non-Publication Request:** No

**Early Publication Request:** No

**\*\* SMALL ENTITY \*\***

**Title**

Tilt Correction System and Method for Rail Seat Abrasion

**Preliminary Class**

238

**PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

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**Title 37, Code of Federal Regulations, 5.11 & 5.15**

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set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

#### **NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:	§	
Villar et al	§	
	§	
	§	Group Art Unit: N/A
Serial No.: 12/489,570	§	
	§	
Confirmation no.: 1864	§	Examiner: N/A
	§	
Filed: June 23, 2009	§	
	§	Docket No: 11042.0098.CPUS02
Title: <b><i>TILT CORRECTION SYSTEM</i></b>	§	
<b><i>AND METHOD FOR RAIL SEAT</i></b>	§	
<b><i>ABRASION</i></b>	§	
	§	

**RESPONSE TO JULY 7, 2009, NOTICE TO FILE MISSING PARTS**

**MAIL STOP MISSING PARTS**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In response to the Notice to File Missing Parts of the referenced application under 37 C.F.R. § 1.53(b), dated July 7, 2009, there are enclosed herewith:

- (a) Declaration executed by John Anthony Nagle, Christopher M. Villar, and Steven C. Orrell;
- (b) Power of Attorney executed by Christopher M. Villar; and
- (c) Replacement Figures 11 and 12.

The Commissioner is authorized to charge the fee of \$65.00 to deposit Account No. **08-3038/11042.0098.CPUS02/LAYE**. Should any additional fees under 37 C.F.R. §§ 1.16 to 1.21 be required for any reason relating to the enclosed materials, the Commissioner is authorized to deduct said fees from said Deposit Account.

Respectfully submitted,



JADE O. LAYE, E.S.Q.  
Reg. No. 54,255  
ATTORNEY FOR ASSIGNEE

**HOWREY LLP**  
2941 Fairview Park Drive, Box 7  
Falls Church, VA 22042  
Phone: (713) 787-1400  
Fax: (703) 336-6950

Date: 9-4-09

ASSIGNMENT

FOR GOOD AND VALUABLE CONSIDERATION, the receipt, sufficiency and adequacy of which are hereby acknowledged, the undersigned, do hereby:

SELL, ASSIGN AND TRANSFER to **Georgetown Rail Equipment Company** (the "Assignee"), having a place of business at 111 Cooperative Way, Suite 100, Georgetown, TX 78626, the entire right, title and interest for the United States and all foreign countries in and to any and all improvements which are disclosed in the application for United States Letters Patent, Serial No. **12/489,570**, which has been filed on **June 23, 2009** and is entitled "**TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION**", such application and all divisional, continuing, substitute, renewal, reissue and all other applications for patent which have been or shall be filed in the United States and all foreign countries on any of such improvements; all original and reissued patents which have been or shall be issued in the United States and all foreign countries on such improvements; and specifically including the right to file foreign applications under the provisions of any convention or treaty and claim priority based on such application in the United States;

AUTHORIZE AND REQUEST the issuing authority to issue any and all United States and foreign patents granted on such improvements to the Assignee;

WARRANT AND COVENANT that no assignment, grant, mortgage, license or other agreement affecting the rights and property herein conveyed has been or will be made to others by the undersigned, and that the full right to convey the same as herein expressed is possessed by the undersigned;

COVENANT, when requested and at the expense of the Assignee, to carry out in good faith the intent and purpose of this assignment, the undersigned will execute all divisional, continuing, substitute, renewal, reissue, and all other patent applications on any and all such improvements; execute all rightful oaths, declarations, assignments, powers of attorney and other papers; communicate to the Assignee all facts known to the undersigned relating to such improvements and the history thereof; and generally do everything possible which the Assignee shall consider desirable for vesting title to such improvements in the Assignee, and for securing, maintaining and enforcing proper patent protection for such improvements;

TO BE BINDING on the heirs, assigns, representatives and successors of the undersigned and extend to the successors, assigns and nominees of the Assignee.

IN WITNESS WHEREOF, executed by the undersigned on the date(s) opposite their name(s).

Signature:   
Name: Steven C. Orrell

Date: 8/24/09

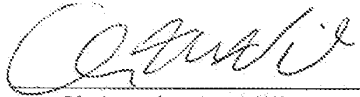
STATE OF Texas )  
 ) ss.  
COUNTY OF Williamson

BEFORE ME, the undersigned authority, on this 24<sup>th</sup> day of August, 2009, personally appeared Steven C. Orrell, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same of his own free will for the purposes and consideration therein expressed.

[SEAL]



Lara D. Hite  
Notary or Consular Officer

Signature:   
Name: Christopher M. Villar

Date: August 11, 2009

STATE OF Texas )  
 ) ss.  
COUNTY OF Williamson )

BEFORE ME, the undersigned authority, on this 11<sup>th</sup> day of August, 2009, personally appeared Christopher M. Villar, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same of his own free will for the purposes and consideration therein expressed.

[SEAL]



Lara D. Hite  
Notary or Consular Officer

Signature: \_\_\_\_\_

Name: John Anthony Nagle, II

Date: \_\_\_\_\_

8/20/2009

STATE OF

Texas

)

COUNTY OF

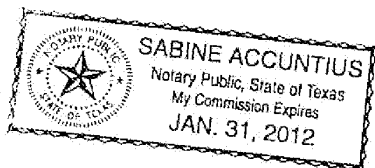
Williamson

)

ss.

BEFORE ME, the undersigned authority, on this 20 day of August, 2009, personally appeared John Anthony Nagle, II, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same of his own free will for the purposes and consideration therein expressed.

[SEAL]



Sabine Accuntius  
Notary or Consular Officer

DECLARATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or the below named inventors are the original, first and joint inventors (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION**, the Specification of which:

☐ is attached hereto.  
☒ was filed on June 23, 2009 as Application Serial No. 12/489,570.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent, United States provisional application(s), or inventor's certificate listed below and have also identified below any foreign application for patent, United States provisional application, or inventor's certificate having a filing date before that of the application on which priority is claimed:

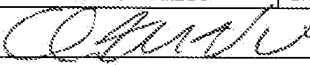
PRIORITY APPLICATION(S)			<u>Priority Claimed</u>
(Number)	(Country)	(Date Filed)	Yes/No

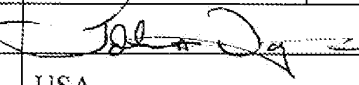
I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose all information known to me to be material to patentability of the subject matter claimed in this application, as "materiality" is defined in Title 37, Code of Federal Regulations, § 1.56, which become available between the filing date of the prior application and the national or PCT international filing date of this application:

12/465,473	05/13/2009	Pending
(Application Serial No.)	(Filing Date)	(Status)
(Application Serial No.)	(Filing Date)	(Status)

I hereby direct that all correspondence and telephone calls be addressed to JADE O. LAYE, Howrey LLP, 2941 Fairview Park Drive, Suite 200, Falls Church, Virginia 22042, (713) 787-1400.

I HEREBY DECLARE THAT ALL STATEMENTS MADE 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.

Inventor's Full Name:	CHRISTOPHER	M.	VILLAR
Inventor's Signature:			
Country of Citizenship:	USA	Date:	8-24-09
Residence Address: (street, number, city, state, and/or country)	301 Ranch Road 1869 Liberty Hill, TX 78642		
Post Office Address: (if different from above)			

Inventor's Full Name:	JOHN	ANTHONY	NAGLE, II
Inventor's Signature:			
Country of Citizenship:	USA	Date:	8/20/2009
Residence Address: (street, number, city, state, and/or country)	1005 Tallow Trl Cedar Park, TX 78613		
Post Office Address: (if different from above)			

Inventor's Full Name:	STEVEN	C.	ORRELL
Inventor's Signature:	<i>Steven C. Orrell</i>		
Country of Citizenship:	USA	Date:	2/24/09
Residence Address: (street, number, city, state, and/or country)	414 W. 10th Street Georgetown, TX 78626		
Post Office Address: (if different from above)			

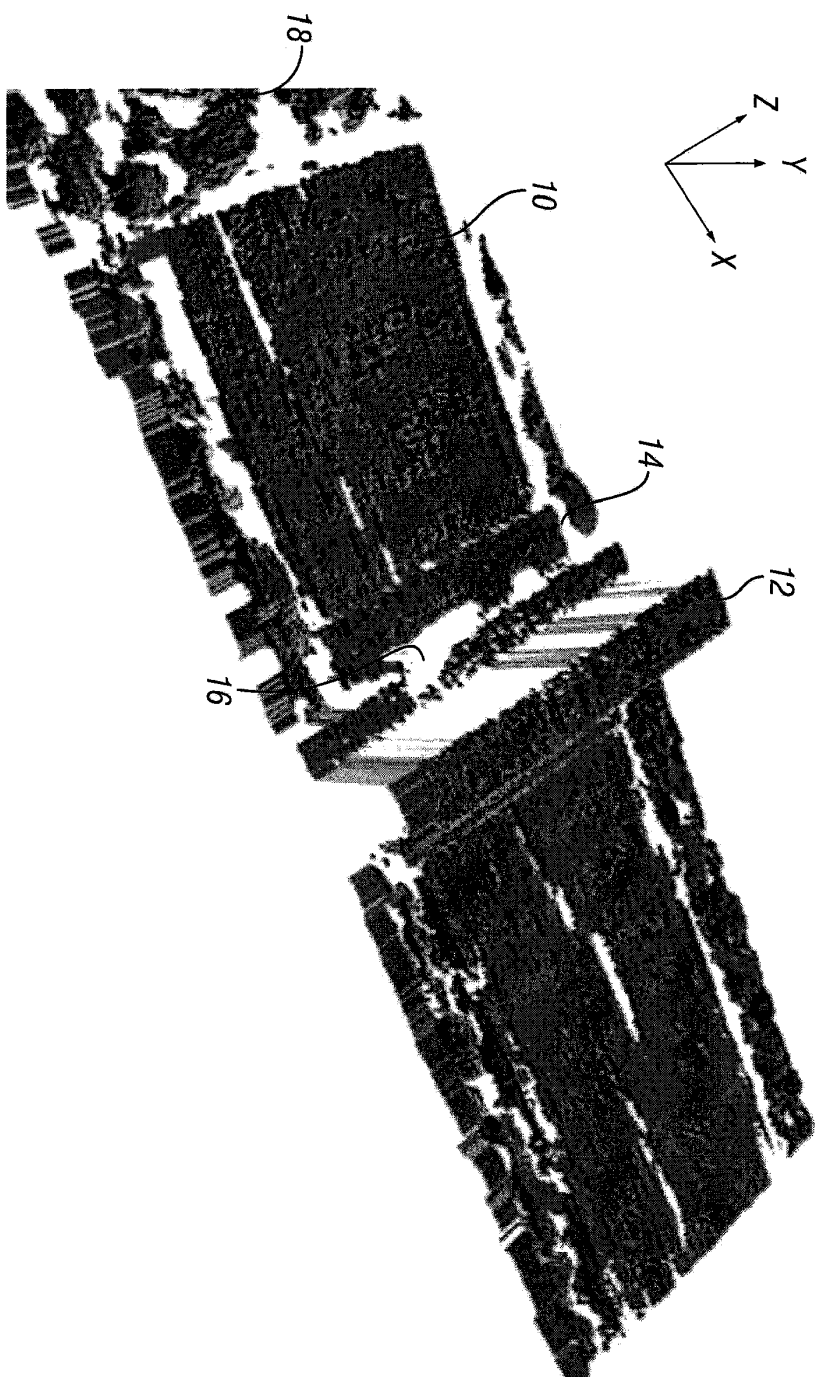


FIG. 11

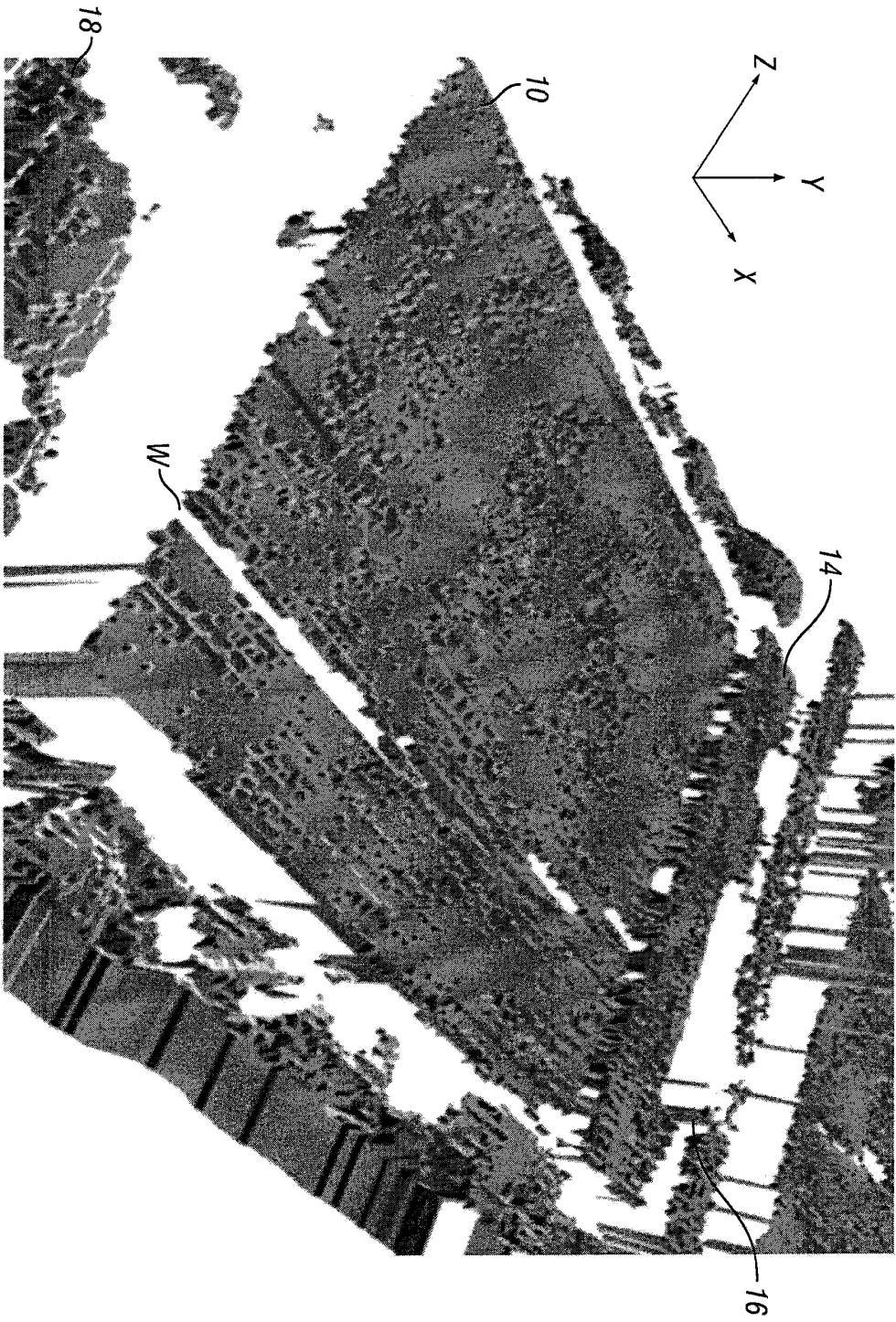


FIG. 12

**PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:  
Christopher M. Villar  
John Anthony Nagle, II  
Steven C. Orrell

Group Art Unit: 3617

Examiner: Unknown

Serial No.: 12/489,570

Atty. Dkt. No.: 11042.0098.CPUS02

Filed: June 23, 2009

Confirmation No.: 1864

For: TILT CORRECTION SYSTEM AND  
METHOD FOR RAIL SEAT ABRASION

ELECTION UNDER 37 C.F.R. §§ 3.71 AND 3.73  
AND POWER OF ATTORNEY

Commissioner for Patents  
P.O. Box 1450  
Alexandria VA, 22313-1450

Sir:

The undersigned, being Assignee of record of the entire interest in the above-identified application by virtue of an assignment recorded in the United States Patent and Trademark Office as set forth below, hereby elects, under 37 C.F.R. § 3.71, to prosecute the application to the exclusion of the inventors.

The Assignee hereby revokes any previous Powers of Attorney and appoints: practitioners associated with Customer Number 23369, including Floyd R. Nation, Reg. No. 27,580, Jade O. Laye, Reg. No. 54,255, Gregory A. Duffey, Reg. No. 42,501, and Jeffrey J. Phillips, Reg. No. 51,125, each being an attorney or agent with the law firm of Howrey LLP, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to transact all business in the Patent and Trademark Office in

Power of Attorney

connection therewith, to receive the Letters Patent document, and for one year after the issuance of such Letters Patent to file any request for a certificate of correction that may be deemed appropriate.

Pursuant to 37 C.F.R. § 3.73, the undersigned has reviewed the evidentiary documents, specifically the Assignment to Georgetown Rail Equipment Company referenced below, and certifies that to the best of my knowledge and belief, title remains in the name of the Assignee.

Please direct all future communications regarding this application as follows:

Customer Number 23369  
Howrey LLP  
c/o IP Docketing Department  
2941 Fairview Park Drive, Suite 200  
Falls Church, VA 22042-7195

ASSIGNEE: GEORGETOWN RAIL EQUIPMENT CO.

By:

Name: Christopher M. Villar

Title: Vice President - Engineering

Date:

8-11-09

ASSIGNMENT:

- ☒ Concurrently filed by EPAS, copy attached.  
☐ Previously recorded

Date:

Reel:

Frames:

Electronic Patent Application Fee Transmittal				
<b>Application Number:</b>		12489570		
<b>Filing Date:</b>		23-Jun-2009		
<b>Title of Invention:</b>		Tilt Correction System and Method for Rail Seat Abrasion		
<b>First Named Inventor/Applicant Name:</b>		Christopher M. Villar		
<b>Filer:</b>		Jade O. Laye		
<b>Attorney Docket Number:</b>		11042.0098.CPUS02		
Filed as Small Entity				
<b>Utility under 35 USC 111(a) Filing Fees</b>				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
<b>Basic Filing:</b>				
<b>Pages:</b>				
<b>Claims:</b>				
<b>Miscellaneous-Filing:</b>				
Late filing fee for oath or declaration	2051	1	65	65
<b>Petition:</b>				
<b>Patent-Appeals-and-Interference:</b>				
<b>Post-Allowance-and-Post-Issuance:</b>				
<b>Extension-of-Time:</b>				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				65

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	6021502
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Jade O. Laye
<b>Filer Authorized By:</b>	
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	04-SEP-2009
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	17:12:25
<b>Application Type:</b>	Utility under 35 USC 111(a)

**Payment information:**

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$65
RAM confirmation Number	12333
Deposit Account	083038
Authorized User	
<p>The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:</p> <p>Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)</p>	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	02Remarks.pdf	45671	no	2
			b19a672f1cf3478867f3fb599975887ac95df837		
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73(b).	02Assignment.pdf	1040153	no	4
			6a28d1fa7c5c0a367f5dddae2cc051b67653c179		
Warnings:					
Information:					
3	Oath or Declaration filed	02Declaration.pdf	918168	no	3
			bf25f1d5e1129d8825ccea2f05ed0bd33c58d75		
Warnings:					
Information:					
4	Drawings-only black and white line drawings	02Drawings.pdf	675677	no	2
			d3437d6c4643106b4cafb0c69566c0c6df3c89b3		
Warnings:					
Information:					
5	Power of Attorney	02PoA.pdf	510035	no	2
			9568ed5fbf4691676580e56f856d397d3c28d1bb		
Warnings:					
Information:					
6	Fee Worksheet (PTO-875)	fee-info.pdf	30027	no	2
			c195d7b988bf6ac52ea3e5ed368b97cbb37947dd		
Warnings:					
Information:					
Total Files Size (in bytes):			3219731		

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  
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	GRP ART UNIT	FIL FEE REC'D	ATTY DOCKET NO	TOT CLAIMS	IND CLAIMS
12/489,570	06/23/2009	3617	527	11042.0098.CPUS02	17	3

CONFIRMATION NO. 1864

UPDATED FILING RECEIPT



OC000000037817980

23369  
HOWREY LLP-HN  
C/O IP DOCKETING DEPARTMENT  
2941 FAIRVIEW PARK DRIVE, SUITE 200  
FALLS CHURCH, VA 22042-7195

Date Mailed: 09/16/2009

Receipt is acknowledged of this non-provisional 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 APPLICANT, 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 Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections 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**

**Applicant(s)**

Christopher M. Villar, Liberty Hill, TX;  
John Anthony Nagle II, Cedar Park, TX;  
Steven C. Orrell, Georgetown, TX;

**Power of Attorney:** The patent practitioners associated with Customer Number 23369

**Domestic Priority data as claimed by applicant**

This application is a CIP of 12/465,473 05/13/2009  
which is a CIP of 11/172,618 06/30/2005  
which claims benefit of 60/584,769 06/30/2004

**Foreign Applications**

**If Required, Foreign Filing License Granted:** 07/01/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/489,570**

**Projected Publication Date:** 12/24/2009

**Non-Publication Request:** No

**Early Publication Request:** No

**\*\* SMALL ENTITY \*\***

**Title**

Tilt Correction System and Method for Rail Seat Abrasion

**Preliminary Class**

238

**PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES**

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

**LICENSE FOR FOREIGN FILING UNDER**

**Title 35, United States Code, Section 184**

**Title 37, Code of Federal Regulations, 5.11 & 5.15**

**GRANTED**

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

#### **NOT GRANTED**

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).



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
12/489,570	06/23/2009	Christopher M. Villar	11042.0098.CPUS02

**CONFIRMATION NO. 1864**

**POA ACCEPTANCE LETTER**

23369  
HOWREY LLP-HN  
C/O IP DOCKETING DEPARTMENT  
2941 FAIRVIEW PARK DRIVE, SUITE 200  
FALLS CHURCH, VA 22042-7195



Date Mailed: 09/16/2009

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 09/04/2009.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/nbekele/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:  
Christopher M. Villar  
John Anthony Nagle, II  
Steven C. Orrell

Group Art Unit: 3617

Examiner: Unknown

Serial No.: 12/489,570

Atty. Dkt. No.: 11042.0098.CPUS02

Filed: June 23, 2009

Confirmation No.: 1864

For: TILT CORRECTION SYSTEM AND  
METHOD FOR RAIL SEAT ABRASION

ELECTION UNDER 37 C.F.R. §§ 3.71 AND 3.73  
AND POWER OF ATTORNEY

Commissioner for Patents  
P.O. Box 1450  
Alexandria VA, 22313-1450

Sir:

The undersigned, being Assignee of record of the entire interest in the above-identified application by virtue of an assignment recorded in the United States Patent and Trademark Office as set forth below, hereby elects, under 37 C.F.R. § 3.71, to prosecute the application to the exclusion of the inventors.

The Assignee hereby revokes any previous Powers of Attorney and appoints: practitioners associated with Customer Number 23369, including Floyd R. Nation, Reg. No. 27,580, Jade O. Laye, Reg. No. 54,255, Gregory A. Duffey, Reg. No. 42,501, and Jeffrey J. Phillips, Reg. No. 51,125, each being an attorney or agent with the law firm of Howrey LLP, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to transact all business in the Patent and Trademark Office in

connection therewith, to receive the Letters Patent document, and for one year after the issuance of such Letters Patent to file any request for a certificate of correction that may be deemed appropriate.

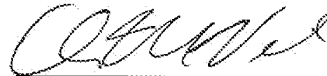
Pursuant to 37 C.F.R. § 3.73, the undersigned has reviewed the evidentiary documents, specifically the Assignment to Georgetown Rail Equipment Company referenced below, and certifies that to the best of my knowledge and belief, title remains in the name of the Assignee.

Please direct all future communications regarding this application as follows:

Customer Number 23369  
Howrey LLP  
c/o IP Docketing Department  
2941 Fairview Park Drive, Suite 200  
Falls Church, VA 22042-7195

ASSIGNEE: GEORGETOWN RAIL EQUIPMENT CO.

By:



Name: Christopher M. Villar

Title: Vice President - Engineering

Date: 11-4-09

ASSIGNMENT:

- ☐ Concurrently filed by EPAS, copy attached.  
☒ Previously recorded

Date: 09/04/2009  
Reel: 023197  
Frame: 0859

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	6415688
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Jade O. Laye/Leticia Haney
<b>Filer Authorized By:</b>	Jade O. Laye
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	09-NOV-2009
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	13:51:32
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	098__2_Power_of_Attorney. pdf	516032 <small>261fe06b5e95d8b729e41310c94812ecdf7bfa68</small>	no	2

### Warnings:

### Information:

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.

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:  
Christopher M. Villar  
John Anthony Nagle, II  
Steven C. Orrell

Group Art Unit: 3617

Examiner: Unknown

Serial No.: 12/489,570

Atty. Dkt. No.: 11042.0098.CPUS02

Filed: June 23, 2009

For: TILT CORRECTION SYSTEM AND  
METHOD FOR RAIL SEAT ABRASION

Confirmation No.: 1864

**SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56, it is respectfully requested that this Supplemental Information Disclosure Statement be entered and the documents listed on attached Form PTO-1449 be considered by the Examiner and made of record. Copies of the listed documents required by 37 C.F.R. § 1.98(a)(2) are enclosed for the convenience of the Examiner.

In accordance with 37 C.F.R §§ 1.97(g) and (h), this Supplemental Information Disclosure Statement is not to be construed as a representation that a search has been made, and is not to be construed to be an admission that the information cited is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

In accordance with 37 C.F.R § 1.97(e)(1), Applicant hereby certifies that each item of information contained in this Supplemental Information Disclosure Statement was cited in a

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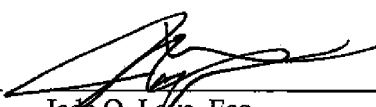
Decision on Grant in a counterpart Russian application not more than three months prior to the filing of the present statement, as evidenced by the date of the enclosed search report. Only those references which have not been previously submitted in a prior Information Disclosure Statement are submitted herewith.

The present Supplemental Information Disclosure Statement is being filed prior to the receipt of a first Official Action reflecting an examination on the merits, and hence is believed to be timely filed in accordance with 37 C.F.R. § 1.97(b). No fees are believed to be due in connection with the filing of this Supplemental Information Disclosure Statement, however, if this is not the case the Commissioner is authorized to deduct fees from Deposit Account No. 08-3038/11042.0098.CPUS02.

Applicants respectfully request that the listed documents be made of record in the present case.

Respectfully submitted,

Date: 12-9-07

  
\_\_\_\_\_  
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Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. 12/489,570
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: 06/23/2009	Group: 3617
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 1</i>	

### U.S. Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	6,615,648	09/09/2003	Ferguson et al	73	146	12/22/1998

### Foreign Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1	JP 200/221146 A1	08/11/200	Japan			Yes (Abstract)
	B2	RU 2142892	12/20/1999	Russia			Yes (Abstract)
	B3	SU 1418105	08/23/1988	Russia			No

### Other Art (Including Author, Title, Date Pertinent Pages, Etc.)

Exam. Init.	Ref. Des.	Citation
	C1	Decision on Grant, dated October 22, 2009, for corresponding Russian patent application No. 2007103331.
	C2	

<b>EXAMINER:</b>	<b>DATE CONSIDERED:</b>
EXAMINER: INITIAL IF REFERENCE CONSIDERED, WHETHER OR NOT CITATION IS IN CONFORMANCE WITH MPEP609; DRAW LINE THROUGH CITATION IF NOT IN CONFORMANCE AND NOT CONSIDERED. INCLUDE COPY OF THIS FORM WITH NEXT COMMUNICATION TO APPLICANT.	

INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)

DM\_US:22967205\_1

(19)日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11)特許出願公開番号

特開2000-221146

(P2000-221146A)

(43)公開日 平成12年8月11日(2000.8.11)

(51)Int.Cl. <sup>7</sup>	識別記号	F I	テマコード*(参考)
G 0 1 N 21/91		G 0 1 N 21/91	A 2 F 0 6 j
B 6 1 K 13/00		B 6 1 K 13/00	Z 2 G 0 5 1
G 0 1 B 11/30		G 0 1 B 11/30	A
G 0 1 N 21/88		G 0 1 N 21/88	K

審査請求 未請求 請求項の数3 O L (全 5 頁)

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(22)出願日	平成11年2月3日(1999.2.3)	(72)発明者	八木 武人 神奈川県横浜市磯子区新中原町1番地 石 川島播磨重工業株式会社技術研究所内
		(74)代理人	10009/515 弁理士 堀田 実 (外1名)

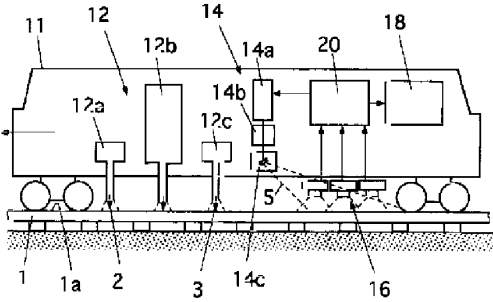
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(54)【発明の名称】 金属表面高速検査装置

(57)【要約】

【課題】 鉄道レールのような連続した金属表面の欠陥を、走行しながら高速で検査することができる金属表面高速検査装置を提供する。

【解決手段】 車両11上に設置された蛍光剤浸透装置12、UVパルスレーザ装置14及び撮像装置16と、撮像装置により撮影された画像を解析する解析装置18とを備える。蛍光剤浸透装置は、被検査物1の金属表面1aに蛍光剤2を塗布し、表面に付着している蛍光剤を除去し、表面に現像剤3を塗布して、欠陥部4のみに蛍光剤を残す。UVパルスレーザ装置14により、蛍光剤浸透装置で処理した金属表面に波長約355nmの紫外パルスレーザ5を照射し、撮像装置により紫外パルスレーザの発振に同期して金属表面を撮影し、解析装置により金属表面の蛍光位置(欠陥位置)を検出する。



【特許請求の範囲】

【請求項1】 車両(11)上に設置された蛍光剤浸透装置(12)、UVパルスレーザ装置(14)及び撮像装置(16)と、撮像装置により撮影された画像を解析する解析装置(18)とを備え、

蛍光剤浸透装置は、被検査物(1)の金属表面に蛍光剤(2)を塗布し、表面に付着している蛍光剤を除去し、表面に現像剤(3)を塗布して、欠陥部(4)のみに蛍光剤を残すようになっており、

UVパルスレーザ装置により、蛍光剤浸透装置で処理した金属表面に紫外パルスレーザ(5)を照射し、撮像装置により紫外パルスレーザの発振に同期して前記金属表面を撮影し、解析装置により金属表面の蛍光位置を検出する、ことを特徴とする金属表面高速検査装置。

【請求項2】 前記UVパルスレーザ装置は、波長約1064nm、パルス幅約2〜10nsのレーザ光を発振するNd:YAGパルスレーザ発振器と、このレーザ光の波長を約355nmに変調する変調装置とからなる、ことを特徴とする請求項1に記載の金属表面高速検査装置。

【請求項3】 前記撮像装置は、フレームレートが約30コマ/s以上のCCDカメラを備えたビデオカメラである、ことを特徴とする請求項1又は2に記載の金属表面高速検査装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、金属表面の欠陥を高速で検査する高速検査装置に関する。

【0002】

【従来の技術】我が国の道路網の発達に伴い、その維持管理のため路面性状(ひび割れ、わだち掘れ、平坦性)を自動計測する装置が一部で開発されている。例えばひび割れ測定装置は、計測車に連続写真測定装置を搭載し、スリット投影法を応用して、フィルム送りと被写体の移動速度の同期をとり、被写体(ひび割れ)をフィルムに撮影し、これを解析処理機で拡大し、人の目で判読するようになっている。また、わだち掘れ測定装置は、道路面を真上から見るように設置されたCCDカメラ直下に、レーザーファンビームを斜めに投射し、その軌跡から横断面を測定記録する。更に、平坦性(縦断凹凸)の測定は、車体の基礎フレームにレーザ変位計を下向きに取り付けてその読みを測定記録するようになっている。

【0003】

【発明が解決しようとする課題】しかし、上述したひび割れ測定装置、わだち掘れ測定装置及び平坦性測定装置は、金属表面の欠陥検出には適用できない問題点があった。そのため、例えば敷設済の鉄道レールの亀裂等を欠陥を検出するために、従来は、列車運行の休止時間に、保安員が目視等により検査していた。しかし、人間によ

る目視検査では、鉄道レールが長い場合に検査時間がかかりすぎる問題点があった。また、特に地震等の際に、安全検査の迅速性に限界があり、車両の運行再開に時間がかかっていた。

【0004】この問題点を解決するために、音響探傷法を適用したレール自動検査装置が提案され、一部で利用されている。この装置は、音波を効率的に伝搬させるために、レールを水で濡らしながら音波の伝搬を計測し、その変化から欠陥を検出するものである。しかし、この装置は自動検査ができるものの、その検査速度が遅く、そのため高速自動検査ができない問題点があった。

【0005】本発明は、かかる問題点を解決するために創案されたものである。すなわち、本発明の目的は、鉄道レールのような連続した金属表面の欠陥を、走行しながら高速で検査することができる金属表面高速検査装置を提供することにある。

【0006】

【課題を解決するための手段】本発明によれば、車両(11)上に設置された蛍光剤浸透装置(12)、UVパルスレーザ装置(14)及び撮像装置(16)と、撮像装置により撮影された画像を解析する解析装置(18)とを備え、蛍光剤浸透装置は、被検査物(1)の金属表面に蛍光剤(2)を塗布し、表面に付着している蛍光剤を除去し、表面に現像剤(3)を塗布して、欠陥部(4)のみに蛍光剤を残すようになっており、UVパルスレーザ装置により、蛍光剤浸透装置で処理した金属表面に紫外パルスレーザ(5)を照射し、撮像装置により紫外パルスレーザの発振に同期して前記金属表面を撮影し、解析装置により金属表面の蛍光位置を検出する、ことを特徴とする金属表面高速検査装置が提供される。

【0007】上記本発明の構成によれば、蛍光剤浸透装置(12)により、被検査物(1)の金属表面に蛍光剤(2)を塗布し、表面に付着している蛍光剤を除去し、表面に現像剤(3)を塗布して、欠陥部(4)のみに蛍光剤を残すことができる。次いで、UVパルスレーザ装置(14)により、蛍光剤浸透装置で処理した金属表面に非常に短い(例えば5ns)紫外パルスレーザ(5)を照射し、撮像装置により紫外パルスレーザの発振に同期して対象とする金属表面を撮影することにより、欠陥部の残る蛍光剤を紫外パルスレーザで短時間発光させ、これを撮像装置によりレーザの発振に同期して撮影することにより、金属表面の欠陥部を静止した蛍光剤の発光として記録することができる。従って、これらの装置を車両(11)上に設置し、被検査物の金属表面に沿って移動させながら画像を撮影して記録し、これを解析装置により解析して金属表面で蛍光を発する位置を検出し特定することにより、鉄道レールのような連続した金属表面の欠陥を、走行しながら検査することができる。

【0008】本発明の好ましい実施形態によれば、前記UVパルスレーザ装置は、波長約1064nm、パルス

幅約2～10 nsのレーザ光を発振するNd:YAGパルスレーザ発振器と、このレーザ光の波長を約355 nmに変調する変調装置とからなる。また、前記撮像装置は、フレームレートが約30コマ/s以上のCCDカメラを備えたビデオカメラであることが好ましい。

【0009】この構成により、約355 nmの紫外線レーザ光を効率よく発振させ、被検査物に照射して蛍光を光らせることができる。また、このレーザ光のパルス幅が非常に短い(約2～10 ns)ので、例えば時速100 km/hで車両を走行させた場合でも、発光時間の間の車両移動距離は非常に短く(5 nsの場合に約0.2 μm以下)、蛍光の発光を静止画像として撮影して欠陥位置を容易に特定することができる。更に、撮像装置に、フレームレートが約30コマ/s以上のCCDカメラを備えたビデオカメラを用いることにより、数台のビデオカメラの同期使用により、高速走行時の被検査物の全面を静止画像として記録することができる。例えば、3台のビデオカメラで長さ1 mのレールを1コマに撮影するとすると、30コマ/sの場合に、30 m/sであり、時速100 km/h以上に対応してレール全面を静止画像として記録することができる。

【0010】

【発明の実施の形態】以下、本発明の実施形態を図面を参照して説明する。図1は、本発明による金属表面高速検査装置の全体構成図であり、図2は、図1の主要部の構成図である。これらの図に示すように、本発明の金属表面高速検査装置10は、車両11上に設置された蛍光剤浸透装置12、UVパルスレーザ装置14及び撮像装置16と、撮像装置により撮影された画像を解析する解析装置18とを備える。この例において、被検査物1は、鉄道レールであり、車両11は、レール1の上をこの図で左方に高速で走行可能に構成されている。更に、図1及び図2において、20は同調制御装置であり、UVパルスレーザ装置14と撮像装置16との同調を制御するようになっている。

【0011】蛍光剤浸透装置12は、蛍光剤塗布器12a、洗浄剤供給器12b、染出剤塗布器12c、等からなる。蛍光剤塗布器12aは、亀裂等の欠陥部を含む被検査物1(レール)の金属表面1aに蛍光剤2(浸透液)を均一かつ連続的に塗布する。洗浄剤供給器12bは、蛍光剤2を除去するための洗浄剤を連続的にレール1に供給して、欠陥以外の表面1aに付着している蛍光剤2を取り除く。染出剤塗布器12cは、表面1aに現像剤3を薄く塗布して、欠陥部のみに残った蛍光剤2を現像する。この構成により、レール1の表面に欠陥がある場合に、その欠陥部のみに蛍光剤を残しかつ現像することができる。蛍光剤2には紫外線で発光する蛍光体を含んだ浸透液を使用する。黄緑色に発光する蛍光体でも、赤色染料を含み赤色に発光する蛍光体でもよい。現像液には、湿式、乾式、その他の従来のものをそのまま

使用することができる。

【0012】UVパルスレーザ装置14は、波長約1064 nm、パルス幅約2～10 nsのレーザ光を発振するNd:YAGパルスレーザ発振器14aと、このレーザ光の波長を約355 nmに変調する変調装置14bとを有する。Nd:YAGパルスレーザ発振器14aは、YAG結晶ロッドのまわりにアークランプ又はフラッシュランプを配置したものである。変調装置14bは、例えば、SHG(Second Harmonic Generator)とTHG(Third Harmonic Generator)とからなり、約1064 nmの波長を約355 nmの3倍波に変調する。また、14cは、レーザ光拡散素子であり、約355 nmに変調されたレーザ光を撮像装置16が撮影する位置のレール面に照射する。この構成により、UVパルスレーザ装置14により、蛍光剤浸透装置で処理した金属表面1aに紫外パルスレーザ5を発振し照射することができる。

【0013】撮像装置16は、フレームレートが約30コマ/s以上のCCDカメラを備えた複数(この例では3台)のビデオカメラ16aであり、紫外パルスレーザ14の発振に同期して金属表面1aを撮影する。更に、解析装置18は、例えば画像処理装置であり、ビデオカメラ16aで撮影された画像を解析して、金属表面で発光する蛍光の位置や大きさを検出する。

【0014】図3は、撮像画像の模式図である。この図のように3台のビデオカメラ16aの撮影範囲は、被検査物1の金属表面(レール1a)の互いに異なる範囲に設定されている。また、好ましくは、撮影範囲の一部が重複し、未撮影部分が発生しないようになっている。

【0015】上述した構成の金属表面高速検査装置は、レール1aに沿って、車両11を高速で走行(例えば100 km/h程度)させながら、その前方で、蛍光剤浸透装置12によりザイグロ検査と同様の工程を実施し、列車後方で、CCDカメラ列のフレームレート(例えば30コマ/s)と同期させたUVパルスレーザ装置14(Q-sw型Nd:YAGのTHG:355 nmなど)を照明光5として用い、蛍光波長のフィルターを取り付けたCCDカメラ16aからの出力により、レール1の欠陥を自動計測する。

【0016】閃光時間、数ns程度のUVパルスレーザ(Qスイッチ型Nd:YAGのTHG, FHGで、ごく一般的レーザ)を照明光源として用いると、数100 km/h程度的高速移動物体を、ほぼ静止画として取り出すことが可能となる。また、30 Hzの繰返しで動作可能なレーザを用いれば、一般的なCCDカメラ(約30コマ/s)が適用でき、システムが安価にできる。さらに、1/10000 s程度の電子シャッター(最近のCCDカメラでは標準装備)を併用すれば、外光(日光等)と外乱光の排除が可能であり、高S/N比の計測が可能となる。以上の技術を用いれば、高速移動走行を行いながら、検査が可能となる。

【0017】なお、本発明は、上述した実施例に限定されず、本発明の要旨を逸脱しない範囲で種々に変更できることは勿論である。例えば、被検査物は、鉄道レールに限定されずその他の連続した金属表面に同様に適用することができる。

【0018】

【発明の効果】上述したように、本発明の構成によれば、蛍光剤浸透装置12により、被検査物1の金属表面1aに蛍光剤2を塗布し、表面に付着している蛍光剤を除去し、表面に現像剤3を塗布して、欠陥部4のみに蛍光剤を残すことができる。次いで、UVパルスレーザ装置14により、蛍光剤浸透装置で処理した金属表面に非常に短い（例えば5ns）紫外パルスレーザ（5）を照射し、撮像装置により紫外パルスレーザの発振に同期して対象とする金属表面を撮影することにより、欠陥部の残る蛍光剤を紫外パルスレーザで短時間発光させ、これを撮像装置によりレーザの発振に同期して撮影することにより、金属表面の欠陥部を静止した蛍光剤の発光として記録することができる。従って、これらの装置を車両11上に設置し、被検査物の金属表面に沿って移動させながら画像を撮影して記録し、これを解析装置により解析して金属表面で蛍光を発する位置を検出し特定することにより、鉄道レールのような連続した金属表面の欠陥を、走行しながら検査することができる。

【0019】更に、本発明の好ましい実施形態によれば、約355nmの紫外線レーザ光を効率よく発振させ、被検査物に照射して蛍光を光らせることができる。また、このレーザ光のパルス幅が非常に短い（約2～10ns）ので、例えば時速100km/hで車両を走行させた場合でも、発光時間の間の車両移動距離は非常に短く（5nsの場合に約0.2μm以下）、蛍光の発光を静止画像として撮影して欠陥位置を容易に特定することができる。更に、撮像装置に、フレームレートが約30コマ/s以上のCCDカメラを備えたビデオカメラを用いることにより、数台のビデオカメラの同期使用によ

り、高速走行時の被検査物の全面を静止画像として記録することができる。例えば、3台のビデオカメラで長さ1mのレールを1コマに撮影するとすると、30コマ/sの場合に、30m/sであり、時速100km/h以上に対応してレール全面を静止画像として記録することができる。

【0020】従って、本発明の金属表面高速検査装置は、鉄道レールのような連続した金属表面の欠陥を、走行しながら高速で検査することができる、等の優れた効果を有する。

【図面の簡単な説明】

【図1】本発明による金属表面高速検査装置の全体構成図である。

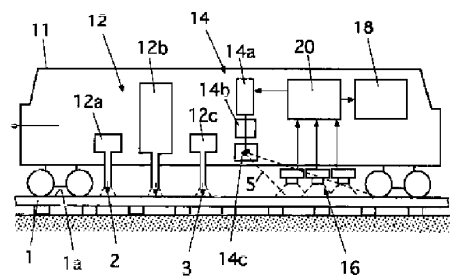
【図2】図1の主要部の構成図である。

【図3】撮像画像の模式図である。

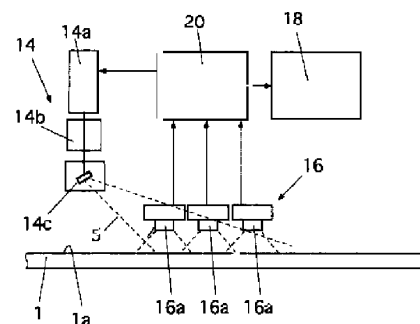
【符号の説明】

- 1 被検査物（レール）
- 1a 金属表面
- 2 蛍光剤
- 3 現像剤
- 4 欠陥部
- 5 紫外パルスレーザ
- 10 金属表面高速検査装置
- 12 蛍光剤浸透装置
- 12a 蛍光剤塗布器
- 12b 洗浄剤供給器
- 12c 染出剤塗布器
- 14 UVパルスレーザ装置
- 14a Nd:YAGパルスレーザ発振器
- 14b 変調装置
- 14c レーザ光拡散素子
- 16 撮像装置
- 16a CCDカメラ
- 18 解析装置
- 20 同調制御装置

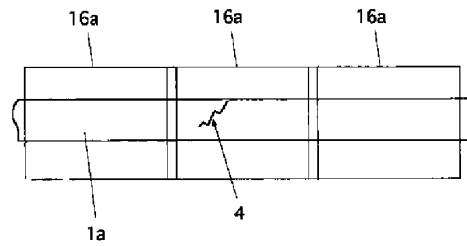
【図1】



【図2】



【図3】



フロントページの続き

Fターム(参考) 2F065 AA49 BB12 BB30 CC35 DD06  
FF04 GG04 GG08 GG22 JJ03  
JJ05 JJ26 MM07 MM14 MM24  
MM28 NN06 NN08 QQ31  
2G051 AA44 AA90 AB03 BA05 BA10  
CA03 CA04 GA10 GB01 GB02  
GC04 GC20

## METAL SURFACE HIGH-SPEED INSPECTION DEVICE

**Publication number:** JP2000221146 (A)

**Publication date:** 2000-08-11

**Inventor(s):** YAGI TAKETO

**Applicant(s):** ISHIKAWAJIMA HARIMA HEAVY IND

**Classification:**

- **international:** **B61K13/00; G01B11/30; G01N21/88; G01N21/89; G01N21/91; B61K13/00; G01B11/30; G01N21/88;** (IPC1-7): G01N21/91; B61K13/00; G01B11/30; G01N21/88

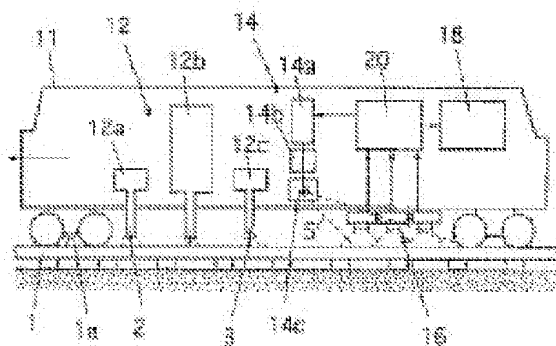
- **European:**

**Application number:** JP19990025763 19990203

**Priority number(s):** JP19990025763 19990203

### Abstract of JP 2000221146 (A)

**PROBLEM TO BE SOLVED:** To provide a metal surface high-speed inspection device for speedily inspecting the defects of a continuous metal surface such as a railroad rail during running. **SOLUTION:** A device is provided with a fluorescent agent permeating device 12 that is installed on a vehicle 11, a UV pulse laser device 14 and an image pickup device 16, and an analytical device 18 for analyzing an image that is picked up by the image pickup device 16. The fluorescent agent permeation device 12 applies a fluorescent agent 2 to a metal surface 1a of an object 1 to be inspected, eliminates the fluorescent agent 2 adhering on the surface, applies a developing agent 3 to the surface, and allows the fluorescent agent 2 to remain only at a defective part. An ultraviolet pulse laser beam 5 with a wavelength of approximately 355 nm is applied to the metal surface, that is treated by the fluorescent agent permeation device 12 by the UV pulse laser device 14, the image of the metal surface is picked up in synchronization with the oscillation of the ultraviolet pulse laser beam by the image pickup device 16, and a fluorescent position (defective position) on the metal surface is detected by the analytical apparatus 18.



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(19) **RU** <sup>(11)</sup> **2 142 892** <sup>(13)</sup> **C1**

(51) МПК<sup>6</sup> **B 61 K 9/08**

РОССИЙСКОЕ АГЕНТСТВО  
ПО ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

(12) ОПИСАНИЕ ИЗОБРЕТЕНИЯ К ПАТЕНТУ РОССИЙСКОЙ ФЕДЕРАЦИИ

(21), (22) Заявка: 95113612/28, 03.08.1995

(46) Дата публикации: 20.12.1999

(56) Ссылки: DE 3611795 A1, 15.10.87. DE 3901185 A1, 26.07.90. DE 2618365 A1, 17.11.77. EP 0461628 A1, 18.12.91. SU 1796514 A1, 23.02.93.

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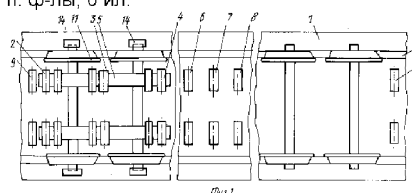
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(54) ОПТОЭЛЕКТРОННАЯ СИСТЕМА БЕСКОНТАКТНОГО ИЗМЕРЕНИЯ В ДВИЖЕНИИ ГЕОМЕТРИЧЕСКИХ ХАРАКТЕРИСТИК ЖЕЛЕЗНОДОРОЖНОЙ КОЛЕИ. ОПТОЭЛЕКТРОННЫЙ ДАТЧИК БЕСКОНТАКТНОГО ИЗМЕРЕНИЯ ПОЛОЖЕНИЯ И ИЗНОСА РЕЛЬСА

(57) Реферат:

Изобретение относится к путеизмерительным средствам для измерения профиля поперечного сечения, боковых и вертикальных отклонений железнодорожных рельсов. Система содержит оптоэлектронные датчики на подрессоренной раме тележки вагона, затем в середине по правому и левому борту в середине вагона, по продольной оси. Ими образованы короткая и длинная измерительные базы. Оптоэлектронный датчик содержит блок засветки, включающий в себя лазерный источник света. Блок засветки оптически связан через рельс с блоком изображений. Последний включает в себя оптические устройства. Одно из них ориентировано для горизонтальной, а другое

для вертикальной составляющих изображения рельса. Оптическое устройство выполнено на основе прибора с зарядовой связью и соединено с блоком обработки сигналов. Техническим результатом, на достижение которого направлено изобретение, является повышение надежности и точности измерений и устранение громоздкости датчика. 2 с. и 2 з. п. ф-лы, 6 ил.



RU 2 142 892 C1

RU 2 142 892 C1



(19) **RU** <sup>(11)</sup> **2 142 892** <sup>(13)</sup> **C1**  
 (51) Int. Cl.<sup>6</sup> **B 61 K 9/08**

RUSSIAN AGENCY  
 FOR PATENTS AND TRADEMARKS

(12) **ABSTRACT OF INVENTION**

(21), (22) Application: 95113612/28, 03.08.1995

(46) Date of publication: 20.12.1999

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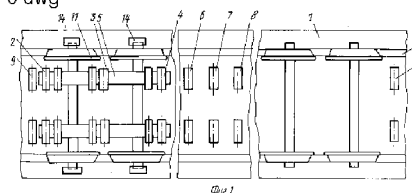
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(54) OPTOELECTRONIC SYSTEM OF NONCONTACT MEASUREMENT OF RAILWAY GAUGE GEOMETRIC CHARACTERISTICS IN MOTION; OPTOELECTRONIC SENSOR FOR NONCONTACT MEASUREMENT OF RAIL POSITION AND WEAR

(57) Abstract:

FIELD: railway transport; testing facilities. SUBSTANCE: invention relates to track measuring devices for measuring rail cross section profile, side and vertical deviations. Proposed system includes optoelectronic sensors mounted on sprung frame of car bogie, also in middle at right and left side, and in middle of car on longitudinal axis. Sensors form short and long measuring bases. Optoelectronic sensor has exposure unit including laser light source. This is optically coupled through rail with image unit which includes optical devices. One of optical devices is oriented for horizontal and the other, for vertical

components of rail image. Optical device is made on basis of instrument with charge coupling and is connected to signal processing unit. EFFECT: enhanced reliability and accuracy of measurement, reduced overall dimensions of sensor. 4 cl, 6 dwg



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Изобретение относится к железнодорожному транспорту, более конкретно к путеизмерительному средству, в частности к устройствам для измерения динамической деформативности железнодорожного полотна, профиля поперечного сечения, боковых и вертикальных отклонений железнодорожных (ж.д.) рельсов. [М.А. Блохоцкий и др. Машины и механизмы для путевого хозяйства. М.: Транспорт, 1970.]

Современные путеизмерительные системы полностью или частично основаны на применении бесконтактных оптоэлектронных датчиков. Известны такие измерительные системы как RCA (Великобритания), Lifeslice (Австралия), ORIAN (Канада) и др., но в этих системах не удалось достигнуть требуемых технических характеристик по различным причинам (несовершенные способы засветки рельсов, неудовлетворительный прием сигналов, использование механических и электромеханических устройств).

Известно изобретение по патенту Германии N 3901185, МПК<sup>5</sup> В 61 К 9/08, G 01 В 11/18, E 01 В 35/08, заявлено 17.01.89г., опубликовано 28.07.90 г. "Метод и устройство бесконтактного измерения деформации и износа рельсов".

Устройство включает блок освещения световыми лучами (блок засветки), который стационарно связан с рельсовым транспортным средством. Блок освещения генерирует направленный перпендикулярно верхней плоскости рельса световой луч в форме контрастной световой полоски. Эта световая полоска освещает как верхнюю сторону головки рельса, так и внутренний край головки рельса. Световая полоска проходит поперек направления движения, т.е. поперек направления рельса.

Кроме того, на рельсовом транспортном средстве жестко закреплена видеокамера, поле зрения или оптическая ось которой направлена в область верхней поверхности рельса, в которой находится световая полоска. Устройство содержит цифровой датчик перемещений, который регистрирует пройденные измерительные отрезки пути и показания которого ставятся в соответствие значениям результатов просмотра видеокамеры для образования сигналов "изображение-перемещение".

После проведения замеров, накопленный объем информации подводится к блоку обработки, усиленному вычислительной машиной и там обрабатывается. По причине различных возможностей установки видеокамеры можно обнаружить снимаемую видеокамерой форму световой полоски, т.е. профиля рельса, по сравнению с фактическим профилем трансформированной, т.е. искаженно представленной формы. Фактическая форма профиля рельса будет определена с помощью вычислительной машины. Определение повышенного износа или деформаций поверхности катания осуществляется в блоке обработки сравнением зафиксированного в процессе измерений сигнала "изображение-перемещение" с заданной характеристикой профиля формы.

Положение видеокамеры изменяется из-за

упругих перемещений рельсового транспортного средства при одновременном изменении положения оптической оси и поля зрения видеокамеры. Для учета этих изменений применяется оптический вспомогательный сигнал в форме видимого лазерного луча. Лазерный луч направляется от стационарно связанного с рельсовым транспортным средством источника излучения на верхнюю поверхность головки рельса, благодаря чему может быть установлена опорная высота Н. Определенная высота Н используется для расчетного определения фактического профиля верхней поверхности рельса.

Недостатком указанного устройства является то, что необходимо обрабатывать большое количество информации, сложность обработки информации и, как следствие, недостаточные точность получения результата и быстрдействие.

Известны "Система измерений ширины колеи, а также горизонтального и вертикального износа железнодорожных рельсов". Патент Германии Р 3538439.5-52 опубликов. 29.10.1985, и "Оптоэлектронная система бесконтактного измерения в движении профиля поперечного сечения железнодорожных рельсов, профиля поперечного сечения и параметров колес железнодорожного подвижного состава, поперечного сечения железнодорожных вагонов, боковых и вертикальных отклонений железнодорожных рельсов, патент Германии N DE 3611795, заявл. 8.04.86 г., опублик. 15.10.87 г. МПК G 01 В 11/24, G 01 В 11/14, выбранная нами за прототип.

Система содержит жесткую опорную штангу, которая подвешивается над рельсом на рельсовом (транспортном) средстве. На концах и в середине штанги расположены датчики бесконтактного измерения профиля поперечного сечения бокового и вертикальных отклонений железнодорожных рельсов. Для определения бокового отклонения замеряют проекции отрезков Р<sub>1</sub>, Р<sub>2</sub>, Р<sub>3</sub> между жесткой штангой и рельсом. Измерения проводят в горизонтальной плоскости для определения бокового отклонения и в вертикальной плоскости для определения отклонения по высоте.

Датчик включает в себя проектирующий блок "OS" (блок засветки), состоящий из источника света Q с зеркалом и вращающимся барабаном Т, блок приема отраженных от рельса световых лучей (блок изображений), состоящий из линз LS и LD, в фокусе которых находятся пучки оптических волокон GS, размещенных по схеме "строка-столбец". Все волокна одного столбца ведут к одному и тому же фототранзистору. Сигнал фототранзистора затем подвергается дальнейшей обработке во входном устройстве Е, усилителе V и преобразователе F (блок обработки). Сумматоры Е<sub>1</sub> и Е<sub>2</sub> принимают импульсы от преобразователя и генерируют на своих выходах напряжения, пропорциональные уровню освещенности поверхностей рельса. Барабан Т при вращении обеспечивает освещение рельса последовательно в точках с, d, f, h, p.

Барабан установлен так, чтобы освещение точки "С" осуществлялось под углом 45° с целью отметить ее по возможности более точно. При этом учитывается тот факт, что

участок  $ab$  для любого рельса образует угол  $30^\circ$  с горизонталью.

Проекционная система с помощью электронно-оптического блока освещает рельс лучом, который пробегает отрезок от точки "с" к точке "Р". Проекция на горизонтальную плоскость непосредственно считывается линзой  $LS_1$ , а проекция на вертикаль - линзой  $LD_1$ , однако после отражения от кругового зеркала  $TS_2$ , с целью более точной записи профиля рельса линзу  $LD$  можно повернуть на угол  $\alpha$  от вертикали, причем она займет положение  $LD_2$ . Сигнал, который будет подведен к регистратору, должен быть умножен перед этим на  $\cos \alpha$ .

Однако рассмотренная система имеет следующие недостатки.

Во-первых, она не позволяет определять динамическую деформативность железнодорожной колеи.

Во-вторых, низкая надежность, т.к. датчики расположены на штанге, жестко связанной с неподдрессоренной частью тележки.

Кроме того, в рассматриваемой системе недостаточная защита оптических блоков от пыли и грязи, т.к. они расположены в непосредственной близости от железнодорожной колеи.

Отклонение геометрических характеристик от нормы может быть обусловлено различными причинами, например износом рельса, деформацией земляного полотна и т.д. Рассматриваемое техническое решение не обеспечивает возможности учета этих причин.

К недостаткам датчика следует отнести то, что мала надежность из-за привязки к частоте засветки рельса, а скорость вращения барабана определенная. Кроме того, засветка рельса осуществляется с помощью вращающегося узла барабана, что также влияет на надежность.

Наличие отражающих зеркал, расположенных ниже уровня головки рельса, затрудняет прохождение ж.д. стрелок, переездов. Кроме того, необходимо поддерживать отражающие зеркала достаточно чистыми, а при таком их расположении это проблематично.

Малая точность измерения, т.к. на весь диапазон измерения приходится 100 чувствительных элементов оптического устройства.

Конструкция датчика громоздка, т.к. для обеспечения работоспособности необходим второй источник засветки нижней кромки головки рельса.

Задача, на решение которой направлено заявляемое изобретение, - устранение указанных недостатков.

Эта задача решена тем, что оптоэлектронная система бесконтактного измерения в движении геометрических характеристик железнодорожной колеи, содержащая по крайней мере по одному двухкоординатному датчику в трех точках хорды, представляющей собой жесткую измерительную базу, размещенных на рельсовом средстве, снабжена датчиками, расположенными так, что образуют дополнительную измерительную базу, при этом одна из баз расположена в области нагружения, а другая вне области нагружения рельса, в середине рельсового средства по

продольной его оси.

Система снабжена датчиками, расположенными по краям рельсового средства по продольной его оси, образуя измерительную базу.

В оптоэлектронном датчике бесконтактного измерения положения и износа рельсов, содержащем расположенные на рельсовом средстве оптически связанные через рельс блок засветки, включающий в себя лазерный источник света с узлом формирования засветки на рельс, и включающий в себя оптические системы, одна из которых ориентирована для горизонтальной, а другая для вертикальной составляющих, блок изображений, блок обработки сигналов, узел формирования засветки на рельс выполнен в виде объектива, обеспечивающего засветку головки рельса в виде полосы лазерного света, оптическое устройство выполнено на основе прибора с зарядовой связью (ПЗС), снабженного на входе формирователем изображений, например анаморфотным объективом, и соединено с блоком обработки, при этом чувствительность прибора с зарядовой связью выбрана удовлетворяющей выражению

$$F = K \cdot \frac{L \cdot Z}{IR},$$

где  $I$  - интенсивность засветки рельса;

$R$  - отражательная способность рельса;

$L$  - удаленность оси рельса;

$F$  - чувствительность прибора с зарядовой связью (ПЗС);

$K$  - коэффициент пропорциональности.

Согласно пункту 2 ПЗС представляет собой по крайней мере две ПЗС-линейки, расположенные так, что поля зрения их не влияют одно на другое.

Таким образом, дополнительные датчики и указанное их размещение, образуя измерительную базу в нагруженной части (на тележке) рельсового средства (вагона) и в середине вагона "короткая база" по продольной оси, "длинная база" по краям вагона по продольной оси, позволяют измерить прогиб, обусловленный нагрузкой на рельс и ненагруженный рельс, определить их разницу, которая и характеризует деформативность железнодорожной колеи.

Надежность системы повышена тем, что датчики расположены на подрессоренной части рельсового средства. По этой же причине увеличена защищенность оптических блоков и обеспечена возможность беспрепятственного прохождения стрелок и переездов.

При измерении геометрических характеристик ж/д колеи обеспечена возможность учесть динамическое изменение этих характеристик (ширина колеи, уровень, перекося, изгиб и т.д.) под действием нагрузки на колено со стороны колесных пар тележек вагона. По динамическому изменению геометрических характеристик можно судить о деформативности ж/д пути.

Схема размещения датчиков и конструкция датчиков позволяют измерить различные вклады при определении характеристик железнодорожной колеи.

Повышение надежности датчика обеспечено тем, что за счет выполнения узла засветки, создающего засветку головки

рельса в виде сплошной или пунктирной полосы лазерного света и выполнения блока изображений, считывающего информацию с узла засветки, позволяет производить замер положения рельса по крайним точкам засветки, в результате обеспечена возможность разделения величины искривления пути от износа рельса.

Предложенная в системе продольная схема размещения датчиков по отношению к рельсу позволяет избежать прямого попадания отраженных лучей, а обрабатывать только сигнал изображения.

Сущность изобретения пояснена чертежами, где изображено:

- фиг. 1 - общий вид системы сверху;
- фиг. 2 - общий вид системы сбоку;
- фиг. 3 - общий вид датчика;
- фиг. 4 - схема измерения ширины колеи;
- фиг. 5 - схема измерения уровня;
- фиг. 6 - схема измерения рихтовки.

На рельсовом средстве (вагоне) 1 размещены оптоэлектронные датчики.

Датчики 2, 3, 4 размещены на подрессоренной раме тележки 5 вагона 1.

Датчики 6, 7, 8 размещены в средней части рамы вагона (1) по правому и левому борту.

Датчики 9, 10 размещены по краям вагона 1 по правому и левому борту.

Датчики 2, 3, 4 образуют измерительную базу в области нагружения рельса рельсовым средством.

Датчики 6, 7, 8 образуют "короткую" измерительную базу вне области нагружения.

Датчики 9, 7, 10 образуют "длинную" измерительную базу вне области нагружения.

На раме тележки 5 вагона 1 размещен датчик износа рельса 11. Система снабжена гироскопом 12, задающим искусственный горизонт для измерения уровня колеи. Кроме того, система снабжена датчиком пути 13.

На буксах колесной пары тележки 5 размещены тензодатчики 14 для определения величины статической и динамической нагрузки рельсов 15 от транспортного средства.

Все датчики связаны посредством локальной сети с центральным модулем ЭВМ (на чертеже не показан), для обработки данных.

Оптоэлектронный датчик фиг. 3 содержит блок засветки 16, включающий лазерный источник света 17 и узел формирования засветки на рельс 18, закрепленные на рельсовом средстве 1, 5. Датчик содержит блок изображений 19, включающий в себя прибор с зарядовой связью 20 и формирователь изображений 21.

Прибор с зарядовой связью 20 соединен с блоком обработки 22.

На фиг. 3 изображен световой растр 23, формируемый блоком засветки 16, создающий световую полосу 24 на рельсе 15.

На фиг. 4 изображена схема, поясняющая измерение ширины рельсовой колеи.

На фиг. 5 изображена схема, поясняющая измерение уровня рельсовой колеи, где:

25 - положение искусственного уровня гироскопа;

26 - положение уровня рамы тележки;

27 - положение уровня рельсовой колеи.

На фиг. 6 изображена схема, поясняющая измерение стрелы изгиба рельсовой колеи в

плане (рихтовка), где 28 - измерительная база.

Работа системы основана на учете различных причин, вызывающих отклонение от нормы геометрических характеристик жд. колеи.

Все измерения производят в области динамического нагружения железнодорожного рельса тележкой (колесными парами) рельсового средства (вагона) и в ненагруженных областях:

- середина вагона - "короткая" база,
- по длине вагона - "длинная база".

При определении деформативности жд. пути при движении вагона снимают показания датчиков 2, 3, 4, которые характеризуют состояние под нагрузкой, затем в этой же точке снимают показания датчиков 6, 7, 8, которые характеризуют состояние без нагрузки. Разница между этими показаниями характеризует деформативность жд. пути S, определяемую как упругую осадку пути Y при воздействии динамической нагрузки P:  $S = P/Y$  [см. М.Ф. Вериго, А.Я. Коган "Взаимодействие пути и подвижного состава". М, Транспорт, 1986].

Для измерения ширины рельсовой колеи "Ш" снимают показания датчиков 2 и 11, которые характеризуют состояние рельса под нагрузкой, затем в этой же точке снимают показания датчиков 7, которые характеризуют состояние рельса без нагрузки.

Датчиком 2 измеряют расстояние в горизонтальной плоскости между рамой тележки и внутренней боковой гранью рельса  $a_1$ ,  $a_2$  (фиг. 1). В результате имеем ширину колеи в т. В (фиг. 4), которая равна  $a_0 + a_1 + a_2$ , где  $a_0$  - расстояние между датчиками 2.

Датчиком 11 измеряют величину износа головки рельса  $\Delta a_1$ ,  $\Delta a_2$ .

Получаем величину ширины колеи

$$a_0 + \Delta a_1 + \Delta a_2 + a_1 + a_2.$$

Аналогично датчику 2 снимает показания датчика 7.

Отклонение ширины колеи от нормы ( $Ш_n$ ) может быть обусловлено следующими причинами:

- износом рельсов ( $\Delta a_1 + \Delta a_2$ );
- деформацией земляного полотна ( $\Delta a_3$ );
- отклонением рельсов от первоначальной прокладки в процессе эксплуатации  $\Delta a_4$ .

$$Ш = Ш_n + \Delta a_1 + \Delta a_2 + \Delta a_3 + \Delta a_4$$

Как показано, износ рельсов определяем прямым измерением датчиками износа 11.

Разность показаний  $\Delta a_3$  между величинами, определяемыми датчиками 2 и 7, характеризует изменение ширины колеи, вызванное деформацией земляного полотна.

Оставшаяся величина отклонений ширины колеи характеризует отклонение, вызванное статическим деформированием рельсов  $\Delta a_4$ .

Таким образом, мы получаем как значение ширины рельсовой колеи, так и определяем причины, вызвавшие отклонение ширины колеи от нормы.

При определении взаимного положения рельсовых нитей в поперечном профиле (уровень) снимаем показания датчиков 2 и 7, характеризующие расстояние от головки рельса до датчика в вертикальной плоскости.

Гироскопом 12 задан искусственный горизонт, относительно которого и определяем уровень.

При появлении ненулевого уровня (фиг. 5)  $\alpha \neq 0$  по отношению к искусственному горизонту 25 происходит наклон оси колесной пары тележки. Вследствие этого происходит наклон рамы тележки вагона на угол  $\beta$  (фиг. 5) по отношению к уровню колеи.

Величина угла  $\beta$  определяется в центральном модуле, по показаниям датчиков 2.

С гироскопа снимают значение угла наклона рамы тележки к искусственному горизонту  $\gamma$  (фиг. 5).

Значение угла  $\alpha$  определяют соотношением

$$\alpha = \beta + \gamma.$$

Величину превышения одного рельса над другим определяют выражением

$$h = W \cdot \sin \alpha,$$

где  $W$  - значение ширины колеи в месте определения уровня.

Парой датчиков 7 производят измерение уровня в том же месте колеи, но без нагрузки на колею вагоном.

Соответственно, значение угла  $\alpha$  может отличаться на величину  $\Delta\alpha$ :

$$\Delta\alpha = \alpha_2 - \alpha_7$$

$$\Delta h = h_2 - h_7 = W_2 \cdot \sin \alpha_2 - W_7 \cdot \sin \alpha_7,$$

где  $\Delta h$  - характеризует отклонение уровня от нормы, обусловленное неодинаковой деформативностью железнодорожной колеи под левым и правым рельсом;

$\alpha_2, \beta_2, \gamma_2, W_2$  - значения, определяемые по показаниям датчика 2;

$\alpha_7, \beta_7, \gamma_7, W_7$  - значения, определяемые по показаниям датчика 7.

По значениям величины износа верхней поверхности катания рельсов, измеряемой датчиками 11, определяют вклад износа в отклонение уровня колеи от нормы.

При определении положения рельсовых нитей в плане (рихтовка) снимают показания датчиков:

2, 3, 4 - измерительная база под нагрузкой;  
6, 7, 8 - "короткая" измерительная база,  
9, 7, 10 - "длинная" измерительная база.

Определение величины рихтовки производят хордовым методом [Плохачкий М. А. и др. Машины и механизмы для путевого хозяйства. М.: Транспорт, 1970].

Датчиками измеряют расстояние "P" в плане от внутренней поверхности головки рельса точка "B" (фиг. 4) до датчика.

Отклонение от прямолинейности рельса в плане на измерительной базе под нагрузкой определяют значением стрелы прогиба (фиг. 6).

$P_1, P_2, P_3$  - расстояние от датчиков до рельса 17;

$\Delta$  - стрела прогиба.

На базе тележки под нагрузкой

$$\Delta t = P_3 - \frac{P_2 + P_4}{2}.$$

На "короткой" базе вагона

$$\Delta k = P_7 - \frac{P_6 + P_8}{2}.$$

На "длинной" базе вагона

$$\Delta d = P_7 - \frac{P_9 + P_{10}}{2}.$$

Измерение производят в точке "B", поэтому не происходит учет износа рельсов.

Разница значений  $\Delta T - \Delta K$  определяет вклад, обусловленный деформацией жд. колеи в величину рихтовки.

При определении просадок рельсовых нитей снимают показания датчиков 2, 4; 6, 8 и 9, 10, определяют расстояние от верхней поверхности головки рельса до датчика.

Постоянно фиксируют разность показаний между парами датчиков 2, 4; 6, 8 и 9, 10, а также фиксируют разность показаний между парами датчиков 4, 2; 8, 6 и 10, 9 в той же точке.

При проезде над локальной неровностью пути происходит перекося тележки относительно рельса в вертикальной плоскости. Разность показаний между датчиками 2 и 4 определяет величину этой неровности. Затем при проходе над этой же неровностью датчика 4, так же определяется разность показаний между датчиками 4-2.

Если эта разность по величине будет одинаковой, но противоположной по знаку, то эта величина характеризует просадку.

Аналогично определяют просадки другими парами датчиков 6-8 и 9-10.

Датчики 2-4 и 6-8 фиксируют короткие просадки, а датчики 9-10 фиксируют длинные просадки [М.А. Плохачкий и др. Машины и механизмы для путевого хозяйства. М.: Транспорт, 1970].

Учет причин, приводящих к отклонению просадок от нормы, производят аналогично как при измерениях других характеристик.

По результатам измерения износа поверхности катания головки рельса определяют вклад износа в перекося рельсов.

Разность значений перекосов, определяемых датчиками 2, 4 и 6, 8, характеризует изменение величины перекося под действием динамической нагрузки.

Датчик работает следующим образом.

Лазерным источником света 17 (фиг. 3) создают пучок света, который, проходя через узел формирования засветки 20, приобретает форму растровой подоски света 25. Размеры светового растра формируют такими, чтобы при всех взаимных уходах оптической оси блока засветки 16 и рельса 15 головка рельса оказывалась засвеченной полоской лазерного излучения. Таким образом, точки "А" и "В" (фиг. 3), по которым производят отсчет положения рельса, всегда оказываются подсвеченными. При измерении износа рельса полоса засветки штриховая.

Точки "А" и "В" расположены на неизнашиваемых частях головки рельса. Точка "А" - начало закругленной внешней части верхней поверхности головки рельса, а точка "В" - нижняя внутренняя кромка головки рельса.

По точке "А" производят привязку профиля рельса (износа) к точке "В", поскольку штриховая засветка не обеспечивает точную привязку к точке "В".

Свет, рассеянный от головки рельса, попадает на формирователь изображений 21 блока изображений 19, который расположен под острым углом к продольной оси рельса.

Изображение засвеченной части головки рельса формируют на ПЗС линейках 20, с которых посредством блоков обработки 20 ведут отсчет вертикальных и горизонтальных значений положения рельса.

При измерении положения рельса датчик выдает на центральный модуль (ЦМ)

значения вертикальных  $H$  и горизонтальных  $S$  координат точек  $A$  и  $B$ .

При измерении износа рельсов датчик выдает на ЦМ значения  $H$  и  $S$  всех точек засветки, попавших на рельс. При обработке в ЦМ происходит привязка износа к положению рельса по точке  $A$ . Значения вертикальных " $H$ " и горизонтальных " $S$ " координат определяются блоком обработки 22 по формулам:

$$H = L_1 - (L_1 \cdot K(n_1 - N_1) / (f_1 \cdot \cos \varphi_1 + \sin \varphi_1 \cdot K(n_1 - N_1)),$$

$$S = L_2 - (L_2 \cdot a(n_2 - N_2) / (f_2 \cdot \cos \varphi_2 + \sin \varphi_2 \cdot K(n_2 - N_2)) + \tan \varphi_2 \cdot H,$$

где  $\varphi_1$  - угол между оптической осью объектива 21, измеряющего вертикальные координаты и горизонтальной плоскостью;

$L_1, L_2$  - расстояние от объективов 21 до реперной точки "В" на рельсе;

$\varphi_2$  - угол между горизонтальной проекцией оптической оси объектива датчика 23, измеряющего горизонтальные координаты, и плоскостью, перпендикулярной оси рельса.

$f_1, f_2$  - фокусные расстояния объективов 21;

$N_1, N_2$  - номер элемента ПЗС, соответствующий началу координат;

$n_1, n_2$  - номер элемента ПЗС, соответствующий измеряемому положению рельса;

$K$  - расстояние между соседними элементами ИЗО;

$H$  - вертикальная координата измеряемой точки рельса;

$S$  - горизонтальная координата измеряемой точки рельса.

#### Формула изобретения:

1. Оптоэлектронная система бесконтактного измерения в движении геометрических характеристик железнодорожной колеи, содержащая по крайней мере по одному двухкоординатному оптоэлектронному датчику в трех точках хорды, представляющей собой измерительную базу, размещенному на

рельсовом средстве, отличающаяся тем, что она снабжена дополнительно датчиками, расположенными так, что образуют дополнительную измерительную базу, при этом одна из измерительных баз расположена в области нагружения рельса, а другая - вне области нагружения в середине рельсового средства по продольной его оси.

2. Система по п.1, отличающаяся тем, что она дополнительно снабжена датчиками, расположенными по краям рельсового средства по продольной его оси, образуя измерительную базу.

3. Оптоэлектронный датчик бесконтактного измерения положения и износа рельса, содержащий расположенные на рельсовом средстве оптически связанные через рельс блок засветки, включающий в себя лазерный источник света с узлом формирования засветки, оптически связанный через рельс с блоком изображений, включающим в себя оптические устройства, одно из которых ориентировано для горизонтальной, а другое для вертикальной составляющих изображений рельса, и блок обработки сигналов, отличающийся тем, что узел формирования засветки на рельс выполнен в виде объектива, обеспечивающего засветку головки рельса в виде полосы лазерного света, оптическое устройство выполнено на основе прибора с зарядовой связью (ПЗС), снабженного на входе формирователем изображений, например анаморфотным объективом, и соединенного с блоком обработки сигналов, при этом чувствительность ПЗС удовлетворяет выражению

$$F = K \cdot \frac{L^2}{IR},$$

где  $F$  - чувствительность ПЗС;

$I$  - интенсивность засветки рельса;

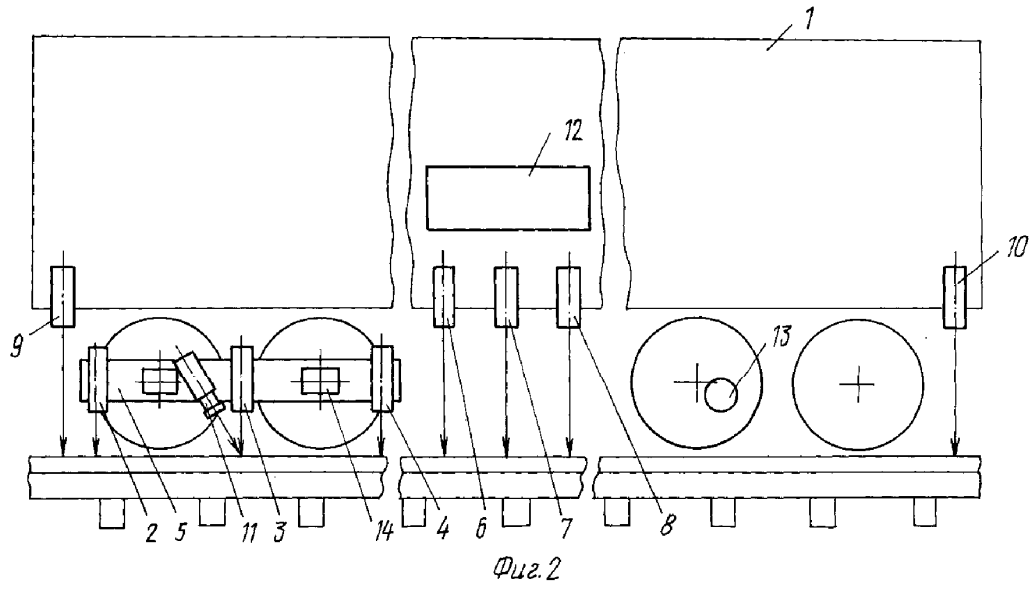
$L$  - удаленность от рельса;

$R$  - отражательная способность рельса;

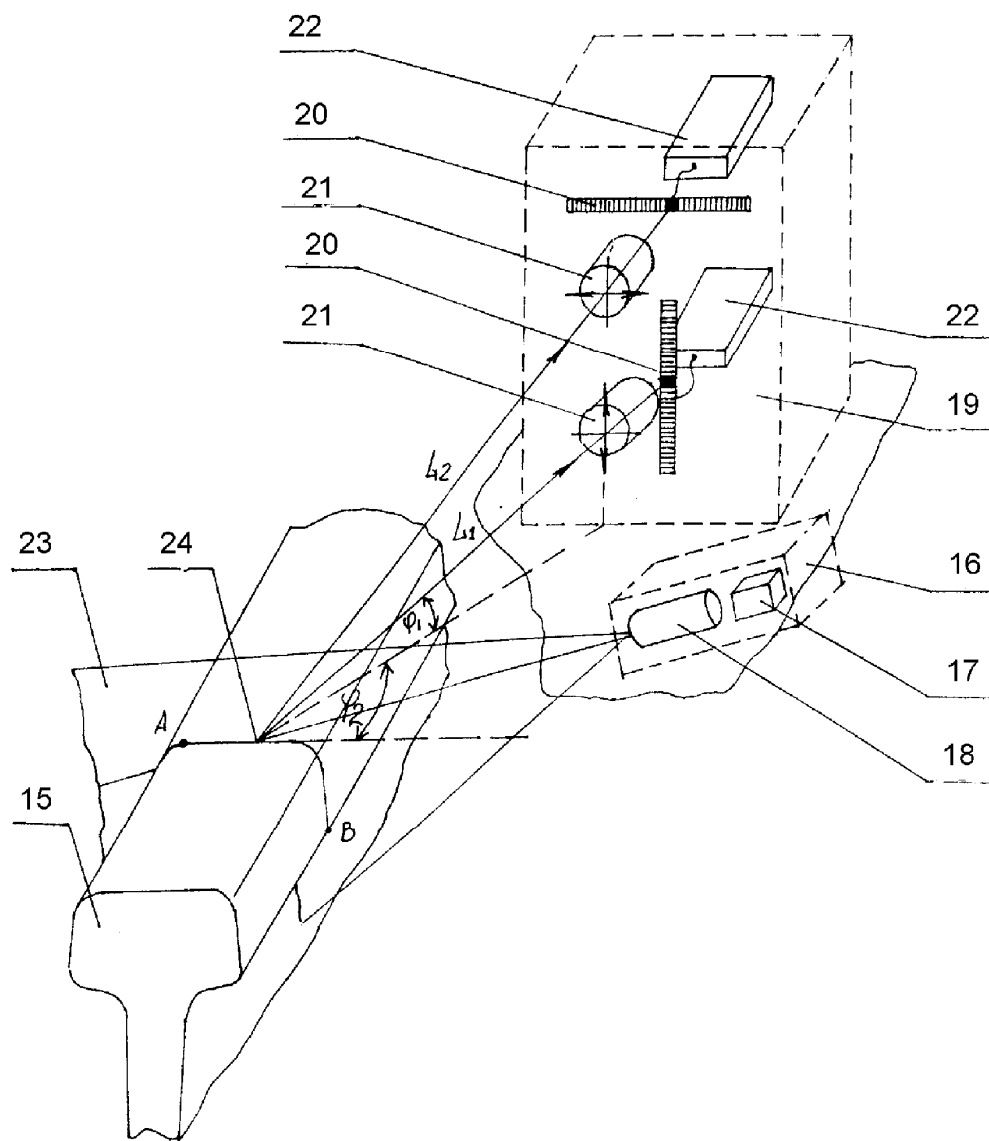
$K$  - коэффициент пропорциональности.

4. Датчик по п.3, отличающийся тем, что ПЗС представляет собой по крайней мере две ПЗС-линейки, расположенные так, что поля зрения их не влияют одно на другое.

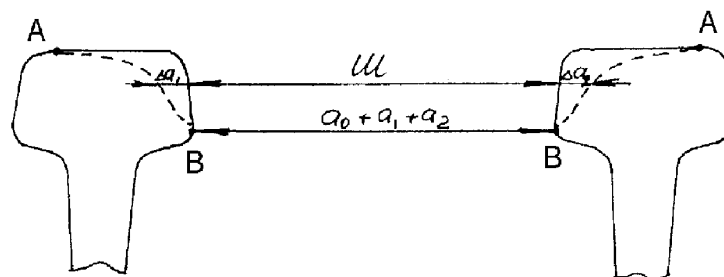
RU 2142892 C1



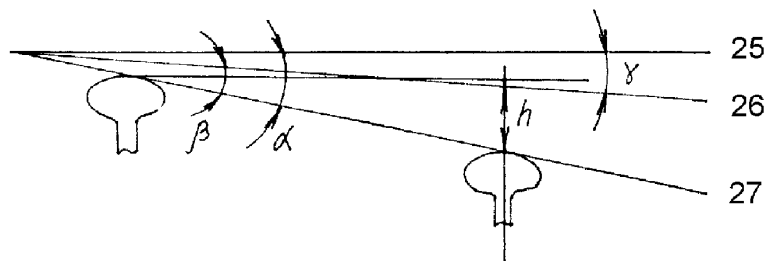
RU 2142892 C1



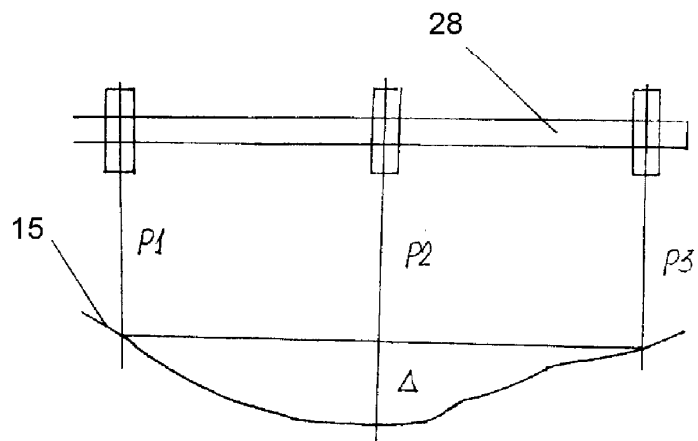
Фиг.3



Фиг.4



Фиг.5



Фиг.6

RU 2142892 C1

RU 2142892 C1

## OPTOELECTRONIC SYSTEM OF NONCONTACT MEASUREMENT OF RAILWAY GAUGE GEOMETRIC CHARACTERISTICS IN MOTION

**Publication number:** RU2142892 (C1)

**Publication date:** 1999-12-20

**Inventor(s):** OSIPOV V V; PAKHOMOV A G

**Applicant(s):** OSIPOV VIKTOR VASIL EVICH; PAKHOMOV ALEKSANDR GEORGIEVICH

**Classification:**

- **international:** **B61K9/08; B61K9/00;** (IPC1-7): B61K9/08

- **European:**

**Application number:** RU19950113612 19950803

**Priority number(s):** RU19950113612 19950803

### Abstract of **RU 2142892 (C1)**

FIELD: railway transport; testing facilities. SUBSTANCE: invention relates to track measuring devices for measuring rail cross section profile, side and vertical deviations. Proposed system includes optoelectronic sensors mounted on sprung frame of car bogie, also in middle at right and left side, and in middle of car on longitudinal axis. Sensors form short and long measuring bases. Optoelectronic sensor has exposure unit including laser light source. This is optically coupled through rail with image unit which includes optical devices. One of optical devices is oriented for horizontal and the other, for vertical components of rail image. Optical device is made on basis of instrument with charge coupling and is connected to signal processing unit. EFFECT: enhanced reliability and accuracy of measurement, reduced overall dimensions of sensor. 4 cl, 6 dwg

.....  
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СОЮЗ СОВЕТСКИХ  
СОЦИАЛИСТИЧЕСКИХ  
РЕСПУБЛИК

(19) **SU** (11) **1418105** **A1**

(5D) 4 В 60 L 3/10

ГОСУДАРСТВЕННЫЙ КОМИТЕТ СССР  
ПО ДЕЛАМ ИЗОБРЕТЕНИЙ И ОТКРЫТИЙ

## ОПИСАНИЕ ИЗОБРЕТЕНИЯ К АВТОРСКОМУ СВИДЕТЕЛЬСТВУ

(21) 4196879/31-11

(22) 18.02.87

(46) 23.08.88. Бюл. № 31

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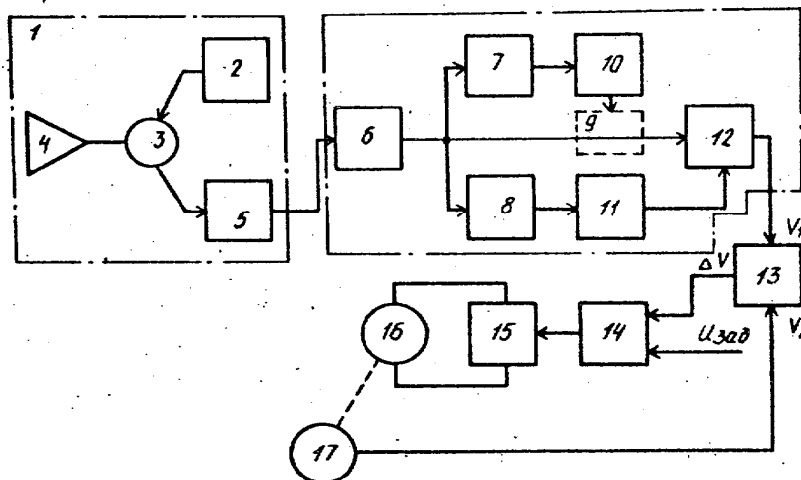
(53) 621.335.11(088.8)

(56) Авторское свидетельство СССР № 659425, кл. В 60 L 3/10, 1978.

(54) УСТРОЙСТВО ДЛЯ ЗАЩИТЫ ОТ БОКСОВАНИЯ И ЮЗА РЕЛЬСОВЫХ ТРАНСПОРТНЫХ СРЕДСТВ

(57) Изобретение относится к транспорту и направлено на повышение точности и надежности. Частотный сигнал от доплеровского измерителя 1 скорости, пропорциональный скорости движе-

ния транспортного средства, является амплитудно-модулированным из-за отражения от неоднородной поверхности рельсового полотна. Фильтры 7 и 8 с помощью порогового элемента 9, ключевого элемента 10 и инвертора 11 формируют сигнал скорости на выходе сумматора 12 по амплитудной модуляции при низкой скорости движения и по сигналу доплеровской частоты при высокой скорости движения. Сигнал скорости движения сравнивается в блоке 13 сравнения с сигналом, пропорциональным частоте вращения контролируемой колесной пары, а результирующий сигнал с блока 13 воздействует через блок 14 управления на тиристорный преобразователь 15, питающий тяговый электродвигатель 16. 1 ил.



(19) **SU** (11) **1418105** **A1**

Изобретение относится к транспорту, в частности к устройствам для защиты от боксования и юза рельсовых транспортных средств.

Цель изобретения - повышение точности и надежности.

На чертеже представлена блок-схема предлагаемого устройства.

Устройство содержит доплеровский измеритель 1 скорости, включающий генератор 2, ферритовый циркулятор 3, приемно-передающую антенну 4 и усилитель 5, выход которого является выходом измерителя 1. Выход измерителя 1 подключен к входу амплитудного детектора 6, к выходу которого подключены входами фильтры 7 и 8 частот и ключевой элемент 9. Выход фильтра 7 через пороговый элемент 10 подключен к второму входу ключевого элемента 9. Выход фильтра 8 через инвертор 11 подключен к одному из входов сумматора 12, другой вход которого подключен к выходу ключевого элемента 9, а выход соединен с одним из входов блока 13 сравнения. Выход последнего соединен с входом блока 14 управления тиристорным преобразователем 15, питающим тяговый электродвигатель 16, с которым сочленен датчик 17 частоты вращения, подключенный к другому входу блока 13 сравнения.

Устройство работает следующим образом.

Генератор 2 вырабатывает электромагнитные колебания, которые через циркулятор 3 попадают в рупорно-линзовую приемно-передающую антенну 4 и излучаются, осуществляя зондирование железнодорожного полотна. Отраженный сигнал воспринимается той же антенной 4 и через циркулятор 3 подается на вход усилителя 5 высокой частоты. На вход последнего через циркулятор 3 приходит также зондирующий сигнал. При наложении этих двух сигналов возникает явление биеения с частотой Доплера. Сигнал доплеровской частоты является амплитудно-модулированным из-за отражения от неоднородной поверхности железнодорожного полотна, вызванной наличием шпал. Из этого сигнала фильтрами 7 и 8 выделяются сигнал доплеровской частоты и сигнал амплитудной модуляции. Если скорость локомотива выбранной уставки, например, меньше

10 км/ч, т.е. входное напряжение порогового элемента 10 меньше порогового значения, ключевой элемент 9 разомкнут, и линейная скорость локомотива определяется по частоте сигнала амплитудной модуляции. Если скорость локомотива больше 10 км/ч, срабатывает ключевой элемент 9 и на первый вход сумматора 12 подается модулированный сигнал Доплера, а на второй вход сумматора 12 подается инвертированный инвертором 11 сигнал амплитудной модуляции. На выходе сумматора 12 будет сигнал доплеровской частоты, которой подается на первый вход блока 13 сравнения.

Сигнал линейной скорости  $V_1$  в блоке 13 сравнения сравнивается с сигналом скорости локомотива  $V_2$ , приходящим на второй вход блока 13 сравнения от датчика 17.

В случае, когда  $V_1 = V_2$ , т.е. когда буксование (юз) колесных пар отсутствует, на выходе блока 13 сравнения присутствует разностный сигнал  $\Delta V = 0$ , и, следовательно, на входы блока 14 управления поступает только сигнал  $V_{зад}$  задания скорости.

Если  $V_1 \neq V_2$ , на выходе блока 13 сравнения присутствует разностный сигнал  $\Delta V$ . В этом случае возможны два варианта. Если  $\Delta V < 0$ , т.е.  $V_1 < V_2$  (буксование),  $\Delta V$  в блоке 14 вычитается из  $V_{зад}$ , тем самым снижается напряжение тиристорным преобразователем 15 на тяговом двигателе 16, уменьшается скорость вращения колесных пар локомотива, прекращается избыточное буксование колесных пар. Если  $\Delta V > 0$ , т.е.  $V_1 > V_2$  (юз),  $\Delta V$  подается на устройство (не показано) прекращения юза колесных пар.

#### Ф о р м у л а и з о б р е т е н и я

Устройство для защиты от боксования и юза рельсовых транспортных средств, содержащее доплеровский измеритель скорости транспортного средства, блок сравнения, один из входов которого соединен с датчиком частоты вращения тягового электродвигателя, сочлененного с контролируемой колесной парой, а выход - с блоком управления тиристорным преобразователем напряжения, отличающееся тем, что, с целью повышения точности и надежности, оно снабжено амплитудным детектором, фильтрами частот,

пороговым элементом, ключевым элементом, инвертором и сумматором, выход которого подключен к другому входу блока сравнения, а один и другой входы которого подключены соответственно к выходам ключевого элемента и инвертора, последний из которых подключен входом к выходу одного из фильтров частот, вход кото-

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рого, один из входов ключевого элемента и вход другого фильтра частот соединены с выходом амплитудного детектора, подключенного входом к выходу доплеровского измерителя скорости, при этом выход другого фильтра частот соединен с входом порогового элемента, выход которого подключен к другому входу ключевого элемента.

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Заказ 4106/16

Тираж 569

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Your reference: 11042.0098.PCRU00  
Our reference: 2412-141421RU/8272  
Application No.: 2007103331  
Attorney Name: Yury D.Kuznetsov



Page 1 of 9

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To No. 2412-141421RU/8272  
(21) Our No. 2007103331/28(003582)

To "Gorodissky & Partners" Law firm Ltd.,  
B. Spasskaya str., 25, bldg. 3, Moscow, 129090, Russia

**DECISION ON GRANT  
A PATENT FOR INVENTION**

(21) Application No. 2007103331/28(003582)

(22) Application filing date 30 June 2005

As a result of the substantive examination of the present application for invention, it has been stated that  
☐ the claimed invention  
☒ the claimed group of inventions  
relates to the objects of patent rights and complies with the patentability conditions stipulated by the Civil Code of the Russian Federation and, in view of this, a decision to grant a patent for the invention has been taken.

A Report on Examination Results is enclosed.

Enclosure: on 15 sheets in 1 copy.

Head

Signature

B.P. Simonov

Your reference: **11042.0098.PCRU00**  
Our reference: **2412-141421RU/8272**  
Application No.: **2007103331**  
Attorney Name: **Yury D.Kuznetsov**

**Decision on Grant**

Page 2 of 9

**TRANSLATION**

**CONCLUSION ON EXAMINATION RESULTS**

(21) Application № <b>2007103331/28(003582)</b>	(22) Date of filing the application <b>June 30, 2005</b>		
(24) Date from which industrial property rights may have effect <b>June 30, 2005</b>			
(85) Date of commencement of the national phase <b>January 30, 2007</b>			
PRIORITY IS FIXED ON DATE			
<input type="checkbox"/> (22) Date of filing the application			
<input type="checkbox"/> (23) Date of filing of additional materials of to the earlier application №			
<input type="checkbox"/> (62) <input type="checkbox"/> priority date of the application № of from which the present application has been divided up			
<input type="checkbox"/> <input type="checkbox"/> filing date of the application № of from which the present application has been divided up			
<input type="checkbox"/> (66) Filing date of the earlier application №			
<input checked="" type="checkbox"/> (30) Data relating to priority under the Paris Convention			
(31) Number assigned to priority application	(32) Date of filing priority application	(33) Country code	Claim
<b>60/584,769</b>	<b>June 30, 2004</b>	<b>US</b>	
(86) PCT Application number and date <b>US 2005/023132 of June 30, 2005</b>			
(87) PCT Publication number and date <b>WO 2006/004846 of January 12, 2006</b>			
(72) Inventor(s)	<b>NAGLE, John, Anthony, II., US</b> <b>ORRELL, Steven, C., US</b> <b>VILLAR, Christopher, M., US</b>		
(73) Assignee(s)	<b>GEORGETOWN RAIL EQUIPMENT COMPANY, US</b>		
(54) Title	<b>SYSTEM AND METHOD FOR INSPECTING RAILROAD TRACK</b>		

As a result of the substantive examination of the application as conducted with respect to [ ] the original set of claims [x] the set of claims amended by the Applicant, the concordance of [ ] the claimed invention [x] the claimed group of inventions to the requirements of the Articles 1349 and 1350 of the Civil Code of the Russian Federation has been revealed.

The set of claims is presented in page(s) 3–13.

NOTE: to eliminate a technical error the feature “a first frame” was canceled from dependent claims 13, 23, 36, 46, 59, 69 (according to the third line of the said claims states “analyzing one or more intermediate frames and an end frame...” from where this feature is deleted).

(21) 2007103331/28

(51) IPC

**G01C 3/08** (2006.01)

**B61K 9/08** (2006.01)

(57)

1. A system for inspecting a railroad track bed, including the railroad track, to be mounted on a vehicle for movement along the railroad track, the system comprising:

at least one light generator positioned adjacent the railroad track for projecting a beam of light across the railroad track bed;  
at least one optical receiver positioned adjacent the railroad track for receiving at least a portion of the light reflected from the railroad track bed and generating a plurality of images representative of the profile of at least a portion of the railroad track bed; and

at least one processor for analyzing the plurality of images and determining a geographic location of the plurality of images, the processor being further capable of compiling the plurality of images with one or more respective physical characteristics and recording the respective geographical location of the plurality of images.

2. The system of claim 1, wherein the light generator is a laser.

3. The system of claim 2, wherein the laser emits an infrared beam of light.

4. The system of claim 1, wherein the at least one light generator is positioned substantially above the railroad track and emits the beam of light substantially perpendicular to the railroad track.

5. The system of claim 2, wherein the laser emits the beam of light with an angular expanse.

6. The system of claim 1, wherein the at least one optical receiver comprises a digital camera.

7. The system of claim 1, wherein the optical device comprises a band pass filter allowing substantially only the wavelength of the beam of light to be captured in the plurality of images.

8. The system of claim 1, wherein the at least one processor comprises a data storage device for storing the plurality of images.

9. The system of claim 1, further comprising a GPS receiver or an encoder that provides the geographical location data for analysis by the processor.

10. The system of claim 1, further comprising a temperature sensor positioned adjacent the railroad track that provides a temperature of the railroad track for analysis by the processor.

11. The system of claim 1, wherein each of the plurality of images comprises a plurality of pixels given X-Y-coordinates.

12. The system of claim 1, wherein each of the plurality of images comprises a Z-coordinate representing the location of the image along the length of railroad track.

13. The system of claim 1, wherein the processor includes an algorithm for determining the distance between crossties of the railroad track bed, the algorithm comprising the steps of:

(a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frames comprising crossties while the one or more intermediate frames lack crossties:

- (b) determining a number of the one or more intermediate frames lacking crossties;
  - (c) determining a known spacing between frames; and
  - (d) determining the distance between the crossties of the end frame based upon the number of the one or more intermediate frames lacking crossties and the known spacing between the frames.
14. The system of claim 1, wherein the processor includes an algorithm for identifying specific components of the railroad track bed.
15. The system of claim 1, wherein the processor includes an algorithm for determining a defect in a crosstie of the railroad track bed.
16. The system of claim 1, wherein the processor includes an algorithm for detecting missing, misaligned, damaged, or defective fastener components of the railroad track bed.
17. The system of claim 1, wherein the processor includes an algorithm for detecting a misaligned or sunken tie plate of the railroad track bed, the algorithm comprising the steps of:
- (a) analyzing a frame of the plurality of images, the frame comprising a region of interest;
  - (b) determining whether the region of interest contains a tie plate;
  - (c) if a tie plate is present, determining a crosstie contour and a tie plate contour;
  - (d) comparing an orientation of the crosstie contour and an orientation of the tie plate contour; and
  - (e) determining whether the tie plate is misaligned or sunken based upon the comparison.
18. The system of claim 1, wherein the processor includes an algorithm for determining wear of the rails of the railroad track.
19. The system of claim 1, wherein the processor includes an algorithm for determining spacing of the rails of the railroad track.
20. The system of claim 1, wherein the processor includes an algorithm for determining a height of ballast relative to a crosstie of the railroad track bed.
21. The system of claim 1, wherein the processor includes an algorithm for determining a size of ballast stones of the railroad track bed.
22. The system of claim 1, wherein the processor includes an algorithm for determining a gap size between sections of the railroad track.
23. The system of claim 1, wherein the processor includes an algorithm for identifying a break in a rail of the railroad track bed, the algorithm comprising the steps of:
- (a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frame comprising rails while the one or more intermediate frames lack rails;
  - (b) determining a number of the one or more intermediate frames lacking rails;
  - (c) determining a known spacing between frames; and
  - (d) identifying the break in the rail based upon the number of the one or more intermediate frames lacking rails and the known spacing between the frames.
24. A method for inspecting railroad track bed, the railroad track bed including crossties, rails, associated fastening hardware, and ballast, the method comprising the steps of:
- a) illuminating a line across the span of the railroad track bed;

- b) receiving at least a portion of the light reflected from the railroad track bed;
  - c) generating a plurality of images representative of the profile of at least a portion of the railroad track bed;
  - d) analyzing the plurality of images and determining a geographic location of the plurality of images along the railroad track bed;
  - e) compiling the plurality of images with one or more respective physical characteristics of the railroad track bed;
  - f) recording the respective geographical location of the images; and
  - g) displaying the determined physical characteristics of the said portion of the railroad track bed.
25. The method of claim 24, wherein a laser illuminates the line across the span of the railroad track bed.
26. The method of claim 25, wherein the laser emits an infrared beam of light.
27. The method of claim 24, wherein the line across the span of the railroad track bed is substantially perpendicular to the rails of the railroad track bed.
28. The method of claim 25, wherein the laser emits the line with an angular expanse.
29. The method of claim 24, wherein a digital camera receives the at least a portion of light reflected from a portion of the railroad track bed.
30. The method of claim 24, further comprising the step of filtering the portion of light reflected from a portion of the railroad track bed with a band pass filter.
31. The method of claim 24, further comprising the step of storing the plurality of images.
32. The method of claim 24, further comprising the step of providing the geographical location data from a GPS receiver or an encoder.
33. The method of claim 24, further comprising the step of obtaining a temperature of the rails of the railroad track bed.
34. The method of claim 24, wherein the plurality of images comprises a plurality of pixels given X-Y coordinates.
35. The method of claim 34, wherein the plurality of images further comprise a Z coordinate representing the location of the image along the length of rail of the railroad track bed.
36. The method of claim 24, further comprising the step of determining the distance between crossties of the railroad track bed, the step of determining distance comprising the steps of:
- (a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frame comprising crossties while the one or more intermediate frames lack crossties;
  - (b) determining a number of the one or more intermediate frames lacking crossties;
  - (c) determining a known spacing between frames; and
  - (d) determining the distance between the crossties of the end frame based upon the number of the one or more intermediate frames lacking crossties and the known spacing between the frames.
37. The method of claim 24, further comprising the step of identifying specific components of the railroad track bed.
38. The method of claim 24, further comprising the step of determining a defect in a crosstie of the railroad track bed.
39. The method of claim 24, further comprising the step of detecting missing, misaligned, damaged, or defective fastener hardware of the railroad track bed.
40. The method of claim 24, further comprising the step of detecting a misaligned or sunken tie plate of the railroad track bed, the step of detecting comprising the steps of:

- (a) analyzing a frame of the plurality of images, the frame comprising a region of interest;
  - (b) determining whether the region of interest contains a tie plate;
  - (c) if a tie plate is present, determining a crosstie contour and a tie plate contour;
  - (d) comparing an orientation of the crosstie contour and an orientation of the tie plate contour; and
  - (e) determining whether the tie plate is misaligned or sunken based upon the comparison.
41. The method of claim 24, further comprising the step of determining wear of a rail of the railroad track bed.
42. The method of claim 24, further comprising the step of determining spacing of rails of the railroad track bed.
43. The method of claim 24, further comprising the step of determining a height of ballast relative to a crosstie of the railroad track bed.
44. The method of claim 24, further comprising the step of determining a size of ballast stones of the railroad track bed.
45. The method of claim 24, further comprising the step of determining a gap size between sections of rail of the railroad track bed.
46. The method of claim 24, further comprising the step of identifying a break in a rail of the railroad track bed, the step of identifying comprising the steps of:
- (a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frame comprising rails while the one or more intermediate frames lack rails;
  - (b) determining a number of the one or more intermediate frames lacking rails;
  - (c) determining a known spacing between frames; and
  - (d) identifying the break in the rail based upon the number of the one or more intermediate frames lacking rails and the known spacing between the frames.
47. A method of inspecting railroad track bed having a crosstie, rails, associated fastening hardware, and ballast, the method comprising the steps of:
- a) traveling along the rails;
  - b) projecting a focused beam of light across the span of the railroad track bed;
  - c) capturing a plurality of images of the focused beam of light projected across a portion of railroad track bed while traveling along the rails;
  - d) determining one or more aspects of the portion of the railroad track bed by processing the plurality of images;
  - e) compiling respective images of the portion of the railroad track bed with respective physical characteristics of the railroad track bed;
  - f) recording the respective geographical location of the respective images; and
  - g) outputting the determined one or more aspects of the portion of the railroad track bed.
48. The method of claim 47, wherein a laser projects the focused beam of light across the span of the railroad track bed.
49. The method of claim 48, wherein the laser emits an infrared beam of light.
50. The method of claim 48, wherein the laser is positioned substantially above the rails and emits the focused beam of light substantially perpendicular to the rails.
51. The method of claim 48, wherein the laser emits the focused beam of light with an angular expanse.
52. The method of claim 47, wherein a digital camera captures the plurality of images.

53. The method of claim 47, further comprising the step of filtering the projected beam of light with a band pass filter.
54. The method of claim 47, further comprising the step of storing the plurality of images on a data storage device.
55. The method of claim 47, further comprising the step of obtaining the geographical location data from a GPS receiver or an encoder.
56. The method of claim 47, further comprising the step of obtaining the temperature of the rails.
57. The method of claim 47, wherein the plurality of images further comprises a plurality of pixels given X-Y coordinates.
58. The method of claim 57, wherein the plurality of images further comprise a Z coordinate representing the location of the image along the length of the rails.
59. The method of claim 47, further comprising the step of determining the distance between crosstie of the railroad track bed, the step of determining distance comprising the steps of:
- (a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frame comprising crossties while the one or more intermediate frames lack crossties;
  - (b) determining a number of the one or more intermediate frames lacking crossties;
  - (c) determining a known spacing between frames; and
  - (d) determining the distance between the crossties of the end frame based upon the number of the one or more intermediate frames lacking crossties and the known spacing between the frames.
60. The method of claim 47, further comprising the step of identifying specific components of the railroad track bed.
61. The method of claim 47, further comprising the step of determining a defect in a crosstie of the railroad track bed.
62. The method of claim 47, further comprising the step of detecting a missing, misaligned, damaged, or defective fastening hardware.
63. The method of claim 47, further comprising the step of detecting a misaligned or sunken tie plate of the railroad track bed, the step of detecting comprising the steps of:
- (a) analyzing a frame of the plurality of images, the frame comprising a region of interest;
  - (b) determining whether the region of interest contains a tie plate;
  - (c) if a tie plate is present, determining a crosstie contour and a tie plate contour;
  - (d) comparing an orientation of the crosstie contour and an orientation of the tie plate contour; and
  - (e) determining whether the tie plate is misaligned or sunken based upon the comparison.
64. The method of claim 47, further comprising the step of determining wear of the rails.
65. The method of claim 47, further comprising the step of determining spacing of the rails.
66. The method of claim 47, further comprising the step of determining a height of ballast relative to a crosstie of the railroad track bed.
67. The method of claim 47, further comprising the step of determining a size of ballast stones of the railroad track bed.
68. The method of claim 47, further comprising the step of determining a gap size between sections of rail.
69. The method of claim 47, further comprising the step of identifying a break in a rail of the railroad track bed, the step of identifying comprising the steps of:
- (a) analyzing one or more intermediate frames and an end frame of the plurality of images, the end frame comprising rails while the one or more intermediate frames lack rails;

- (b) determining a number of the one or more intermediate frames lacking rails;
- (c) determining a known spacing between the frames; and
- (d) identifying the break in the rail based upon the number of the one or more intermediate frames lacking rails and the known spacing between the frames.

70. A system for inspecting a railroad track bed including the rails, the system to be mounted on a vehicle for movement along the track, the system comprising:

at least one light generator positioned adjacent the railroad bed for projecting a beam of light across the entire track bed;  
at least one optical receiver positioned adjacent the railroad track bed for capturing at least a portion of the image of the railroad track bed by receiving at least a portion of the light reflected from the railroad track bed, wherein the optical receiver includes a processor to generate a dimensional profile of the captured image of the railroad track bed; and  
at least one processor for analyzing the dimensional profile and determining a geographic location of the plurality of images, the processor being further capable of compiling the plurality of images with one or more respective physical characteristics and recording the respective geographical location of the plurality of images along the railroad track bed.

(56) RU 2142892 C1, 20.12.1999  
SU 1418105 A1, 23.08.1988  
US 6615648 A1, 09.09.2003  
JP 2000/221146 A1, 11.08.2000

When publishing information on issuance of the patent the specification and the figures in the original Applicant's version will be used.

Enclosure:

1. Abstract corrected by the Examiner on 1 sheet in 1 copy.

State Patent Examiner

Your reference: 11042.0098.PCRU00  
Our reference: 2412-141421RU/8272  
Application No.: 2007103331  
Attorney Name: Yury D.Kuznetsov

Decision on Grant

Page 9 of 9

To be published with Fig. 1

Enclosure № 1

For application № 2007103331/28

**G01C 3/08** (2006.01)

**B61K 9/08** (2006.01)

**(54) SYSTEM AND METHOD FOR INSPECTING RAILROAD TRACK**

**Abstract**

(57) The invention relates to a system and method for inspecting railroad track and, more particularly to a system and method for inspecting aspects of a railroad track using a laser, camera, and a processor. The technical result is to simplify the inspecting of the railroad track condition. The method for inspecting railroad track bed comprises the steps of: illuminating a line across the span of the railroad track bed; receiving a portion of the light reflected from the railroad track bed; generating a plurality of images; analyzing the plurality of images; compiling the plurality of images; recording the respective geographical location of the images; and displaying the determined physical characteristics of the portion of the railroad track bed. The system implementing the method of inspecting railroad track bed and to be mounted on a vehicle comprises at least one light generator being a laser and positioned adjacent the railroad track for projecting a beam of light across the railroad track bed; one optical receiver positioned adjacent the railroad track. The optical receiver comprises a digital camera, one processor for analyzing the plurality of images and determining a geographic location of the plurality of images. The processor is configured to compile the plurality of images and to record the respective geographical location of the plurality of images. 4 independent and 66 dependent claims, 12 figures.

**ФЕДЕРАЛЬНАЯ СЛУЖБА ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ,  
ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ  
(РОСПАТЕНТ)**

Бережковская наб, 30, корп 1, Москва, Г-59, ГСП-5, 123995 Телефон (8-499) 240- 60- 15 Факс (8-495) 234- 30- 58

На № 2412-141421RU/8272 от 16.07.2009  
09.09.2009  
Наш № 2007103331/28(003582)

129090, Москва, ул. Б.Спаская, 25, стр.3,  
ООО "Юридическая фирма Городисский и  
Партнеры"

*При перепiske просим ссылаться на номер заявки и  
сообщить дату получения настоящей корреспонденции  
от*

17 СЕН 2009

**РЕШЕНИЕ  
о выдаче патента на изобретение**

(21) Заявка № 2007103331/28(003582)

(22) Дата подачи заявки 30.06.2005

В результате экспертизы заявки на изобретение по существу установлено, что

☐ заявленное изобретение

☒ заявленная группа изобретений

относится к объектам патентных прав и соответствует условиям патентоспособности,  
предусмотренным Гражданским кодексом Российской Федерации, в связи с чем  
принято решение о выдаче патента на изобретение.

Заключение по результатам экспертизы прилагается.

Приложение: на 15 л. в 1 экз.

Руководитель



Б.П.Симонов

**ЗАКЛЮЧЕНИЕ ПО РЕЗУЛЬТАТАМ ЭКСПЕРТИЗЫ**

(21) Заявка № 2007103331/28(003582) (22) Дата подачи заявки 30.06.2005  
(24) Дата начала отсчета срока действия патента 30.06.2005  
☒ (85) Дата начала рассмотрения международной заявки на национальной фазе 30.01.2007  
ПРИОРИТЕТ УСТАНОВЛЕН ПО ДАТЕ  
☐ (22) подачи заявки  
☐ (23) поступления дополнительных материалов от  
к ранее поданной заявке № \_\_\_\_\_ ОТ \_\_\_\_\_  
☐ (62) ☐ приоритета изобретения по первоначальной заявке № \_\_\_\_\_ ОТ \_\_\_\_\_,  
из которой данная заявка выделена  
☐ подачи первоначальной заявки № \_\_\_\_\_ ОТ \_\_\_\_\_,  
из которой данная заявка выделена  
☐ (66) подачи ранее поданной заявки № \_\_\_\_\_ ОТ \_\_\_\_\_  
☐ (30) подачи первой(ых) заявки(ок) в государстве-участнике Парижской конвенции  
(31) Номер первой(ых) заявки(ок) (32) Дата подачи первой(ых) заявки(ок) (33) Код страны  
1. 60/584,769 30.06.2004 US  
☒ (86) Заявка № PCT/US2005/023132 от 30.06.2005 ☐ (96) Заявка № EA  
☒ (87) Номер публикации и дата публикации заявки РСТ WO2006/004846 от 12.01.2006  
(72) Автор(ы) НЭГЛ Джон Энтони П, ОРРЕЛЛ Стивен С., ВИЛЛАР Кристофер М., US  
(73) Патентообладатель(и) ДЖОРДЖТАУН РЭЙЛ ЭКВИПМЕНТ КОМПАНИ, US  
(54) Название изобретения СИСТЕМА И СПОСОБ ДЛЯ КОНТРОЛЯ ЖЕЛЕЗНОДОРОЖНОГО  
ПУТИ

(см. на обороте)

04	Д	ДОМ 16.07.2009	280201
		ДОТ 09.09.2009	

**ВНИМАНИЕ!** С целью исключения ошибок просьба проверить сведения, приведенные в заключении, т.к. они без изменения будут внесены в Государственный реестр изобретений Российской Федерации, и незамедлительно сообщить об обнаруженных ошибках.

(21) 2007103331/28

(51) МПК

*G01C 3/08* (2006.01)

*B61K 9/08* (2006.01)

(57)

1. Система для контроля железнодорожного полотна, включающего в себя железнодорожный путь, подлежащая установке на транспортном средстве для перемещения по железнодорожному пути, система содержит:

по меньшей мере, один источник света, расположенный рядом с железнодорожным путем для проецирования пучка света от края до края железнодорожного полотна,

по меньшей мере, один оптический приемник, расположенный рядом с железнодорожным путем, для приема, по меньшей мере, части света, отраженного от железнодорожного полотна, и генерации совокупности изображений, представляющих профиль, по меньшей мере, участка железнодорожного полотна, и

по меньшей мере, один процессор для анализа совокупности изображений и определения географического местоположения совокупности изображений, причем процессор дополнительно выполнен с возможностью компилирования совокупности изображений с одной или более соответствующими физическими характеристиками, и записи соответствующего географического местоположения совокупности изображений.

2. Система по п. 1, в которой источником света является лазер.

3. Система по п. 2, в которой лазер излучает пучок инфракрасного света.

4. Система по п. 1, в которой, по меньшей мере, один источник света расположен, по существу, над железнодорожным путем и излучает пучок света, по существу, перпендикулярный железнодорожному пути.

5. Система по п. 2, в которой лазер излучает пучок света с угловым расхождением.
6. Система по п. 1, в которой, по меньшей мере, один оптический приемник содержит цифровую камеру.
7. Система по п. 1, в которой оптическое устройство содержит полосовой фильтр, позволяющий захватывать, по существу, только определенную длину волны пучка света в совокупности изображений.
8. Система по п. 1, в которой, по меньшей мере, один процессор содержит устройство хранения данных для хранения совокупности изображений.
9. Система по п. 1, дополнительно содержащая приемник GPS или кодер, который предоставляет данные географического местоположения для анализа с помощью процессора.
10. Система по п. 1, дополнительно содержащая датчик температуры, расположенный рядом с железнодорожным путем, который предоставляет температуру железнодорожного пути для анализа с помощью процессора.
11. Система по п. 1, в которой каждое из совокупности изображений содержит совокупность пикселей, заданную в координатах X-Y.
12. Система по п. 1, в которой каждое из совокупности изображений содержит координату Z, представляющую местоположение изображения вдоль железнодорожного пути.
13. Система по п. 1, в которой процессор включает в себя алгоритм для определения расстояния между шпалами железнодорожного полотна, причем алгоритм содержит этапы, на которых:
  - анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит шпалы, тогда как один или более промежуточных кадров с отсутствием шпал;
  - определяют количество из одного или более промежуточных кадров с отсутствием шпал;
  - определяют известный интервал между кадрами; и

определяют расстояние между шпалами конечного кадра, на основании количества из одного или более промежуточных кадров с отсутствием шпал и известного интервала между кадрами.

14. Система по п. 1, в которой процессор включает в себя алгоритм для идентификации конкретных компонентов железнодорожного полотна.

15. Система по п. 1, в которой процессор включает в себя алгоритм для определения дефекта в шпале железнодорожного полотна.

16. Система по п. 1, в которой процессор включает в себя алгоритм для обнаружения отсутствующих, невыровненных, поврежденных или дефектных компонентов крепежа железнодорожного полотна.

17. Система по п. 1, в которой процессор включает в себя алгоритм для обнаружения невыровненных или осевших рельсовых подкладок железнодорожного полотна, причем алгоритм содержит этапы, на которых: анализируют кадр совокупности изображений, причем кадр содержит интересующую область;

определяют содержит ли интересующая область рельсовую подкладку;

определяют контур шпалы и контур рельсовой подкладки, в случае предоставления рельсовой подкладки;

сравнивают ориентацию контура шпалы и ориентацию контура рельсовой подкладки; и

определяют на основании сравнения, является ли рельсовая подкладка невыровненной или осевшей.

18. Система по п. 1, в которой процессор включает в себя алгоритм для определения износа рельсов железнодорожного пути.

19. Система по п. 1, в которой процессор включает в себя алгоритм для определения расстояния между рельсами железнодорожного пути.

20. Система по п. 1, в которой процессор включает в себя алгоритм для определения высоты щебеночного слоя относительно шпалы железнодорожного полотна.

21. Система по п. 1, в которой процессор включает в себя алгоритм для определения размера щебня железнодорожного полотна.

22. Система по п. 1, в которой процессор включает в себя алгоритм для определения размера зазора между секциями железнодорожного пути.

23. Система по п.1, в которой процессор включает в себя алгоритм идентификации разрыва в рельсе железнодорожного полотна, причем алгоритм содержит этапы, на которых:

анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит рельсы, тогда как один или более промежуточных кадров с отсутствием рельс;

определяют количество из одного или более промежуточных кадров с отсутствием рельс;

определяют известный интервал между кадрами; и

идентифицируют разрыв в рельсе на основании количества из одного или более промежуточных кадров с отсутствием рельс и известного интервала между кадрами.

24. Способ контроля железнодорожного полотна, причем железнодорожное полотно включает в себя шпалы, рельсы, соответствующее крепежное оборудование и щебеночный слой, способ содержит этапы, на которых

a) освещают линию от края до края железнодорожного полотна,

b) принимают, по меньшей мере, часть света, отраженного от железнодорожного полотна,

c) генерируют совокупность изображений, представляющих профиль, по меньшей мере, участка железнодорожного полотна, и

d) анализируют совокупность изображений и определяют географическое местоположение совокупности изображений по железнодорожному полотну;

е) компилируют совокупность изображений с одной или более соответствующими физическими характеристиками железнодорожного полотна;

ф) записывают соответствующее географическое местоположение изображений; и

г) отображают определенные физические характеристики упомянутого железнодорожного полотна.

25. Способ по п. 24, в котором лазер освещает линию от края до края железнодорожного полотна.

26. Способ по п. 25, в котором лазер излучает пучок инфракрасного света.

27. Способ по п. 24, в котором линия от края до края железнодорожного полотна, по существу, перпендикулярна рельсам железнодорожного полотна.

28. Способ по п. 25, в котором лазер излучает линию с угловым расхождением.

29. Способ по п. 24, в котором цифровая камера принимает, по меньшей мере, часть света, отраженного от участка железнодорожного полотна.

30. Способ по п. 24, дополнительно содержащий этап, на котором отфильтровывают часть света, отраженного от участка железнодорожного полотна, с помощью полосового фильтра.

31. Способ по п. 24, дополнительно содержащий этап, на котором сохраняют совокупность изображений.

32. Способ по п. 24, дополнительно содержащий этап, на котором выдают данные географического местоположения из приемника GPS или кодера.

33. Способ по п. 24, дополнительно содержащий этап, на котором получают температуру рельсов железнодорожного полотна.

34. Способ по п. 24, в котором совокупность изображений содержит совокупность пикселей, заданных в координатах X-Y.

35. Способ по п. 34, в котором совокупность изображений дополнительно содержит координату  $Z$ , представляющую местоположение изображения вдоль рельса железнодорожного полотна.

36. Способ по п. 24, дополнительно содержащий этап, на котором определяют расстояние между шпалами железнодорожного полотна, причем этап определения расстояния содержит этапы, на которых:

анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит шпалы, тогда как один или более промежуточных кадров с отсутствием шпал;

определяют количество из одного или более промежуточных кадров с отсутствием шпал;

определяют известный интервал между кадрами; и

определяют расстояние между шпалами конечного кадра, на основании количества из одного или более промежуточных кадров с отсутствием шпал и известного интервала между кадрами.

37. Способ по п. 24, дополнительно содержащий этап, на котором идентифицируют конкретные компоненты железнодорожного полотна.

38. Способ по п. 24, дополнительно содержащий этап, на котором определяют дефект в шпале железнодорожного полотна.

39. Способ по п. 24, дополнительно содержащий этап, на котором обнаруживают отсутствующие, невыровненные, поврежденные или дефектные крепежные приспособления железнодорожного полотна.

40. Способ по п. 24, дополнительно содержащий этап, на котором обнаруживают невыровненные или осевшие рельсовые подкладки железнодорожного полотна, причем этап обнаружения содержит этапы, на которых:

анализируют кадр совокупности изображений, причем кадр содержит интересующую область;

определяют содержит ли интересующая область рельсовую подкладку;

определяют контур шпалы и контур рельсовой подкладки, в случае предоставления рельсовой подкладки;

сравнивают ориентацию контура шпалы и ориентацию контура рельсовой подкладки; и

определяют на основании сравнения, является ли рельсовая подкладка невыровненной или осевшей.

41. Способ по п. 24, дополнительно содержащий этап, на котором определяют износ рельса железнодорожного полотна.

42. Способ по п. 24, дополнительно содержащий этап, на котором определяют расстояние между рельсами железнодорожного полотна.

43. Способ по п. 24, дополнительно содержащий этап, на котором определяют высоту щебеночного слоя относительно шпалы железнодорожного полотна.

44. Способ по п. 24, дополнительно содержащий этап, на котором определяют размер щебня железнодорожного полотна.

45. Способ по п. 24, дополнительно содержащий этап, на котором определяют размер зазора между секциями рельса железнодорожного полотна.

46. Способ по п. 24, дополнительно содержащий этап, на котором идентифицируют разрыв в рельсе железнодорожного полотна, причем этап идентификации содержит этапы, на которых:

анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит рельсы, тогда как один или более промежуточных кадров с отсутствием рельс;

определяют количество из одного или более промежуточных кадров с отсутствием рельс;

определяют известный интервал между кадрами; и

идентифицируют разрыв в рельсе на основании количества из одного или более промежуточных кадров с отсутствием рельс и известного интервала между кадрами.

47. Способ контроля железнодорожного полотна, имеющего шпалы, рельсы, соответствующее крепежное оборудование и щебеночный слой, способ содержит этапы, на которых

- а) перемещаются вдоль рельсов,
- б) проецируют сфокусированный пучок света от края до края железнодорожного полотна,
- в) захватывают совокупность изображений сфокусированного пучка света, проецируемого от края до края железнодорожного полотна при перемещении вдоль рельсов,
- г) определяют один или более параметров участка железнодорожного полотна путем обработки совокупности изображений;
- д) компилируют соответствующие изображения участка железнодорожного полотна с соответствующими физическими характеристиками железнодорожного полотна;
- е) записывают соответствующее географическое местоположение соответствующих изображений;
- ж) выводят определенные один или более параметров участка железнодорожного полотна.

48. Способ по п. 47, в котором лазер проецирует сфокусированный пучок света от края до края железнодорожного полотна.

49. Способ по п. 48, в котором лазер излучает пучок инфракрасного света.

50. Способ по п. 48, в котором лазер расположен, по существу, над рельсами и излучает сфокусированный пучок света, по существу, перпендикулярный рельсам.

51. Способ по п. 48, в котором лазер излучает сфокусированный пучок света с угловым расхождением.

52. Способ по п. 47, в котором цифровая камера захватывает совокупность изображений.

53. Способ по п. 47, дополнительно содержащий этап, на котором фильтруют проецируемый пучок света с помощью полосового фильтра.

54. Способ по п. 47, дополнительно содержащий этап, на котором сохраняют совокупность изображений в устройстве хранения данных.
55. Способ по п. 47, дополнительно содержащий этап, на котором получают данные географического местоположения из приемника GPS или кодера.
56. Способ по п. 47, дополнительно содержащий этап, на котором получают температуру рельсов.
57. Способ по п. 47, в котором совокупность изображений дополнительно содержит совокупность пикселей, заданных в координатах X-Y.
58. Способ по п. 57, в котором совокупность изображений дополнительно содержит координату Z, представляющую местоположение изображения вдоль рельсов.
59. Способ по п. 47, дополнительно содержащий этап, на котором определяют расстояние между шпалами железнодорожного полотна, причем этап определения расстояния содержит этапы, на которых:  
анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит шпалы, тогда как один или более промежуточных кадров с отсутствием шпал;  
определяют количество из одного или более промежуточных кадров с отсутствием шпал;  
определяют известный интервал между кадрами; и  
определяют расстояние между шпалами конечного кадра, на основании количества из одного или более промежуточных кадров с отсутствием шпал и известного интервала между кадрами.
60. Способ по п. 47, дополнительно содержащий этап, на котором идентифицируют конкретные компоненты железнодорожного полотна.
61. Способ по п. 47, дополнительно содержащий этап, на котором определяют дефект в шпале железнодорожного полотна.

62. Способ по п. 47, дополнительно содержащий этап, на котором обнаруживают отсутствующие, невыровненные, поврежденные или дефектные крепежные приспособления.

63. Способ по п. 47, дополнительно содержащий этап, на котором обнаруживают невыровненные или осевшие рельсовые подкладки железнодорожного полотна, причем этап обнаружения содержит этапы, на которых:

анализируют кадр совокупности изображений, причем кадр содержит интересующую область;

определяют содержит ли интересующая область рельсовую подкладку;

определяют контур шпалы и контур рельсовой подкладки, в случае предоставления рельсовой подкладки;

сравнивают ориентацию контура шпалы и ориентацию контура рельсовой подкладки; и

определяют на основании сравнения, является ли рельсовая подкладка невыровненной или осевшей.

64. Способ по п. 47, дополнительно содержащий этап, на котором определяют износ рельсов.

65. Способ по п. 47, дополнительно содержащий этап, на котором определяют расстояние между рельсами.

66. Способ по п. 47, дополнительно содержащий этап, на котором определяют высоту щебеночного слоя относительно шпалы железнодорожного полотна.

67. Способ по п. 47, дополнительно содержащий этап, на котором определяют размер щебня железнодорожного полотна.

68. Способ по п. 47, дополнительно содержащий этап, на котором определяют размер зазора между секциями рельса.

69. Способ по п. 47, дополнительно содержащий этап, на котором идентифицируют разрыв в рельсе железнодорожного полотна, причем этап идентификации содержит этапы, на которых:

анализируют один или более промежуточных кадров и конечный кадр совокупности изображений, причем конечный кадр содержит рельсы, тогда как один или более промежуточных кадров с отсутствием рельс; определяют количество из одного или более промежуточных кадров с отсутствием рельс;

определяют известный интервал между кадрами; и

идентифицируют разрыв в рельсе на основании количества из одного или более промежуточных кадров с отсутствием рельс и известного интервала между кадрами.

70. Система для контроля железнодорожного полотна, включающего в себя рельсы, причем система подлежит установке на транспортном средстве для перемещения по железнодорожному пути, система содержит: по меньшей мере, один источник света расположенный рядом с железнодорожным полотном, для проецирования пучка света от края до края всего полотна,

по меньшей мере, один оптический приемник, расположенный рядом с железнодорожным полотном для захвата, по меньшей мере, части изображения железнодорожного полотна путем приема, по меньшей мере, части света, отраженного от железнодорожного полотна, причем оптический приемник включает в себя процессор для генерации пространственного профиля захваченного изображения железнодорожного полотна, и

по меньшей мере, один процессор для анализа пространственного профиля и определения географического местоположения совокупности изображений, причем процессор дополнительно выполнен с возможностью компилирования совокупности изображений с одной или более соответствующими физическими характеристиками, и записи соответствующего географического местоположения совокупности изображений по железнодорожному полотну.

(56) RU 2142892 C1, 20.12.1999

SU 1418105 A1, 23.08.1988

US 6615648 A1, 09.09.2003

JP 2000221146 A1, 11.08.2000

При публикации сведений о выдаче патента на изобретение будут использованы первоначальное описание и чертежи.

Приложения:

1.Реферат в редакции экспертизы на 1 л. в 1 экз.

Заместитель заведующего  
отделом измерительной техники  
и приборостроения ФГУ ФИПС

Е.Г.Водовозова  
8 499 240 61 64



В.А.Рентеев  
8 499 243 94 01

К заявке № 2007103331/28

*G01C3/08* (2006.01)

*B61K9/08* (2006.01)

(54) СИСТЕМА И СПОСОБ ДЛЯ КОНТРОЛЯ ЖЕЛЕЗНОДОРОЖНОГО ПУТИ

Реферат

(57) Изобретение относится к системе и способу контроля железнодорожного пути, в частности, к системе и способу контроля параметров железнодорожного пути с использованием лазера, камеры и процессора. Технический результат изобретения заключается в упрощении процедуры контроля состояния железнодорожного полотна. Способ контроля железнодорожного пути содержит этапы, на которых: освещают линию от края до края железнодорожного пути; принимают часть света, отраженного от железнодорожного полотна; генерируют совокупность изображений; анализируют совокупность изображений; компилируют совокупность изображений; записывают соответствующее географическое местоположений изображений; отображают физические характеристики участка железнодорожного пути. Система, реализующая способ контроля железнодорожного пути, подлежащая установке на транспортном средстве, содержит: по меньшей мере, один источник света, являющийся лазером, расположенный рядом с железнодорожным путем для проецирования пучка света от края до края железнодорожного полотна, один оптический приемник, расположенный рядом с железнодорожным путем. При этом оптический приемник содержит цифровую камеру, один процессор для анализа совокупности изображений и определения географического местоположения совокупности изображений. Причем процессор выполнен с

возможностью компилирования совокупности изображения и записи соответствующего географического местоположения совокупности изображений. 4н.п.ф-лы, 6бз.п.ф-лы, 12ил.

Референт Е.Г. Водовозова

Адрес для переписки с патентообладателем или его представителем, который будет опубликован в официальном бюллетене

☐

☒ указан на лицевой стороне решения

Адрес для направления патента

☐

☒ указан на лицевой стороне решения

☐ указан в графе «Адрес для переписки с патентообладателем...»

В результате экспертизы заявки по существу, проведенной в отношении

☐ первоначальной формулы изобретения      ☒ уточненной заявителем формулы изобретения установлено соответствие ☐ заявленного изобретения ☒ заявленной группы изобретений требованиям статей 1349 и 1350 Гражданского кодекса Российской Федерации.

Формула изобретения приведена на странице(ах) 3-13.

Примечание: с целью устранения технической опечатки из зависимых п.п.13,23,36,46,59,69 формулы исключен признак «первый кадр» (по аналогии с четвертой строкой упомянутых пунктов формулы, откуда этот признак исключен: «анализируют один или более промежуточных кадров и конечный кадр...»).

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	6608474
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Jade O. Laye/Leticia Haney
<b>Filer Authorized By:</b>	Jade O. Laye
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	10-DEC-2009
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	11:31:00
<b>Application Type:</b>	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) Filed (SB/08)	098__2_Suppl_Info_Disclosure_Statement.pdf	70040 de4498ba11797937f895e5415d651cf2725b a83d	no	3

**Warnings:**

**Information:**

This is not an USPTO supplied IDS fillable form					
2	Foreign Reference	JP2000221146A.pdf	301559 818e57076831e451559604ef14784df818234183	no	6
<b>Warnings:</b>					
<b>Information:</b>					
3	Foreign Reference	RU2142892C1.pdf	457284 74d7edefbe7cdc780335f2ddafa0ff624c907747	no	11
<b>Warnings:</b>					
<b>Information:</b>					
4	Foreign Reference	SU1418105A1.pdf	169391 f609fe243498f4ba67abee20bd294985633e48cb	no	3
<b>Warnings:</b>					
<b>Information:</b>					
5	NPL Documents	098RU_Decision_of_Grant.pdf	1190660 75ec6812b13839d90359aa6d156b6ccdea7790f9	no	26
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>			2188934		
<p>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.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b>  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.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b>  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.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b>  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.</p>					



# 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](http://www.uspto.gov)

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/489,570	06/23/2009	Christopher M. Villar	11042.0098.CPUS02

**CONFIRMATION NO. 1864**

23369

HOWREY LLP-HN

C/O IP DOCKETING DEPARTMENT

2941 FAIRVIEW PARK DRIVE, SUITE 200

FALLS CHURCH, VA 22042-7195

## PUBLICATION NOTICE



0000000039361864

**Title:**Tilt Correction System and Method for Rail Seat Abrasion

**Publication No.**US-2009-0319197-A1

**Publication Date:**12/24/2009

## 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](http://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 Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, 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](http://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 <http://pair.uspto.gov/>. 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 Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:  
Christopher M. Villar  
John Anthony Nagle, II  
Steven C. Orrell

Serial No.: 12/489,570

Filed: June 23, 2009

For: TILT CORRECTION SYSTEM AND  
METHOD FOR RAIL SEAT ABRASION

Group Art Unit: 3617

Examiner: Unknown

Atty. Dkt. No.: 11042.0098.CPUS02

Confirmation No.: 1864

**SECOND SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56, it is respectfully requested that this Second Supplemental Information Disclosure Statement be entered and the documents listed on attached Form PTO-1449 be considered by the Examiner and made of record. Copies of the listed documents required by 37 C.F.R. § 1.98(a)(2) are enclosed for the convenience of the Examiner.

In accordance with 37 C.F.R §§ 1.97(g) and (h), this Second Supplemental Information Disclosure Statement is not to be construed as a representation that a search has been made, and is not to be construed to be an admission that the information cited is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b). In addition, this Second Supplemental Information Disclosure Statement is not to be construed as a representation the cited art is, in fact, prior art.

DM\_US:23229321\_1

In accordance with 37 C.F.R. § 1.97(e)(1), Applicant hereby certifies that each item of information contained in this Second Supplemental Information Disclosure Statement was cited in a Search Report in a counterpart PCT application not more than three months prior to the filing of the present statement, as evidenced by the date of the enclosed search report. Only those references which have not been previously submitted in a prior Supplemental Information Disclosure Statement are submitted herewith.

As this Second Supplemental Information Disclosure Statement is being filed prior to the receipt of a first Official Action reflecting an examination on the merits, and is believed that no fee is required. However, if any fees under 37 C.F.R. § 1.16 to 1.21 are deemed necessary for any reason related to these materials, the Commissioner is hereby authorized to deduct said fees from Deposit Account No. 08-3038/11042.0098.CPUS02.

Assignee respectfully request that the listed documents be made of record in the present case. In order to facilitate the resolution of any issues or questions presented by this paper, the Examiner may directly contact the undersigned by phone to further the discussion.

Respectfully submitted,

Date:

5/3/10



Jade O. Laye, Esq.

Reg. No. 54,255

Attorney for Applicants/Assignee

Customer No. 23369  
HOWREY LLP  
1111 Louisiana, 25<sup>th</sup> Floor  
Houston, Texas 77002  
Telephone: (713) 787-1400  
Facsimile: (713) 787-1440

DM\_US:23229321\_1

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. 12/489,570
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: 06/23/2009	Group: 3617
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 1</i>	

### U.S. Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	US 2006/0017911 A1	01/26/2006	Villar et al	356	4.01	06/30/2005
	A2	4,700,223	10/13/1987	Shoutaro et al	358	93	02/24/1986
	A3	3,562,419	02/09/1971	Beckmann et al	178	6	12/21/1967

### Foreign Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1						
	B2						
	B3						

### Other Art (Including Author, Title, Date Pertinent Pages, Etc.)

Exam. Init.	Ref. Des.	Citation
	C1	PCT International Search Report and Written Opinion dated April 22, 2010 for corresponding PCT/US2010/025004
	C2	

<b>EXAMINER:</b>	<b>DATE CONSIDERED:</b>
EXAMINER: INITIAL IF REFERENCE CONSIDERED, WHETHER OR NOT CITATION IS IN CONFORMANCE WITH MPEP609; DRAW LINE THROUGH CITATION IF NOT IN CONFORMANCE AND NOT CONSIDERED. INCLUDE COPY OF THIS FORM WITH NEXT COMMUNICATION TO APPLICANT.	

INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)

DM\_US:23229334\_1

# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

## 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)

To: JADE LAYE HOWREY LLP 2941 FAIRVIEW PARK DR. SUITE 200 FALLS CHURCH, VA 22042	Date of mailing (day/month/year)
Applicant's or agent's file reference 11042.0098.00PC01	<b>FOR FURTHER ACTION</b> See paragraphs 1 and 4 below
International application No. PCT/US2010/025004	International filing date (day/month/year)    23 February 2010
Applicant GEORGETOWN RAIL EQUIPMENT COMPANY	

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.

**Where?** Directly to the International Bureau of WIPO, 34 chemin des Colombettes  
 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

**For more detailed instructions**, see the notes on the accompanying sheet.

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 the 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 the applicant's 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**

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 as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. 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. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

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.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

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:  Blaine R. Copenhaver  Telephone No. 571-272-7774
---	---

Form PCT/ISA/220 (January 2004)

(See notes on accompanying sheet)

REC'D HOWREY NT 04/26/10

# PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

# 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)

To: JADE LAYE  
HOWREY LLP  
2941 FAIRVIEW PARK DR. SUITE 200  
FALLS CHURCH, VA 22042

Date of mailing  
(day/month/year) **22 APR 2010**

Applicant's or agent's file reference

11042.0098.00PC01

**FOR FURTHER ACTION** See paragraphs 1 and 4 below

International application No.

PCT/US2010/025004

International filing date  
(day/month/year)

23 February 2010

Applicant

GEORGETOWN RAIL EQUIPMENT COMPANY

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.

**Where?** Directly to the International Bureau of WIPO, 34 chemin des Colombettes  
1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

**For more detailed instructions,** see the notes on the accompanying sheet.

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 the 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 the applicant's 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**

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 as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. 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. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

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.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

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:

Blaine R. Copenheaver

Telephone No. 571-272-7774

Form PCT/ISA/220 (January 2004)

(See notes on accompanying sheet)

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 11042.0098.00PC01	<b>FOR FURTHER ACTION</b> <div style="float: right; font-size: small;">see Form PCT/ISA/220 as well as, where applicable, item 5 below.</div>	
International application No. PCT/US2010/025004	International filing date ( <i>day/month/year</i> ) 23 February 2010	(Earliest) Priority Date ( <i>day/month/year</i> ) 23 June 2009
Applicant GEORGETOWN RAIL EQUIPMENT COMPANY		

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 43.6bis(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. 18  
☒ 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/US2010/025004

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - G01C 3/08 (2010.01) USPC - 356/4.01 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8) - G01C 3/08; G06F 19/00; E01B 35/00; B61K 9/00, 9/08 (2010.01) USPC - 356/4.01, 445, 625; 342/357.08; 701/300; 702/34  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) PatBase		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0017911 A1 (VILLAR et al) 26 January 2006 (26.01.2006) entire document	1-17
A	US 4,700,223 A (KATO et al) 13 October 1987 (13.10.1987) entire document	1-17
A	US 3,562,419 A (BECKMANN et al) 09 February 1971 (09.02.1971) entire document	1-17
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p>		
Date of the actual completion of the international search 12 April 2010		Date of mailing of the international search report <b>22 APR 2010</b>
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: Blaine R. Copenheaver  PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

## PCT

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

To: JADE LAYE HOWREY LLP 2941 FAIRVIEW PARK DR. SUITE 200 FALLS CHURCH, VA 22042			Date of mailing <i>(day/month/year)</i> <b>22 APR 2010</b>	
Applicant's or agent's file reference <b>11042.0098.00PC01</b>			<b>FOR FURTHER ACTION</b> See paragraph 2 below	
International application No. <b>PCT/US2010/025004</b>	International filing date <i>(day/month/year)</i> <b>23 February 2010</b>	Priority date <i>(day/month/year)</i> <b>23 June 2009</b>		
International Patent Classification (IPC) or both national classification and IPC <b>IPC(8) - G01C 3/08 (2010.01)</b> <b>USPC - 356/4.01</b>				
Applicant <b>GEORGETOWN RAIL EQUIPMENT COMPANY</b>				

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 43bis.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 66.1bis(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.

3. For further details, see notes to Form PCT/ISA/220.

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	Date of completion of this opinion  <b>12 April 2010</b>	Authorized officer:  <b>Blaine R. Copenheaver</b>  <small>PCT Helpdesk: 571-272-4300          PCT OSP: 571-272-7774</small>
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Form PCT/ISA/237 (cover sheet) (July 2009)

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.  
PCT/US2010/025004

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/US2010/025004

**Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Claims	None	YES
	Claims	1-17	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-17	NO
Industrial applicability (IA)	Claims	1-17	YES
	Claims	None	NO

**2. Citations and explanations:**

Claims 1-17 lack novelty under PCT Article 33(2) as being anticipated by Villar et al. Referring to claims 1-6, Villar et al discloses [Cl. 1] a system (30) for determining rail seat abrasion of a rail road track (12), the system (30) comprising: at least one light generator (40) positioned adjacent the rail road track (12), the light generator (40) adapted to project a beam of light (42) across the rail road track (12); at least one camera (50) positioned adjacent the rail road track (12) for receiving at least a portion of the light (42) reflected from the rail road track (12) and for generating at least one image (Para [0030]) representative of a profile of at least a portion of the rail road track (12), and at least one processor (60) adapted to perform the steps comprising: analyzing the at least one image (Para [0025]); and determining whether rail seat abrasion is present along the rail road track (12) (Para [0055]), wherein, when determining whether rail seat abrasion is present, the at least one processor compensates for a tilt of the rail road track (12) (Para [0047]); [Cl. 2] wherein the processor (60) compensates for the tilt (L1) of the rail road track (12) by the steps comprising: determining a height of a left rail base (12), right rail base (12), left crosstie (10) and right crosstie (10); determining a tilt correction factor (difference between the heights of the rails); determining an actual delta for the right (12) and left rail bases (12); and determining a rail seat abrasion value for the right (12) and left rail bases (12) (Fig. 5, Para [0047]); [Cl. 3] wherein the step of determining the heights further comprises the steps of: determining vertical pixel counts for each of the heights of the left rail base (12), right rail base (12), left crosstie (10) and right crosstie (10); and normalizing the vertical pixel counts based upon a measurement index (Para [0049]); [Cl. 4] wherein the step of determining the tilt correction factor is accomplished based upon the left (12) and right rail base heights (12) and a standard tilt correction factor (Para [0047]); [Cl. 5] wherein the step of determining the actual delta (angle) is accomplished based upon the tilt correction factor (See. Fig. 5, the height of the rails are shown by L1 compared to the height of the crossties shown by L2 provide the angle between the two lines to determine the angle, Para [0049]); [Cl. 6] wherein the step of determining the rail seat abrasion value is accomplished based upon the actual delta (Fig. 5, Para [0047]).

Referring to claims 7-11, Villar et al disclose [Cl. 7] a method for determining rail seat abrasion of a rail road track (12), the method comprising the steps of: (a) determining a height of a left rail (12) base, right rail (12) base, left crosstie (10) and right crosstie (10); (b) recording the heights of the left rail (12) base right rail (12) base, left crosstie (10) and right crosstie (10); (c) determining a tilt correction factor (differences between the heights of the rails); (d) determining an actual delta for the right (12) and left rail (12) bases; and (e) determining a rail seat abrasion value for the right (12) and left rail (12) bases (Para [0047]); [Cl. 8] wherein step (a) further comprises the steps of: determining vertical pixel counts for each of the heights of the left rail (12) base, right rail (12) base, left crosstie (10) and right crosstie (10); and normalizing the vertical pixel counts based upon a measurement index (Para [0046]); [Cl. 9] wherein the step (c) is accomplished based upon the left (12) and right rail (12) base heights and a standard tilt correction factor (differences between heights of the rails); [Cl. 10] wherein step (d) is accomplished based upon the tilt correction factor (actual delta takes into account the heights of both the rails 12 and crossties 10 and the differences between the left and right sides); [Cl. 11] wherein step (e) is accomplished based upon the actual delta for the right (12) and left rail (12) bases (the height of both rails and crossties would be the most reliable way to confirm the presence of rail seat abrasion, Para [0047]).

Continued on Supplemental Box

WRITTEN OPINION OF THE  
INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2010/025004

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

Box V

Referring to claims 12-17, Villar et al disclose [Cl. 12] a method for determining rail seat abrasion of a rail road track (12), the method comprising the steps of: (a) moving an inspection system (30) along the track (12); (b) receiving image data (Para [0030]) corresponding to at least a portion of the track (12); (c) determining a measurement of the rail seat abrasion for the portion of the track (Para [0047]), wherein the measurement are adjusted for tilt encountered as the inspection system (30) moves along the track (12) (heights of the rail and crossties are both taken to determine if tilt or rail abrasion has happen, Para [0047]); and (d) determining whether rail seat abrasion exists based upon the adjusted measurement (as seen in Fig. 5, a problem section of track is shown, also, as seen in Fig. 8, defects are shown in crosstie 10, which could show rail seat abrasion on a portion of track); [Cl. 13] wherein step (c) further comprises the steps of: determining a height of a left rail (12) base, right rail (12) base; left crosstie (10) and right crosstie (10) (see Fig. 2); determining a tilt correction factor (difference between heights of the two rails); determining an actual delta for the right (12) and left rail (12) bases (differences between rail and crossties are considered); and determining a rail seat abrasion value (amount that one rail may have sunken below its original height); [Cl. 14] wherein the step of determining the heights further comprises the steps of: determining vertical pixel counts (Para [0046]) for each of the heights of the left rail (12) base, right rail (12) base, left crosstie (10) and right crosstie (10); and normalizing the vertical pixel counts based upon a measurement index; [Cl. 15] wherein the step of determining the tilt correction factor (difference between heights of the two rails) is accomplished based upon the left (12) and right rail (12) base heights and a standard tilt correction factor (crossties will often be tilted through curved sections of railroad tracks, so rail abrasion may appear if this tilt is not accounted for); [Cl. 16] wherein the step of determining the actual delta is accomplished based upon the tilt correction factor (the heights of the rails, the crossties and the tilt of the crossties all need to be considered in determining if rail seat abrasion is occurring); [Cl. 17] wherein the step of determining the rail seat abrasion value is accomplished based upon the actual delta (Para [0047]).

Claims 1-17 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.

## NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*.

In these Notes, "Article," "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

### INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Annex B).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, International Phase, paragraph 296).

#### What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Preliminary Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

**When?** Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

#### Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

**How?** Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet or sheets containing a complete set of claims in replacement of all the claims previously filed must be submitted.

Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively in Arabic numerals (Section 205(a)).

**The amendments must be made in the language in which the international application is to be published.**

#### What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

**The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.**

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	7536330
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Jade O. Laye/Esmeralda Mercado
<b>Filer Authorized By:</b>	Jade O. Laye
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	03-MAY-2010
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	14:50:59
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	CPUS02_Suppl_IDS.pdf	79397 4d457769502f5f4ad1b30f88e58cbb77988d2ae	no	3

### Warnings:

### Information:

This is not an USPTO supplied IDS fillable form

2	NPL Documents	CPUS2_Int_search_report.pdf	569142	no	9
			7966ae61fd9172123f90a1d1026d2bbac97f c198		

**Warnings:**

**Information:**

<b>Total Files Size (in bytes):</b>	648539
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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.

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

<b>POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS</b>	<b>Application Number</b>	12/489,570
	<b>Filing Date</b>	6/23/2009
	<b>First Named Inventor</b>	Villar et al.
	<b>Title</b>	TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION
	<b>Art Unit</b>	2877
	<b>Examiner Name</b>	VALENTIN, Juan D.
	<b>Attorney Docket Number</b>	GREX.057CIP2

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

**OR**

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

67559

**OR**

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number:

**OR**

☐ The address associated with Customer Number:

**OR**

☐ Firm or Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the:

☐ Applicant/Inventor

☒ Assignee of record of the entire interest. See 37 CFR 3.71.  
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on \_\_\_\_\_

**SIGNATURE of Applicant or Assignee of Record**

Signature

Name

Title and Company

Date

Telephone

**NOTE:** Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

☐ \*Total of \_\_\_\_\_ forms are submitted.

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 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 3 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.

**STATEMENT UNDER 37 CFR 3.73(b)**

Applicant/Patent Owner: Georgetown Rail Equipment Company

Application No./Patent No.: 12/489,570

Filed/Issue Date: 06-23-2009

Titled: TITLE CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION

Georgetown Rail Equipment Company, a corporation

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;
  2. ☐ an assignee of less than the entire right, title, and interest in  
(The extent (by percentage) of its ownership interest is \_\_\_\_\_ %); or
  3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)
- the patent application/patent identified above, by virtue of either:

A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 023197, Frame 0859, or for which a copy therefore is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

2. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

3. From: \_\_\_\_\_ To: \_\_\_\_\_

The document was recorded in the United States Patent and Trademark Office at  
Reel \_\_\_\_\_, Frame \_\_\_\_\_, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

William C. Shell  
Signature

Jan 3, 2011  
Date

William C. Shell  
Printed or Typed Name

President + CEO  
Title

This collection of information is required by 37 CFR 3.73(b). 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. 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.

Electronic Acknowledgement Receipt	
<b>EFS ID:</b>	9315923
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	Tilt Correction System and Method for Rail Seat Abrasion
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	23369
<b>Filer:</b>	Rexford A. Johnson/Marjorie Dugdale
<b>Filer Authorized By:</b>	Rexford A. Johnson
<b>Attorney Docket Number:</b>	11042.0098.CPUS02
<b>Receipt Date:</b>	26-JAN-2011
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	21:01:18
<b>Application Type:</b>	Utility under 35 USC 111(a)

### Payment information:

Submitted with Payment	no
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### File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	GREX057CIP2_POA.pdf	509714 f72c580c1457102db2450dbc1bd8a51af3d c771c	no	1

### Warnings:

### Information:

2	Assignee showing of ownership per 37 CFR 3.73(b).	GREX057CIP2_Stmt_under_373b.pdf	494229 369dc0e2d604bc2c7fc0440be1e0c6c2a4d398f6	no	1
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>				1003943	
<p><b>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.</b></p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b>  <b>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.</b></p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b>  <b>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.</b></p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b>  <b>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.</b></p>					



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
12/489,570	06/23/2009	Christopher M. Villar	11042.0098.CPUS02

**CONFIRMATION NO. 1864**

**POWER OF ATTORNEY NOTICE**

23369  
HOWREY LLP-HN  
C/O IP DOCKETING DEPARTMENT  
1299 Pennsylvania Avenue, NW, Suite B-3  
Washington, DC 20004-2402



Date Mailed: 02/03/2011

**NOTICE REGARDING CHANGE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 01/26/2011.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/skiflemariam/

Office of Data Management, 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  
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
12/489,570	06/23/2009	Christopher M. Villar	GREX.057CIP2

**CONFIRMATION NO. 1864**

**POA ACCEPTANCE LETTER**

67559  
Zarian Midgley & Johnson PLLC  
University Plaza, 960 Broadway Ave., Suite 250  
Boise, ID 83706



Date Mailed: 02/03/2011

**NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY**

This is in response to the Power of Attorney filed 01/26/2011.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/skiflemariam/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

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

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.

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		12489570	
	Filing Date		2009-06-23	
	First Named Inventor	John Nagle, et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number	GREX.057CIP2		

U.S. PATENTS							Remove	
Examiner Initial*	Cite No	Patent Number	Kind Code <sup>1</sup>	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1							
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 <sup>1</sup>	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear		
	1	20040122569	A1	2004-06-24	Bidaud			
	2	20040088891	A1	2004-05-13	Theurer			
	3	20030140509	A1	2003-07-31	Casagrande			
If you wish to add additional U.S. Published Application citation information please click the Add button.							Add	
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	1	10040139	DE		2003-03-07	DWA Deutsche Waggonbau GMBH		<input type="checkbox"/>

<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		12489570	
	Filing Date		2009-06-23	
	First Named Inventor	John Nagle, et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		GREX.057CIP2	

	2	2674809	FR		1992-10-09	Lorraine Laminage		<input type="checkbox"/>
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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number	12489570
	Filing Date	2009-06-23
	First Named Inventor	John Nagle, et al.
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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	/Rexford A. Johnson/	Date (YYYY-MM-DD)	2011-05-31
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PATENT- UND  
MARKENAMT**

12 **Offenlegungsschrift**  
10 **DE 100 40 139 A 1**

51 Int. Cl. 7:  
**B 61 K 9/08**

21 Aktenzeichen: 100 40 139.2  
22 Anmeldetag: 13. 8. 2000  
43 Offenlegungstag: 7. 3. 2002

**DE 100 40 139 A 1**

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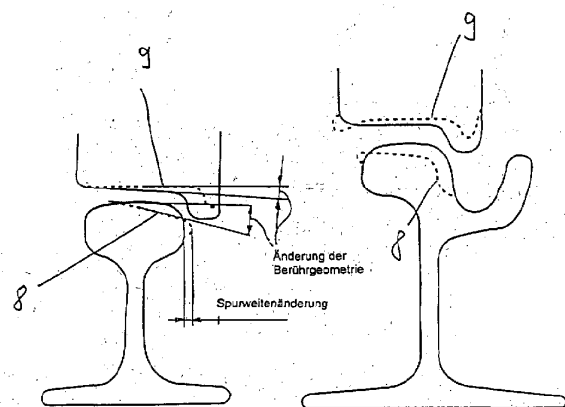
56 Entgegenhaltungen:  
DE 197 21 915 A1  
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Prüfungsantrag gem. § 44 PatG ist gestellt

54 Verfahren zur Messung von Schienenprofilen und Gleislagerstörungen sowie Vorrichtung zur Durchführung des Verfahrens

57 Nach der Erfindung zur Messung von Schienenprofilen und Gleislagerstörungen wird die Kontur des Profils in der y-z-Ebene punktuell erfasst und für diese Punkte werden in der x-z- und x-y-Ebene Relativbewegungen ermittelt, wobei eine laseroptische Messeinrichtung den Relativabstand zwischen der realen Lage des jeweiligen Schienenstranges im Raum zu dem Inertialsystem als Bezugsbasis im Raum sowie die Kontur der Fahrkantenprofile der rechten und linken Schiene misst. Die gemessenen Profile werden als Videobilder abgespeichert und bei nachfolgender Auswertung analysiert, gemittelt und/oder als Datenfile einem Simulationssystem zur Verfügung gestellt. Während der Fahrt werden die rechten und linken Profile optisch ausgewertet, die Höhenänderungen und Seitenänderungen ausgewählter Punkte der Profilkontur sowie der Schienenabstand als Spurweite online analog oder digital wieder ausgegeben. Da die Ausführung der Messtechnik für die linke und rechte Schiene je ein Abtastsystem beinhalten, welche starr miteinander verbunden sind, kann neben der Erfassung der Gleislagefehler auch die Spurweite online ermittelt werden.



**DE 100 40 139 A 1**

## Beschreibung

[0001] Die Erfindung betrifft ein Verfahren zur Messung von Schienenprofilen und Gleislagestörungen sowie Vorrichtung zur Durchführung des Verfahrens nach dem Oberbegriff des Anspruchs 1 und 2.

[0002] Die fahrzeugspezifische Belastung des Fahrwegs, dessen Zustand (Verschleiß, Spurweitenänderungen) sowie der Zustand der Laufflächen am Rad sind wesentliche Kriterien, die das Laufverhalten von Schienenfahrzeugen beeinflussen. Diese haben Auswirkungen auf die Zuordnung der Berührungspunkte an Rad und Schiene bei seitlicher Auslenkung, die Definition der äquivalenten Konizität, die Radien-differenz zwischen linkem und rechtem Rad und den Einfluss der Spurweite und Schienenform.

## Stand der Technik

[0003] Es ist ein Verfahren zur berührungslosen Messung des Verschleißes von Schienen und Vorrichtungen zur Durchführung des Verfahrens bekannt mit folgenden Verfahrensschritten:

- a) der Schienenkopf wird schräg oder senkrecht zur Fahrtrichtung beleuchtet
- b) entlang einer vorgegebenen Messstrecke wird der Lichtstreifen videotechnisch mit einer am Fahrzeug angebrachten Videokamera abgetastet
- c) das erzeugte visuelle Signal wird beim Überfahren der Wegstrecke den Wegsignalen eines Weggebers zugeordnet
- d) die Bild-Wegsignale werden in einem Speicher abgespeichert und die abgelegten Signale werden mit Hilfe einer Auswertungseinheit in schienenspezifische, Weg abhängige Informationen ausgewertet

[0004] Dieses bekannte Bildmesstechnik-Verfahren ist geeignet für die exakte Auswertung von Profillinienkonturen in der y-z-Ebene. Es ist aber nicht geeignet für die Ermittlung der Fahrweg abhängigen Gleislagestörungen.

[0005] Weiterhin ist ein Inertialmess-Verfahren auf der Basis Newtonscher Axiome bekannt, das die Erfassung von Messgrößen während der Fahrt in Bezug auf eine im Raum bewegte kreiselstabilisierte Plattform ermöglicht. Ausgehend von einem Festpunkt lassen sich Lage und Höhe weiterer Punkte bestimmen. Nachteilig bei diesem Verfahren wirken sich die mechanischen Komponenten aus, die berührungsabhängig funktionieren und Ursache für Fehler sind. Mit diesem Verfahren ist es nicht möglich, die Profilkontur zu bestimmen. Außerdem kann dieses Verfahren durch die mechanische Abtastung nur innerhalb begrenzter Geschwindigkeiten angewendet werden.

## Aufgabe der Erfindung

[0006] Aufgabe der Erfindung ist es, ein Verfahren zur Messung von Schienenprofilen und Gleislagestörungen sowie eine Vorrichtung zur Durchführung des Verfahrens zu schaffen, mit denen die Fehler aus der mechanischen Abtastung beseitigt werden, hohe Fahrgeschwindigkeiten zulässt und mittels Bildmesstechnik-Verfahren den Mess- und Auswertungsumfang erweitert. Die Aufgabe der Erfindung wird dadurch gelöst, dass die Kontur des Profils in der y-z-Ebene punktuell erfasst wird und für diese Punkte in der x-z- und x-y-Ebene Relativbewegungen ermittelt werden, wobei eine laseroptische Messeinrichtung den Relativabstand zwischen der realen Lage des jeweiligen Schienenstranges im Raum zu dem Inertialsystem als Bezugsbasis im Raum sowie die

Kontur der Fahrkantenprofile der rechten und linken Schiene misst. Die gemessenen Profile werden als Videobilder abgespeichert und bei nachfolgender Auswertung analysiert, gemittelt und/oder als Datenfile einem Simulationssystem zur Verfügung gestellt. Während der Fahrt werden die rechten und linken Profile optisch ausgewertet, die Höhenänderungen und Seitenänderungen ausgewählter Punkte der Profilkontur sowie der Schienenabstand als Spurweite online analog oder digital wieder ausgegeben. Da die Ausführung der Messtechnik für die linke und rechte Schiene je ein Abtastsystem beinhalten, welche starr miteinander verbunden sind, kann neben der Erfassung der Gleislagefehler auch die Spurweite online ermittelt werden.

## Beispiele

[0007] Die Erfindung soll anhand eines Ausführungsbeispiels näher erläutert werden. In den zugehörigen Zeichnungen zeigen:

[0008] Fig. 1 die Darstellung von Fahrkante der Schiene und Lauffläche des Rades bei eingetretenem Verschleiß

[0009] Fig. 2 die Zuordnung von Messgrößen zueinander bezüglich der gesuchten Messgröße

[0010] Fig. 3 die Darstellung des starr miteinander verbundenen Inertial- und Bildmesssystems

[0011] Fig. 4 die Darstellung der Lage der Schienenprofilkontur, der Bilderfassungssysteme und der Linienprojektoren im Raum

[0012] Fig. 5 ausgewählte Punkte der Schienenprofilkontur

[0013] Fig. 6 Messpunkte der Schienenprofilkontur

[0014] Fig. 7 vertikale Lageänderung der Scheitelpunktkoordinaten über der Fahrstrecke in der x-z-Ebene

[0015] Fig. 8 horizontale Lageänderungen der rechten und linken Spurweitenpunktkoordinaten zueinander und über der Fahrstrecke in der x-y-Ebene

[0016] Fig. 9 Lage der gemessenen Einzelprofile in der y-z-Ebene

[0017] Fig. 10 Ermittlung der Koordinaten eines Scheitelpunktes.

[0018] In Fig. 1 sind Verschleißzustände an Rad und Schiene dargestellt. Bei eingetretenem Verschleiß stellt sich eine reale Profilkontur 8 der Fahrkante der Schiene und eine reale Profilkontur 9 der Lauffläche des Rades ein, die erhebliche Abweichungen zu ihren ursprünglichen Konturen haben. Das bringt eine Veränderung der Berührgeometrie zwischen Rad und Schiene und eine Spurweitenänderung mit sich. In Fig. 2 ist eine Zuordnung von Messgrößen zueinander ersichtlich, deren Verkettung erforderlich ist, um eine gesuchte Messgröße  $M_G$  zu erhalten.

[0019] Über ein sich bewegendes Inertialmesssystem 4, welches sich in der relativen idealen Inertialebene 2 bewegt, wird eine Messgröße  $M_i$  ermittelt, welche den Abstand zu einer absoluten idealen Bezugsebene 1 beinhaltet.

[0020] Von dem sich bewegenden Inertialmesssystem 4, welches sich in der relativen idealen Inertialebene 2 bewegt, wird eine Messgröße  $M_B$  ermittelt, welche den Abstand zu einer relativen realen Messebene 3 am Messobjekt Schienenprofilkontur 7 beinhaltet.

[0021] In Fig. 3 sind die über eine starre Verbindung 6 miteinander verbundenen Komponenten Inertialmesssystem 4 und Bildmesssystem 5 dargestellt. Das Inertialmesssystem 4 enthält die Messplattform 13. Das Bildmesssystem 5 enthält das Bilderfassungssystem 11 und den Linienprojektor 12. In Fig. 4 ist die Lage der Schienenprofilkonturen in der y-z-Ebene, die Lage der Bilderfassungssysteme 11 und der Linienprojektoren 12 im Raum ersichtlich. In der y-z-Ebene sind die Mess- und Auswerteebenen 10 des Bilderfassungs-

systems **11** dargestellt. In **Fig. 5** sind ausgewählte Punkte der Schienenprofilkontur **14**, welche sich aus Einzelmesspunkten zusammensetzt, dargestellt. Hierbei handelt es sich um die Koordinaten des Scheitelpunktes SP auf der z-Achse für die rechte und linke Schiene und den Spurweitenmesspunkt SW auf der y-Achse für die linke und rechte Schiene. **Fig. 6** enthält eine Darstellung der aus zahlreichen Einzelpunkten zusammengesetzten Schienenprofilkontur **14**. In **Fig. 7** ist die vertikale Lageänderung der Koordinaten des Scheitelpunktes SP über der Fahrstrecke in der x-z-Ebene dargestellt. In **Fig. 8** ist die horizontale Lageänderung der rechten und linken Koordinaten der Spurweitenpunkte SW zueinander und über der Fahrstrecke in der x-y-Ebene dargestellt. **Fig. 9** zeigt die Lage aufeinanderfolgend gemessener Schienenprofilkonturen **14** in der y-z-Ebene. **Fig. 10** demonstriert die Ermittlung der Koordinaten eines Scheitelreferenzpunktes SR. Diese beinhaltet als ersten Schritt die Suche des Spurweitenmesspunktes SW 14 mm unterhalb des Scheitelpunktes SP im Bereich der Fahrkante. Von diesem Punkt aus wird im horizontalen Abstand von 35 mm nach oben gelotet der Scheitelreferenzpunkt SR auf der Kontur ermittelt. In den Zeichnungen und Beschreibungen bedeuten:

l = links

r = rechts

i = Zählvariable [1, 2, . . . , n]

x = Raumkoordinate horizontal längs = Fahrtrichtung

y = Raumkoordinate horizontal quer

z = Raumkoordinate senkrecht

#### Bezugszeichenliste

**1** absolute ideale Bezugsebene im Raum  
**2** relative ideale Inertialebene im Raum  
**3** relative reale Messebene am Schienenprofil im Raum  
**4** bewegtes Inertialmesssystem  
**5** bewegtes Bildmeßsystem  
**6** starre Verbindung (von **4** und **5**)  
**7** Messobjekt Schienenprofilkontur  
**8** reale Profilkontur der Fahrkante der Schiene  
**9** reale Profilkontur der Lauffläche des Rades  
**10** Mess- und Auswerteebene  
**11** Bilderfassungssystem  
**12** Linienprojektor  
**13** Messplattform  
**14** Schienenprofilkontur  
 SP Scheitelpunkt  
 SR Scheitelreferenzpunkt  
 SW Spurweitenmesspunkt  
 l links  
 r rechts  
 i Zählvariable [1, 2, . . . , n]  
 x Raumkoordinate horizontal längs (Fahrtrichtung)  
 y Raumkoordinate horizontal quer  
 z Raumkoordinate senkrecht,  
 $M_G$  gesuchte Messgröße des Verfahrens  
 $M_I$  Messgröße des Inertialsystems  
 $M_B$  Messgröße des Bildmesssystems

#### Patentansprüche

1. Verfahren zur Messung von Schienenprofilen und Gleislagestörungen sowie Vorrichtung zur Durchführung des Verfahrens unter Anwendung des Inertialmess-Verfahrens und des Bildmesstechnik-Verfahrens und der Vorrichtungen zur Ausführung der Verfahren, **dadurch gekennzeichnet**, dass eine Schienenprofilkontur (**14**) in einer y-z-Ebene als Matrix im Videobild

einer laseroptischen Messeinrichtung des Bilderfassungssystems (**11**) erfasst wird und für ausgewählte Punkte dieser Kontur in einer x-z- und x-y-Ebene Ortsveränderungen bestimmt werden und das Bilderfassungssystem (**11**) den Relativabstand zwischen der realen Lage des jeweiligen Schienenstranges im Raum zu der Bezugsbasis Inertialmesssystem (**4**) im Raum sowie die Kontur der Fahrkantenprofile der rechten und linken Schiene misst, dass die gemessenen Schienenprofilkonturen (**14**) als Videobilder abgespeichert, die Konturen geglättet und als Datenfile ausgelagert werden, dass während der Fahrt die rechten und linken Schienenprofilkonturen (**14**) optisch ausgewertet werden und die lateralen und vertikalen Lageänderungen der Profilkontur in der y-z-Ebene sowie der Schienenabstand als Spurweite aus den Konturen online während der Fahrt als Messwert ausgegeben werden, wobei die Ausführung der Messtechnik für die linke und rechte Schiene je ein Bilderfassungssystem (**11**) vorsieht, die mechanisch starr miteinander verbunden sind.

2. Verfahren nach Anspruch 1 dadurch gekennzeichnet, dass pro Schienenprofil mehrere Bilderfassungssysteme (**11**) vorhanden sind, die aus unterschiedlichen Einfallswinkeln den Schienenkopf betrachten.

3. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Auswertung der Profilkontur einen Scheitelreferenzpunkt (SR) auf der Lauffläche im Bereich der Mitte des Schienenkopfes ermittelt.

4. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Messdaten der unterschiedlichen Messverfahren, Inertialmesssystem (**4**) und Bildmesssystem (**5**), synchron durch einen oder mehrere synchronisierte Computermesssysteme erfasst werden.

5. Vorrichtung zur Messung von Schienenprofilen und Gleislagestörungen, bestehend aus einem Inertialmesssystem und zwei bereits fest miteinander verbundenen Bildmesssystemen, dadurch gekennzeichnet, dass mindestens zwei Bildmesssysteme (**5**) und mindestens ein Inertialmesssystem (**4**) starr miteinander verbunden sind:

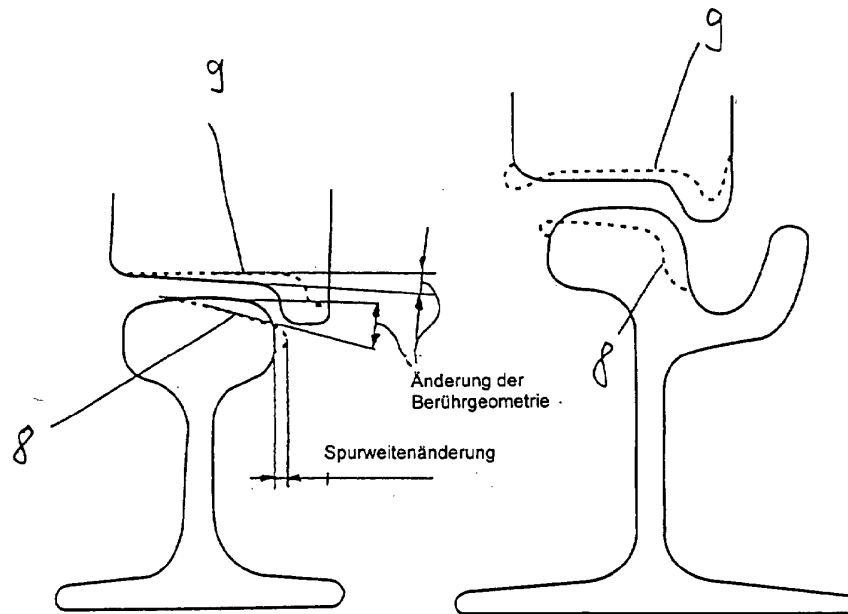
6. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, dass die Vorrichtungen für die unterschiedlichen Messverfahren, Bildmesssystem (**5**) und Inertialmesssystem (**4**), am Wagenkasten angeordnet sind.

7. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, dass die Vorrichtungen für die unterschiedlichen Messverfahren, Bildmesssystem (**5**) und Inertialmesssystem (**4**), im Drehgestell angeordnet sind.

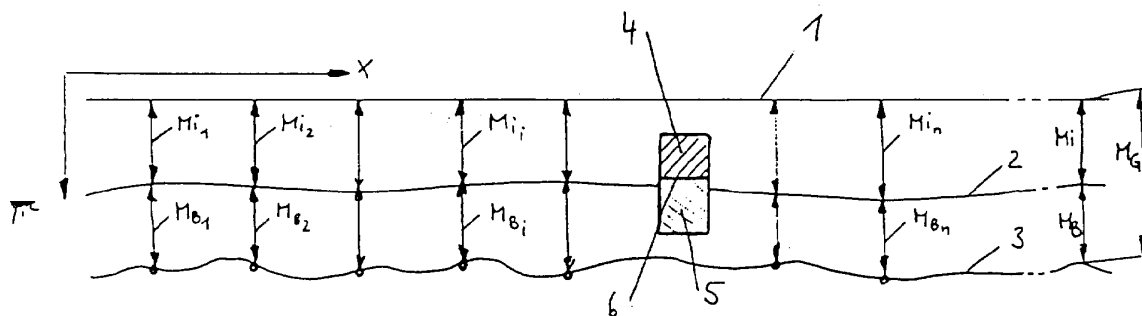
8. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, dass die Vorrichtungen für die unterschiedlichen Messverfahren, Bildmesssystem (**5**) und Inertialmesssystem (**4**), in einem separaten Messfahrzeug angeordnet sind.

9. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, dass in die Vorrichtung ein oder mehrere synchronisierte Computermesssysteme integriert sind.

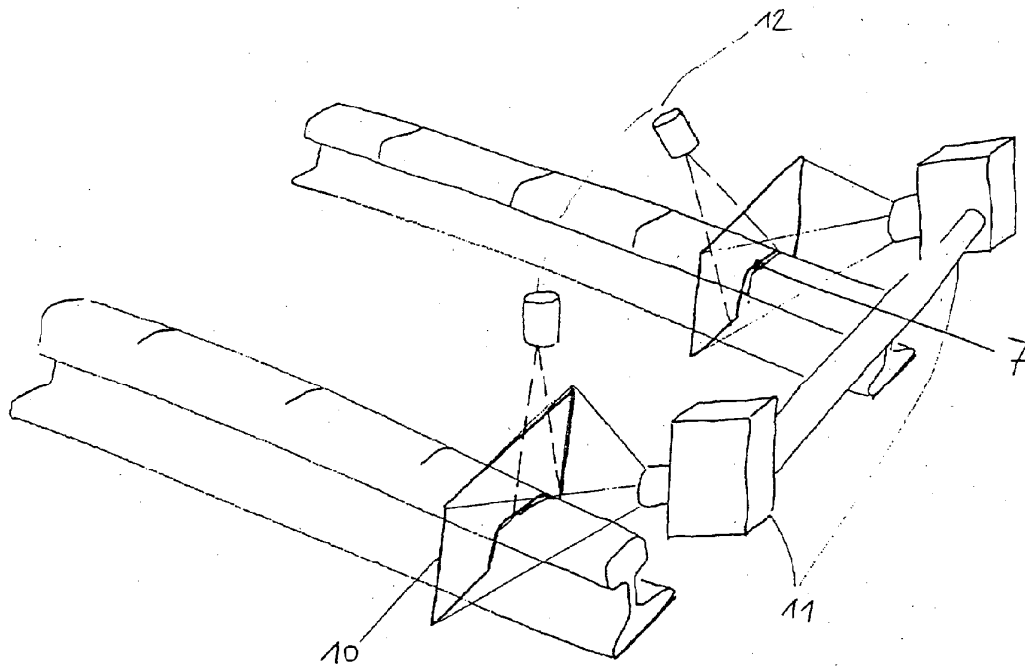
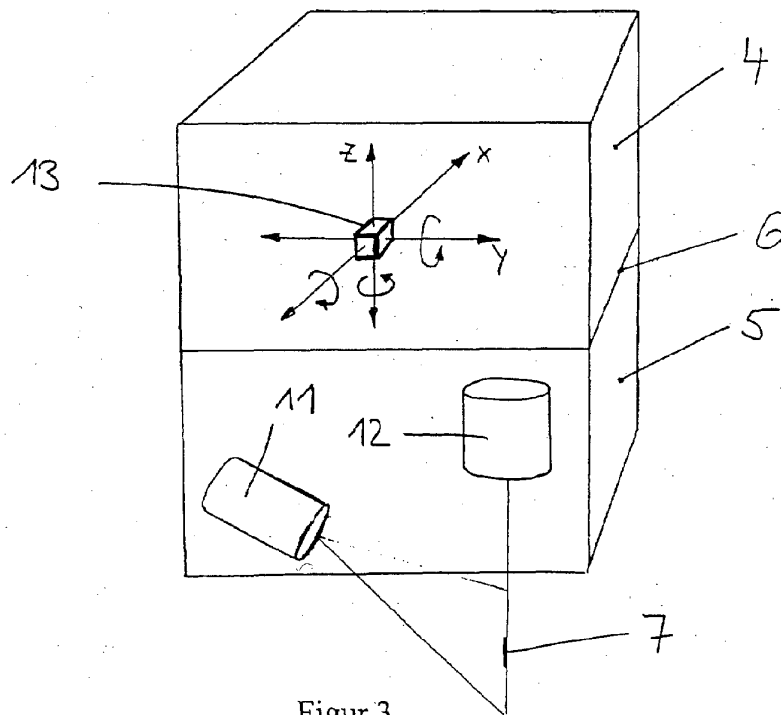
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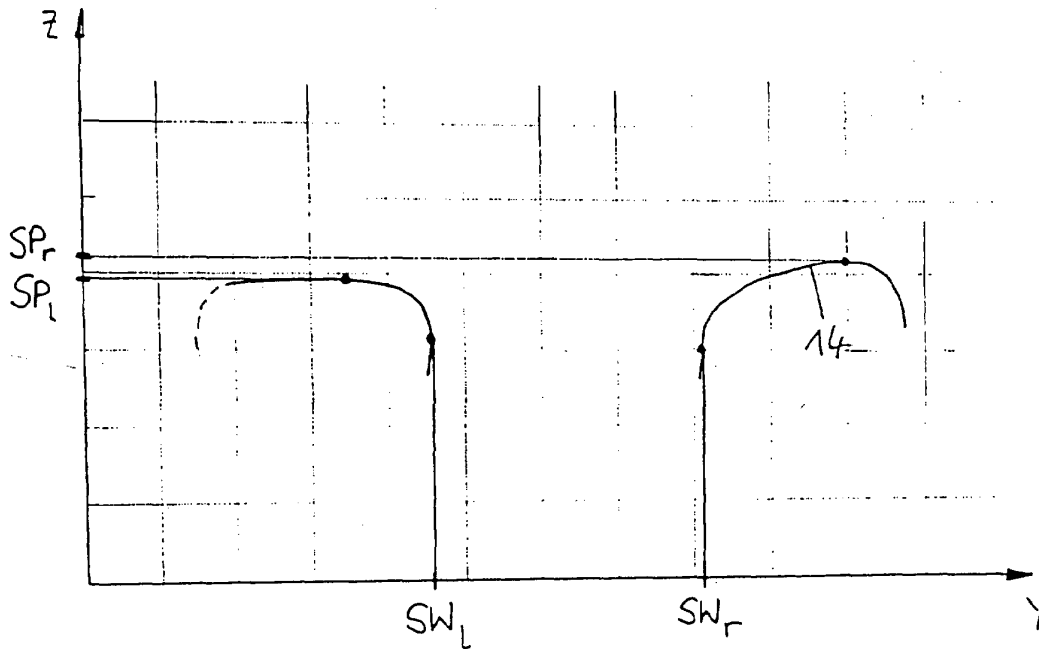


Figur 1

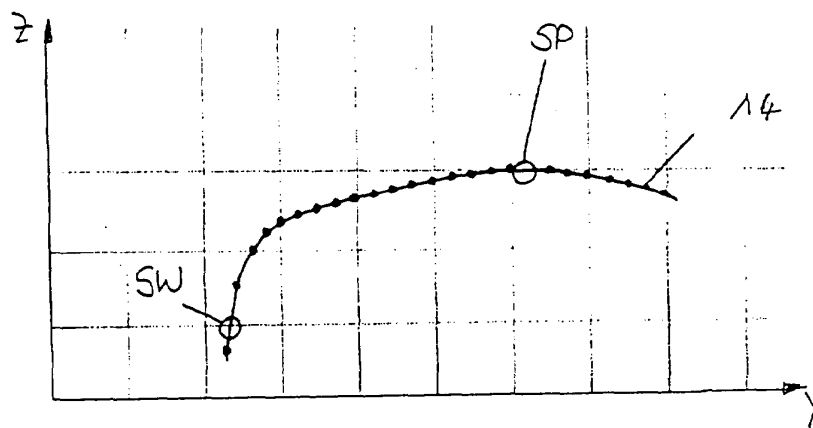


Figur 2

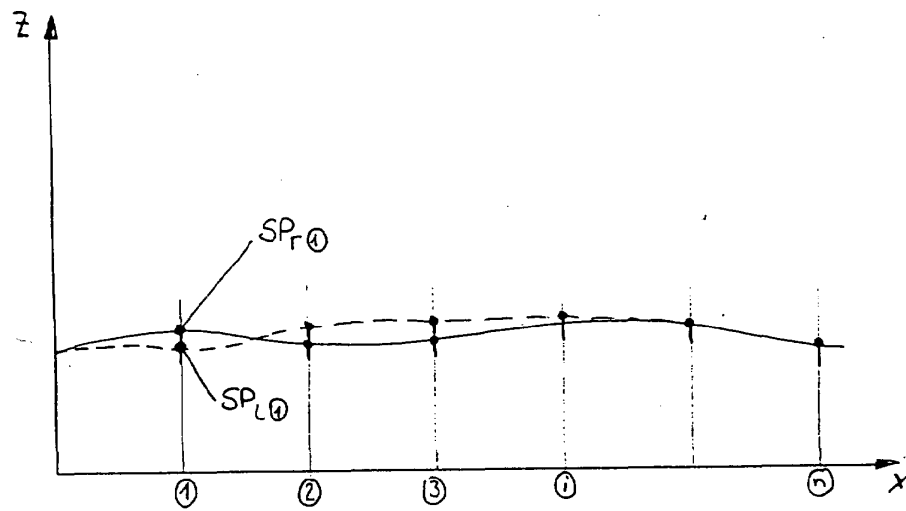




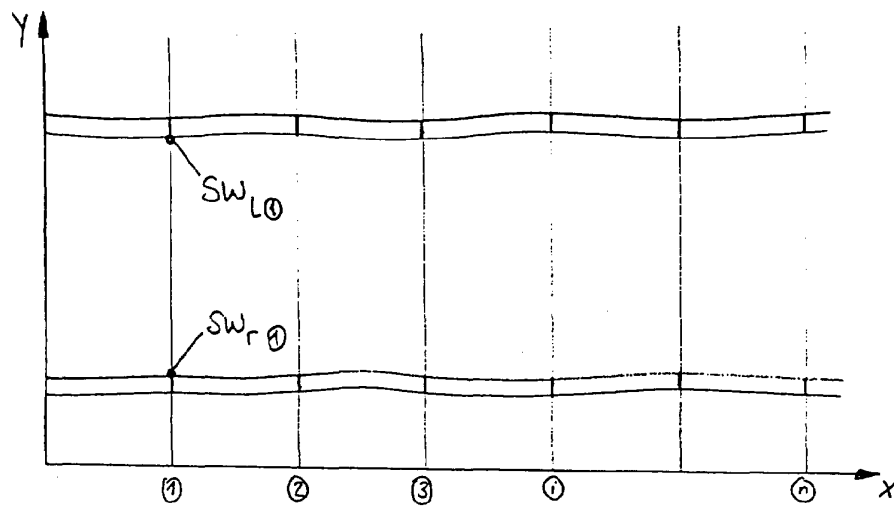
Figur 5



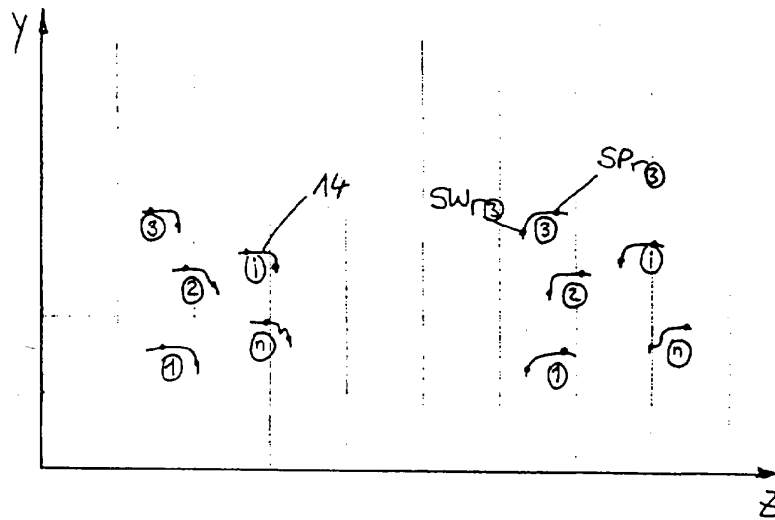
Figur 6



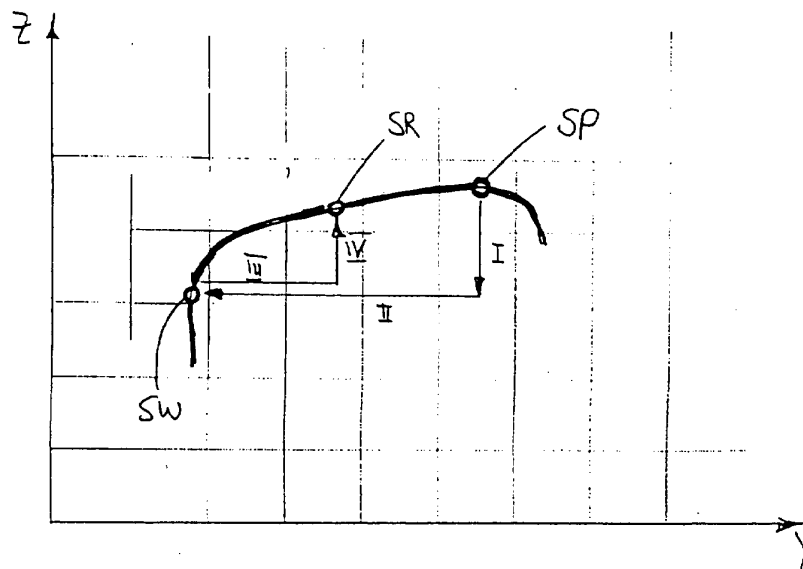
Figur 7



Figur 8



Figur 9



Figur 10

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2 674 809

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51 Int Cl<sup>5</sup> : B 61 K 9/08; G 01 B 11/02

12

## DEMANDE DE BREVET D'INVENTION

A1

22 Date de dépôt : 08.04.91.

30 Priorité :

43 Date de la mise à disposition du public de la  
demande : 09.10.92 Bulletin 92/41.

56 Liste des documents cités dans le rapport de  
recherche : *Se reporter à la fin du présent fascicule.*

60 Références à d'autres documents nationaux  
apparentés :

71 Demandeur(s) : Société dite: SOLLAC — FR.

72 Inventeur(s) : Joly Pascal et Bascop Bernard.

73 Titulaire(s) :

74 Mandataire : Cabinet Lavoix.

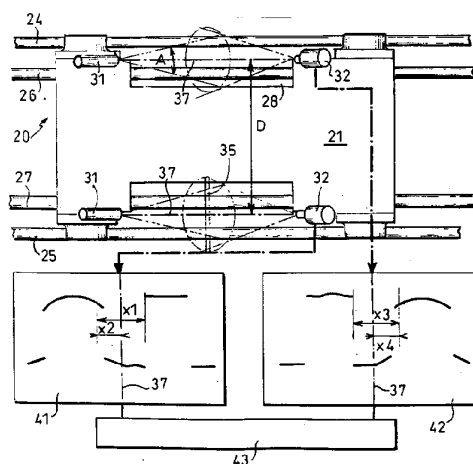
54 Dispositif de contrôle d'une voie de chemin de fer.

57 L'invention concerne un dispositif de contrôle dimensionnel d'une voie de chemin de fer.

Il comprend un chariot (20) se déplaçant sur la voie à contrôler, deux ensembles de mesure (31, 32) disposés chacun sur un côté dudit chariot au voisinage d'un rail et un dispositif de traitement de données (43).

Chaque ensemble de mesure comprend un émetteur de faisceau laser (31) monté à rotation de manière à réaliser un balayage sur le rail dans un plan incliné par rapport à la verticale et une caméra matricielle, réglable en site, azimut et déplacement latéral de manière à visualiser la partie du rail éclairée par le faisceau laser. Le dispositif de traitement de données (43) traite les signaux fournis par les deux caméras (32) pour calculer des caractéristiques dimensionnelles de la voie.

Application aux voies de chemin de fer d'usines métallurgiques.



FR 2 674 809 - A1



## 1

La présente invention concerne le contrôle des caractéristiques dimensionnelles d'une voie de chemin de fer. Pour éviter des accidents, en particulier des déraillements, il est nécessaire de vérifier que les  
5 voies de chemin de fer respectent des normes dimensionnelles.

Or, en particulier les voies de chemin de fer sur lesquelles circulent des wagons de poids élevé, comme c'est le cas des voies de chemin de fer des usines  
10 métallurgiques, sont soumises à une usure importante et il est donc nécessaire de faire des contrôles périodiques pour vérifier que les voies respectent les normes imposées afin de déclencher une opération de remise en état si cela s'avère nécessaire.

15 Ce contrôle s'effectue actuellement par un opérateur qui parcourt les voies à contrôler et effectue les mesures nécessaires. Outre les opérations de mesure, l'opérateur doit noter les résultats de ces mesures ; il y a donc un travail important de relevé et les valeurs  
20 relevées doivent ensuite faire l'objet d'une saisie en vue d'un traitement informatique qui détermine les travaux d'entretien à effectuer. Cette opération est donc longue et pénible et il y a un risque d'erreurs humaines dont les conséquences peuvent être coûteuses.

25 La présente invention se propose de fournir un dispositif de contrôle dimensionnel d'une voie de chemin de fer qui permet de réaliser automatiquement et de manière fiable le contrôle des voies de chemin de fer et de fournir directement les données à un dispositif de  
30 traitement de données.

L'invention a pour objet un dispositif de contrôle dimensionnel d'une voie de chemin de fer, caractérisé en ce qu'il comprend un chariot se déplaçant sur la voie à contrôler, deux ensembles de mesure disposés chacun sur un côté dudit chariot au voisinage d'un rail

et un dispositif de traitement de données, en ce que chaque ensemble de mesure comprend un émetteur de faisceau laser monté à rotation de manière à réaliser un balayage sur le rail dans un plan incliné par rapport à la verticale et une caméra matricielle montée à rotation autour d'un axe horizontal de manière à balayer la partie du rail éclairée par le faisceau laser et en ce que le dispositif de traitement de données traite les signaux fournis par les deux caméras pour calculer des caractéristiques dimensionnelles de la voie.

Le dispositif selon l'invention permet un relevé continu du profil de la voie à contrôler, le chariot se déplaçant en permanence, les mesures étant envoyées directement sur un dispositif de traitement de données qui peut alors fournir un bilan de l'état de la voie et déterminer éventuellement les opérations de remise en état nécessaires.

Selon un mode de réalisation, l'axe médian du faisceau laser est décalé vers l'intérieur de la voie par rapport au plan vertical axial du rail. Cette disposition permet de contrôler simultanément les caractéristiques des contre-rails se trouvant au niveau des aiguillages.

Avantageusement, chaque caméra comporte un filtre interférentiel, ce qui permet de s'affranchir des perturbations dues à la lumière ambiante.

Selon un mode de réalisation de l'invention, la plate-forme du chariot présente, entre les deux essieux, des découpes latérales par lesquelles passent les faisceaux lumineux des appareils des deux ensembles de mesure. De cette manière, les appareils de mesure peuvent être placés près de la voie tout en étant très accessibles.

D'autres caractéristiques et avantages de l'invention ressortiront de la description qui suit, d'exem-

ples de réalisation de l'invention, faite en se référant aux dessins annexés sur lesquels :

- la figure 1 représente le profil d'une voie de chemin de fer ;
- 5       - la figure 2 représente, en vue de dessus, la disposition des rails et contre-rails d'un aiguillage ;
- la figure 3 est une vue de profil d'un chariot de mesure selon la présente invention ;
- la figure 4 est une vue schématique de dessus
- 10       du chariot de la figure 3 ; et
- la figure 5 représente respectivement en vue de profil, en coupe transversale et en vue de dessus un rail illuminé par un faisceau laser dans un premier mode de réalisation de l'invention.

15       La figure 1 représente le profil normalisé d'une voie de chemin de fer. Une des caractéristiques importantes qui doit être vérifiée est la distance E entre les deux champignons 1 et 1' des deux rails 2 et 2' d'une voie ; cette distance E est mesurée à un niveau situé à

20       une distance d prédéterminée, par exemple 12 mm, du plan horizontal supérieur de contact 3 respectivement 3' du rail. Cette distance E doit par exemple être comprise entre 1420 et 1500 mm.

Par ailleurs, comme représenté à la figure 2, les

25       aiguillages comportent des contre-rails tels que 11 et 11' qui servent à guider les roues des wagons et dont l'écartement par rapport aux rails associés est également normalisé et doit être contrôlé.

L'invention a pour objet un appareil de mesure

30       qui permet de mesurer ces différents paramètres de manière continue, les mesures étant directement envoyées à un dispositif de traitement de données. Les figures 3 et 4 représentent de manière schématique un tel dispositif. Il est essentiellement constitué d'un chariot

35       comportant une plate-forme 21 portée par deux essieux 22

et 23. Ce chariot 20 se déplace sur une voie comportant deux rails 24 et 25 et deux contre-rails 26 et 27. On voit sur la figure 4 que le chariot présente sur sa plate-forme 21 entre les deux essieux 22 et 23, à l'a-  
5 plomb de chaque rail, une découpe latérale 28 qui permet de découvrir les rails et les contre-rails 24 à 27.

De chaque côté du chariot 20, on prévoit un ensemble de mesure constitué d'un émetteur laser 31 et d'une caméra matricielle associée 32. L'émetteur laser 31  
10 est monté à rotation de manière à réaliser un balayage dans un plan 33 perpendiculaire au plan vertical axial de chaque rail et incliné par rapport à la verticale. L'amplitude angulaire A (figure 4) de ce balayage est telle que le faisceau laser illumine le rail 24 et le  
15 contre-rail 26, respectivement 25 et 27.

La caméra 32, qui est par exemple de type réseau matriciel CCD, est montée sur la plate-forme 21 à rotation autour d'un axe horizontal 34 réglable en azimut et déplacements latéraux. Chaque caméra 32 vise la zone du  
20 rail et du contre-rail éclairée par le balayage du faisceau laser de l'émetteur 31 correspondant ; la fente d'analyse 35 de chaque caméra 32 est disposée perpendiculairement à l'axe de la voie à contrôler et, du fait de la rotation de la caméra 32 autour de l'axe horizontal  
25 34, cette fente d'analyse 35 balaye la zone du rail et du contre-rail correspondants éclairés par le faisceau laser. Avantageusement, la position médiane 36 du balayage de la caméra 32 est perpendiculaire au plan 33 du balayage du faisceau laser. L'inclinaison de ce plan de  
30 balayage 33 est avantageusement voisine de 45°.

Avantageusement, chaque caméra 32 est équipée d'un filtre interférentiel accordé sur la fréquence d'émission de l'émetteur laser 31 correspondant, de manière à supprimer les perturbations dues à la lumière  
35 ambiante.

Dans le cas de la figure 4, on a illustré de manière schématique les images 41 et 42 fournies par les deux caméras. Sur ces images on voit le profil supérieur des rails et des contre-rails, une partie de leurs talons ainsi que la trace de l'axe optique commun 37 de l'émetteur laser 31 et de la caméra 32 associés. Comme on peut le voir sur la figure 4, ces deux axes optiques communs 37 sont séparés par une distance transversale D.

Les images 41 et 42 sont envoyées à un dispositif de traitement de données 43 qui calcule les différentes dimensions, à savoir la distance  $x_2$ ; respectivement  $x_4$ , entre l'axe optique commun 37 précité et le bord du champignon de chaque rail, mesurée à 12 mm de la partie supérieure du champignon et les distances  $x_1$  et  $x_3$  correspondant à l'écartement des contre-rails par rapport aux rails, qui sont mesurées au même niveau. Le dispositif de traitement de données 43 peut facilement déterminer la distance E de la figure 1 qui est égale à la somme de la distance D séparant les deux axes optiques et des deux distances  $x_2$  et  $x_4$ .

La figure 5 représente le rail respectivement vu de profil, en coupe transversale et en vue de dessus lorsque le rail est illuminé par le faisceau laser du dispositif décrit à la figure 4. La source laser 31 est représentée de manière schématique et on a représenté en traits épais les traces 51 et 52 sur le champignon et sur la semelle du rail 24 du faisceau laser émis par l'émetteur 31.

Le fonctionnement du dispositif qui a été décrit est le suivant. Le chariot 20 parcourt les voies à contrôler à une faible vitesse. Les deux éléments de mesure de chaque ensemble à savoir l'émetteur laser et la caméra linéaire effectuent chacun leur balayage, à savoir dans un plan incliné 33 pour le faisceau laser et dans un plan vertical pour la caméra de manière à balayer la zone

illuminée par le faisceau laser. Les images fournies par la caméra linéaire sont enregistrées et analysées de manière à déterminer les caractéristiques dimensionnelles du rail et du contre-rail. Les résultats de la mesure  
5 sont enregistrés dans une mémoire du dispositif 43 en corrélation avec la position sur la voie.

Lorsqu'une voie a été complètement contrôlée, le dispositif de traitement de données 43 peut définir les opérations de remise en état nécessaires s'il s'avère que  
10 la voie ne répond plus aux normes imposées.

**REVENDICATIONS**

1. Dispositif de contrôle dimensionnel d'une voie de chemin de fer, caractérisé en ce qu'il comprend un chariot (20) se déplaçant sur la voie à contrôler, deux  
5 ensembles de mesure (31,32) disposés chacun sur un côté dudit chariot au voisinage d'un rail et un dispositif de traitement de données (43), en ce que chaque ensemble de mesure comprend un émetteur de faisceau laser (31) monté à rotation de manière à réaliser un balayage sur le rail  
10 dans un plan incliné par rapport à la verticale et une caméra matricielle, réglable en site, azimuth et déplacement latéral de manière à visualiser la partie du rail éclairée par le faisceau laser et en ce que le dispositif de traitement de données (43) traite les signaux fournis  
15 par les deux caméras (32) pour calculer des caractéristiques dimensionnelles de la voie.

2. Dispositif de contrôle dimensionnel d'une voie de chemin de fer selon la revendication 1, caractérisé en ce que le plan moyen (36) du balayage de la caméra (32)  
20 est perpendiculaire au plan de balayage (33) du faisceau laser.

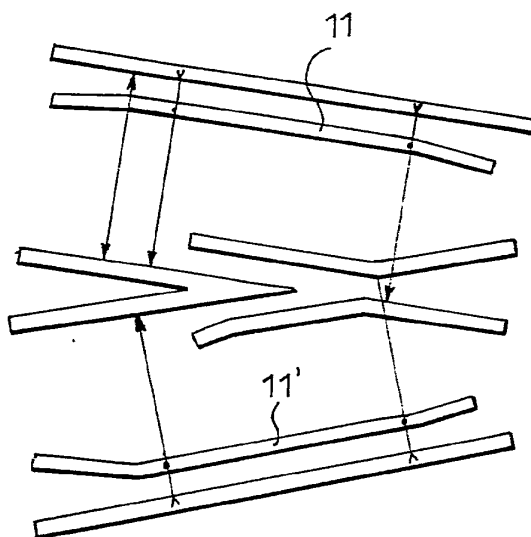
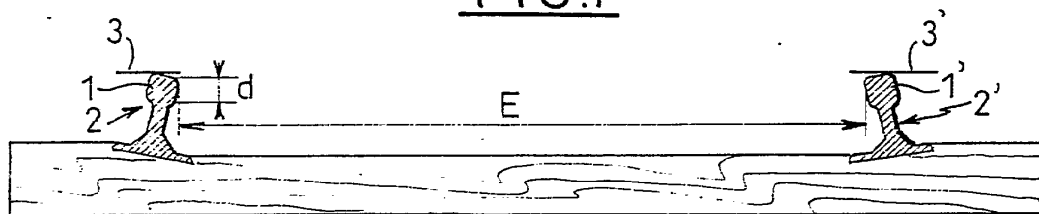
3. Dispositif de contrôle dimensionnel d'une voie de chemin de fer selon la revendication 1 ou 2, caractérisé en ce que le plan de balayage (33) du faisceau laser  
25 est incliné d'environ 45°.

4. Dispositif de contrôle dimensionnel d'une voie de chemin de fer selon l'une quelconque des revendications 1 à 3, caractérisé en ce que l'axe médian (37) du faisceau laser est décalé vers l'intérieur de la voie par rapport au plan vertical axial du rail (24,25).  
30

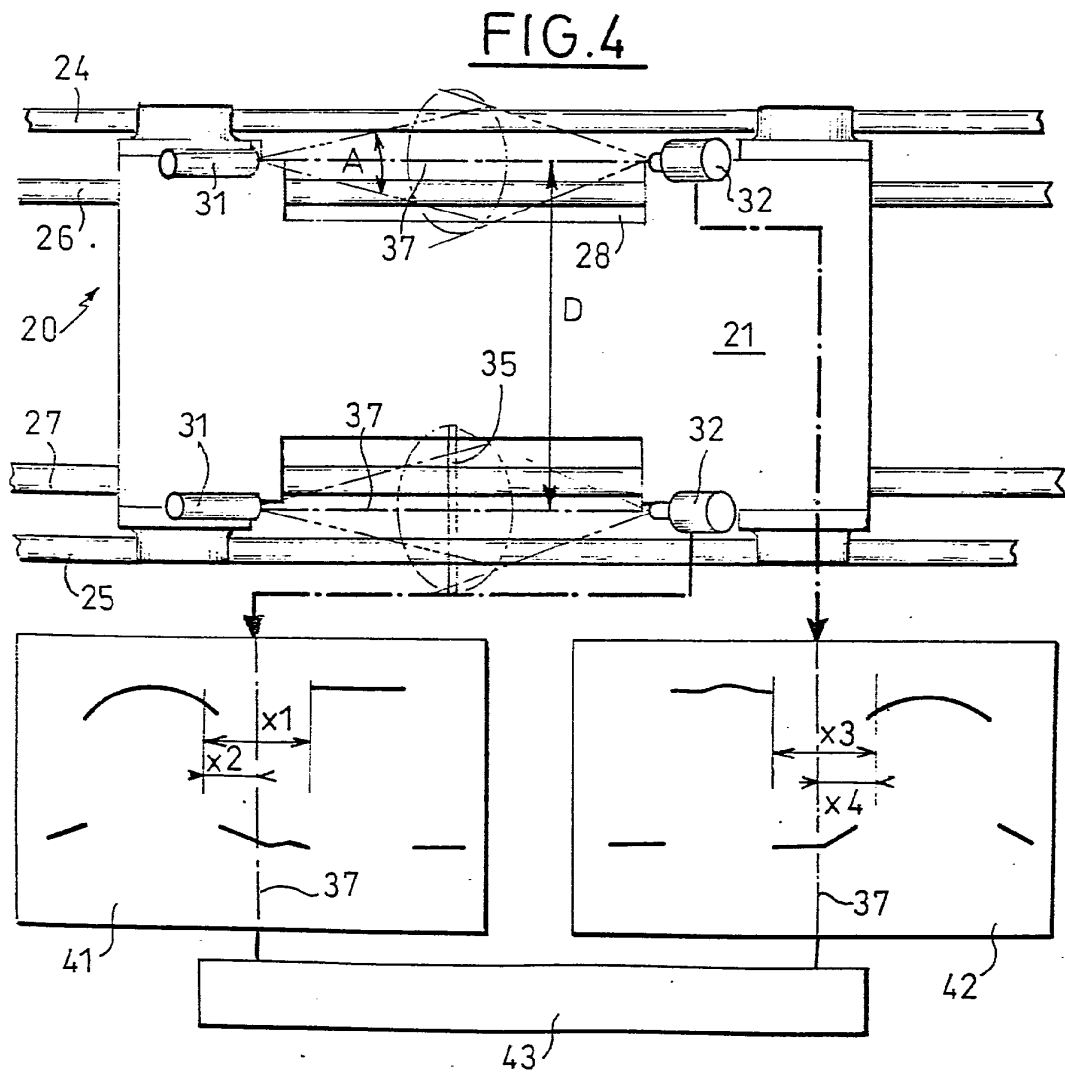
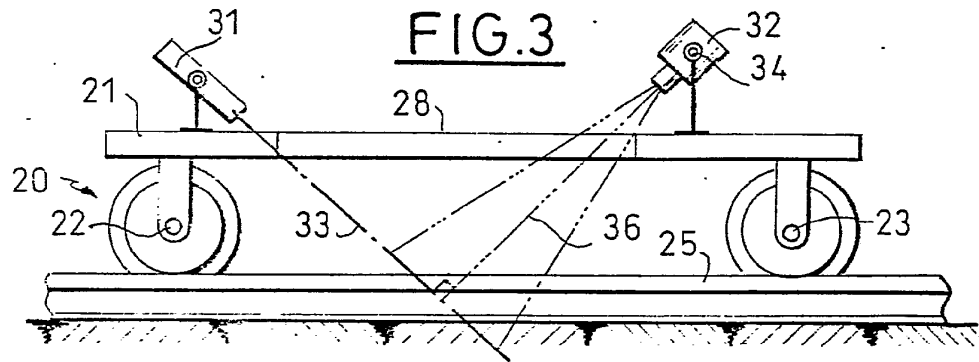
5. Dispositif de contrôle dimensionnel d'une voie de chemin de fer selon l'une quelconque des revendications 1 à 4, caractérisé en ce que chaque caméra (32) comporte un filtre interférentiel.

6. Dispositif de contrôle dimensionnel d'une voie de chemin de fer selon l'une quelconque des revendications 1 à 5, caractérisé en ce que la plate-forme (21) du chariot (20) présente, entre les deux essieux, deux découpes latérales (28) dans lesquelles passent les faisceaux optiques de la caméra (32) et de l'émetteur laser (31) respectifs.

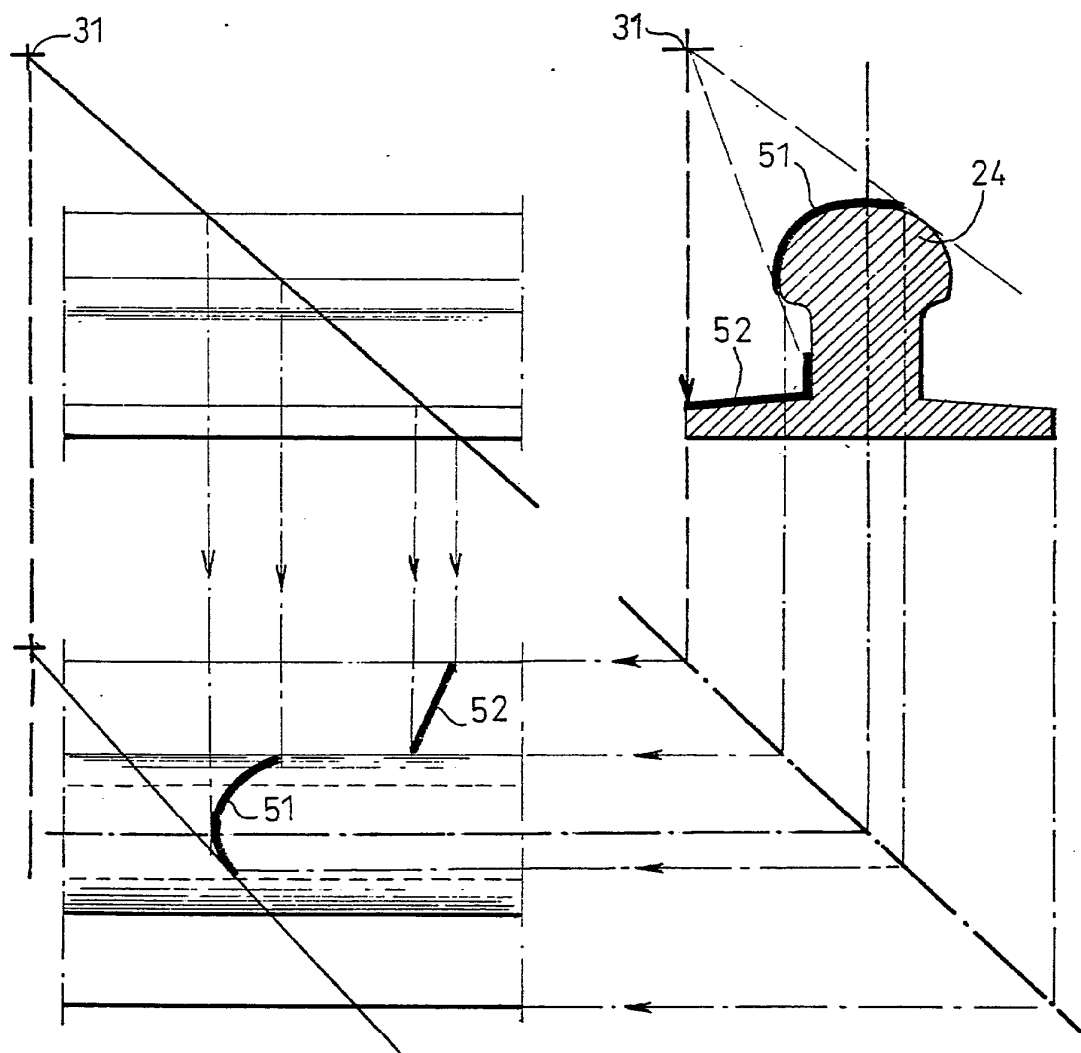
1/3

FIG.1FIG.2

2/3



3/3

FIG.5

2674809

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# RAPPORT DE RECHERCHE

établi sur la base des dernières revendications  
déposées avant le commencement de la recherche

N° d'enregistrement  
national

FR 9104262  
FA 456739

DOCUMENTS CONSIDERES COMME PERTINENTS		Revendications concernées de la demande examinée
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	
Y	US-A-4 198 164 (C. CANTOR) * colonne 3, ligne 11 - colonne 5, ligne 12; figures 1-3 *	1
A	----	2
Y	WERKSTATT UND BETRIEB vol. 122, no. 2, Février 1989, MÜNCHEN pages 151 - 153; G. BLUM: 'LASER - ABTASTSONDE ZUM ABSTANDSMESSEN' * page 151, colonne de gauche, ligne 32 - colonne de droite, ligne 6; figures 1,2 *	1
A	----- US-A-3 864 039 (R. W. WILMARTH) * colonne 3, ligne 6 - ligne 57; figures 2,3 *	1
		DOMAINES TECHNIQUES RECHERCHES (Int. Cl.5)
		B61K G01B E01B
Date d'achèvement de la recherche 04 DECEMBRE 1991		Examinateur CHLOSTA P.
<p><b>CATEGORIE DES DOCUMENTS CITES</b></p> <p>X : particulièrement pertinent à lui seul  Y : particulièrement pertinent en combinaison avec un autre document de la même catégorie  A : pertinent à l'encontre d'au moins une revendication ou arrière-plan technologique général  O : divulgation non-écrite  E : document intercalaire</p> <p>T : théorie ou principe à la base de l'invention  E : document de brevet bénéficiant d'une date antérieure à la date de dépôt et qui n'a été publié qu'à cette date de dépôt ou qu'à une date postérieure.  D : cité dans la demande  L : cité pour d'autres raisons  .....  &amp; : membre de la même famille, document correspondant</p>		



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004765

02.05.11

Reference P42176EP-K	Application No./Patent No. 05767776.7 - 1236 / 1766329 PCT/US2005023132
Applicant/Proprietor Georgetown Rail Equipment Company	

### Communication

The European Patent Office herewith transmits as an enclosure the supplementary European search report under Article 153(7) EPC for the above-mentioned European patent application.

If applicable, copies of the documents cited in the European search report are attached.

- ☒ 1 additional set(s) of copies of the documents cited in the European search report is (are) enclosed as well.

### Refund of search fee

If applicable under Article 9 Rules relating to fees, a separate communication from the Receiving Section on the refund of the search fee will be sent later.



EPO Form 1507.4 10.08



# **SUPPLEMENTARY EUROPEAN SEARCH REPORT**

Application Number  
EP 05 76 7776

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2004/122569 A1 (BIDAUD ANDRE C [CA]) 24 June 2004 (2004-06-24) * abstract; figures 17,21 * * paragraphs [0016], [0051], [0070] *	1-23	INV. G01B11/24
X	US 2004/088891 A1 (THEURER JOSEF [AT] ET AL) 13 May 2004 (2004-05-13) * abstract; figures 1,2 * * paragraph [0015] *	1-23	
X	US 2003/140509 A1 (CASAGRANDE ETTORRE [IT]) 31 July 2003 (2003-07-31) * abstract; figures * * paragraphs [0020], [0021], [0042] *	1-23	
X	DE 100 40 139 A1 (DWA DEUTSCHE WAGGONBAU GMBH [DE]) 7 March 2002 (2002-03-07) * abstract; figure 4 * * paragraph [0021] *	1-23	
A	FR 2 674 809 A1 (LORRAINE LAMINAGE [FR]) 9 October 1992 (1992-10-09)  * abstract * * page 4, lines 31-35 *	1,5,12, 16,18, 21,23	TECHNICAL FIELDS SEARCHED (IPC)  G01B B61K
The supplementary search report has been based on the last set of claims valid and available at the start of the search.			
Place of search <b>The Hague</b>		Date of completion of the search <b>19 April 2011</b>	Examiner <b>de Bakker, Michiel</b>
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons X : member of the same patent family, corresponding document</p>			

1  
EPO FORM 1503 03.02 (P04004)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 76 7776

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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19-04-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004122569 A1	24-06-2004	NONE	
US 2004088891 A1	13-05-2004	AT 5982 U2 AT 362014 T AU 2003259627 A1 CN 1500940 A DK 1420113 T3 EP 1420113 A2 ES 2285083 T3 JP 4113102 B2 JP 2004162524 A PL 363339 A1 RU 2250283 C1	25-02-2003 15-06-2007 24-02-2005 02-06-2004 16-07-2007 19-05-2004 16-11-2007 09-07-2008 10-06-2004 17-05-2004 20-04-2005
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EP0 FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Electronic Acknowledgement Receipt	
EFS ID:	10201101
Application Number:	12489570
International Application Number:	
Confirmation Number:	1864
Title of Invention:	Tilt Correction System and Method for Rail Seat Abrasion
First Named Inventor/Applicant Name:	Christopher M. Villar
Customer Number:	67559
Filer:	Rexford A. Johnson/Marjorie Dugdale
Filer Authorized By:	Rexford A. Johnson
Attorney Docket Number:	GREX.057CIP2
Receipt Date:	31-MAY-2011
Filing Date:	23-JUN-2009
Time Stamp:	19:24:41
Application Type:	Utility under 35 USC 111(a)

**Payment information:**

Submitted with Payment	no
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**File Listing:**

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Filed (SB/08)	022_GREX057CIP2_Supp_IDS. pdf	612547  9e818b748639e80abda09d907761ba59c9 3e76f1	no	4

**Warnings:**

**Information:**

2	Foreign Reference	DE10040139A1-Worbs.pdf	336163 b3136a5f7f8bc74d00f7368d7c72e5b641fc b4cb	no	8
Warnings:					
Information:					
3	Foreign Reference	FR2674809A1-Pascal.pdf	453915 a24bc7c2457ac2fe46471748831d3b410f67 e5a4	no	13
Warnings:					
Information:					
4	NPL Documents	GREX057EP_SuppSearchReport _05767776-7_05-02-2011.pdf	82174 e57fc66b4c2dd2374d9a7c085af9634ee934 9053	no	3
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<p>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.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b> 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.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b> 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.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b> 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.</p>					



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Zarian Midgley & Johnson PLLC  
University Plaza, 960 Broadway Ave., Suite 250  
Boise, ID 83706

EXAMINER

VALENTIN, JUAN D

ART UNIT

PAPER NUMBER

2877

DATE MAILED: 10/12/2011

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/489,570	06/23/2009	Christopher M. Villar	GREX.057CIP2	1864

TITLE OF INVENTION: TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	\$870	\$300	\$0	\$1170	01/12/2012

**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 SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

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: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.**

# **PART B - FEE(S) TRANSMITTAL**

**Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
or Fax (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)

67559 7590 10/12/2011  
Zarian Midgley & Johnson PLLC  
University Plaza, 960 Broadway Ave., Suite 250  
Boise, ID 83706

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

12/489,570	06/23/2009	Christopher M. Villar	GREX.057CIP2	1864
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TITLE OF INVENTION: TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	\$870	\$300	\$0	\$1170	01/12/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
VALENTIN, JUAN D	2877	356-606000

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 03-02 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, 1 \_\_\_\_\_  
(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. 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 has been filed for recordation as set forth in 37 CFR 3.11. 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. The following fee(s) are submitted:

- ☐ Issue Fee  
☐ Publication Fee (No small entity discount permitted)  
☐ Advance Order - # of Copies \_\_\_\_\_

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.  
☐ Payment by credit card. Form PTO-2038 is attached.  
☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number \_\_\_\_\_ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature \_\_\_\_\_

Date \_\_\_\_\_

Typed or printed name \_\_\_\_\_

Registration No. \_\_\_\_\_

This collection of information 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 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, 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.



# 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.
12/489,570	06/23/2009	Christopher M. Villar	GREX.057CIP2	1864
67559 7590 10/12/2011 Zarian Midgley & Johnson PLLC University Plaza, 960 Broadway Ave., Suite 250 Boise, ID 83706			EXAMINER VALENTIN, JUAN D	
			ART UNIT 2877	PAPER NUMBER

DATE MAILED: 10/12/2011

## Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 415 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 415 day(s).

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 Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

## **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.

<b>Notice of Allowability</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	12/489,570	VILLAR ET AL.	
	<b>Examiner</b>	<b>Art Unit</b>	
	JUAN D. VALENTIN II	2877	

**-- 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 06/23/2009.

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 1-17.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
     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. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS ( as "replacement sheets") must be submitted.  
     (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review ( PTO-948) attached  
         1) ☐ hereto or 2) ☐ to Paper No./Mail Date \_\_\_\_.

    (b) ☐ 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).**

7. ☐ 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. <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) 2. <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) 3. <input checked="" type="checkbox"/> Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date <u>See Continuation Sheet</u> 4. <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material	5. <input type="checkbox"/> Notice of Informal Patent Application 6. <input type="checkbox"/> Interview Summary (PTO-413), Paper No./Mail Date ____ . 7. <input type="checkbox"/> Examiner's Amendment/Comment 8. <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance 9. <input type="checkbox"/> Other ____ .
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Continuation of Attachment(s) 3. Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date: 06/23/2009, 12/10/2009, 05/03/2010, & 05/31/2011.

## **DETAILED ACTION**

### ***Allowable Subject Matter***

1. Claims 1-17 are allowed over prior art of record.
2. The following is a statement of reasons for the indication of allowable subject matter:

Regarding claim 1, the prior art fails to disclose or make obvious “wherein, when determining whether rail seat abrasion is present, the at least one processor compensates for a tilt of the rail road track” and in combination with the other recited limitations of claim 1. Claims 2-6 are allowed by virtue of dependency on the allowed claim 1.

Regarding claim 7, the prior art fails to disclose or make obvious “determining a rail seat abrasion value for the right and left rail bases” and in combination with the other recited limitations of claim 7. Claims 8-11 are allowed by virtue of dependency on the allowed claim 7.

Regarding claim 12, the prior art fails to disclose or make obvious “determining whether rail seat abrasion exists based upon the adjusted measurement” and in combination with the other recited limitations of claim 12. Claims 13-17 are allowed by virtue of dependency on the allowed claim 12.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JUAN D. VALENTIN II whose telephone number is (571)272-2433. The examiner can normally be reached on Mon.-Fri..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gregory J. Toatley, Jr. can be reached on (571) 272-2800 ext. 77. 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.

/GREGORY J TOATLEY/  
Supervisory Patent Examiner, Art Unit 2877

JUAN D VALENTIN II  
Examiner  
Art Unit 2877

/JDVII/  
October 6, 2011

<b>Notice of References Cited</b>	Application/Control No. 12/489,570	Applicant(s)/Patent Under Reexamination VILLAR ET AL.	
	Examiner JUAN D. VALENTIN II	Art Unit 2877	Page 1 of 1

**U.S. PATENT DOCUMENTS**

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,915,504 A1	04-1990	Thurston, David F.	356/604
*	B	US-6,647,891 B2	11-2003	Holmes et al.	356/602
*	C	US-2002/0070283 A1	06-2002	Young, Hartley Frank	238/264
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			


**FOREIGN PATENT DOCUMENTS**

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

**NON-PATENT DOCUMENTS**

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	


\*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.

<b>Issue Classification</b> 	<b>Application/Control No.</b> 12489570	<b>Applicant(s)/Patent Under Reexamination</b> VILLAR ET AL.
	<b>Examiner</b> JUAN D VALENTIN	<b>Art Unit</b> 2877

ORIGINAL						INTERNATIONAL CLASSIFICATION												
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED							
356		606				G	0	1	B	11 / 24 (2006.0)								
<b>CROSS REFERENCE(S)</b>																		
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)																	
238	264																	

<input checked="" type="checkbox"/> <b>Claims renumbered in the same order as presented by applicant</b> <input type="checkbox"/> <b>CPA</b> <input type="checkbox"/> <b>T.D.</b> <input type="checkbox"/> <b>R.1.47</b>															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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/JUAN D VALENTIN/ Examiner.Art Unit 2877  (Assistant Examiner)	10/06/2011  (Date)	<b>Total Claims Allowed:</b>  17	
/GREGORY J TOATLEY/ Supervisory Patent Examiner.Art Unit 2877  (Primary Examiner)	10/07/2011  (Date)	O.G. Print Claim(s)  1	O.G. Print Figure  14

<b><i>Search Notes</i></b>  	<b>Application/Control No.</b>  12489570	<b>Applicant(s)/Patent Under Reexamination</b>  VILLAR ET AL.
	<b>Examiner</b>  JUAN D VALENTIN	<b>Art Unit</b>  2877

SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
EAST	10/2/2011	/JDVII/
Searched Prior Art from parent applications #'s 12/465,473 & 11/172,618	10/2/2011	/JDVII/

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
See Search Notes		10/6/2011	/JDVII/

/J.D.V./ Examiner.Art Unit 2877	
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Receipt date: 12/10/2009

12489570 - GAU: 2877  
Page 1 of 1

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. 12/489,570
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: 06/23/2009	Group: 3617
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 1</i>	

**U.S. Patent Documents**

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	6,615,648	09/09/2003	Ferguson et al	73	146	12/22/1998

**Foreign Patent Documents**

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1	JP 200/221146 A1	08/11/200	Japan			Yes (Abstract)
	B2	RU 2142892	12/20/1999	Russia			Yes (Abstract)
	B3	SU 1418105	08/23/1988	Russia			No

**Other Art (Including Author, Title, Date Pertinent Pages, Etc.)**

Exam. Init.	Ref. Des.	Citation
	C1	Decision on Grant, dated October 22, 2009, for corresponding Russian patent application No. 2007103331.
	C2	

EXAMINER: /Juan Valentin/ (10/02/2011) | DATE CONSIDERED:

EXAMINER: INITIAL IF REFERENCE CONSIDERED, WHETHER OR NOT CITATION IS IN CONFORMANCE WITH MPEP609; DRAW LINE THROUGH CITATION IF NOT IN CONFORMANCE AND NOT CONSIDERED. INCLUDE COPY OF THIS FORM WITH NEXT COMMUNICATION TO APPLICANT.

**INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)**

DM\_US:22967205\_1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.V./

**EAST Search History****EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	4	("6647891") or ("4700223").PN.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2007/09/28 13:07
S2	1261	(railroad (rail adj road)) near3 (measur\$4 test\$4 inspect\$4 determin\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:11
S3	103590	"356".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S4	149447	"250".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S5	68859	"382".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S6	298386	S3 or S4 or S5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S7	74	S2 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S8	56	S2 and S6	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/22 16:12
S9	3	("5753808"   "6119353"   "6647891").PN. OR ("7403296").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2008/07/22 16:28

S10	2	"6647891".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/04/10 17:41
S11	2	((("6647891") or ("4700223")).PN.	USPAT; USOCR	OR	OFF	2009/07/27 00:47
S12	3582	determining with rail wirh road with bed with crossties.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2009/07/27 02:09
S15	15	("6615648"   "20060017911"   "20030140509"   "20040088891"   "20040122569"   "4265545"   "20060171704").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/22 20:51
S16	4252	determining with rail wirh road with bed with crossties.clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/09/22 21:08
S17	2	"20090273788".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 11:55
S18	1	S17 and (dip near3 solar)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 11:55
S19	1	S17 and (watts near3 intensity)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 11:58
S20	3	"4265545".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 12:05
S21	3	"20040122569".pn. "20040088891".pn. "20030140509".pn.	US-PGPUB	OR	ON	2011/09/29 12:09

S22	4	laser with (watts near3 inch) with intensity	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 12:13
S23	413	(watts near3 inch) with intensity	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 12:15
S24	11	S23 same laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 12:15
S25	7	S24 not S22	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 12:15
S26	5050	solar near3 spectrum	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:34
S27	49	S26 with laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:34
S28	215870	"356".clas. "382".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:34
S29	10	S27 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:34
S30	215487	railroad (rail adj road) railway tramway (train near3 rail)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:40
S31	3539	S30 and wavelength	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:41

S32	360963	"356".clas. "382".clas. "250".clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:41
S33	412	S31 and S32	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:41
S34	308	S33 and filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:41
S35	26	S33 and ((filtered filtering filter) near3 (sun solar))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:43
S36	2198	"808" near3 (nm (nano adj meter))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:50
S37	5	S30 and S36	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:50
S38	9	lens with spacer with filter with (CCD (charge adj coupled))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 16:14
S39	308975	(CCD (charge adj coupled))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 16:53
S40	6	S39 same spacer same lens same (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 16:54
S41	84	spacer same lens same (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:01

S42	20	S39 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:01
S43	1	detector with spacer with lens with (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:10
S44	9657	lens same (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:10
S45	4033	S39 and S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:10
S46	1447	S39 same S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:11
S47	174	S46 and spacer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:11
S48	2042	detector and spacer and lens and (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:11
S49	959	S48 and S39	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:11
S50	304	S32 and S49	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:11
S51	136	CCD near3 composition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:15

S52	0	S50 and S51	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:15
S53	22323	camera near3 structure	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:15
S54	1	S50 and S53	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:15
S55	13	spacer with lens with (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:21
S56	7	S39 and S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:22
S57	25360	(CCD (charge adj coupled)).ti.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:27
S58	30	S44 and S57	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:27
S59	207	lens same spacer same (filter with wavelength)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:30
S60	0	S57 and S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:31
S61	774	spacer with lens with (bandpass (band adj pass) filter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:33

S62	79	S61 and S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:33
S63	0	S62 and S57	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:34
S64	0	S57 and S61	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:34
S65	9	spacer with lens with (bandpass (band adj pass) filter) with S39	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 17:41
S66	4898	(CCD (charge adj coupled)) near3 (fabrication fabricating fabricate fabricated manufactured manufacturing manufacture)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 18:43
S67	19	S61 and S66	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 18:43
S68	3778	semiconductor near3 imaging near3 device	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:02
S69	10	spacer with bandpass with lens	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:02
S70	774	spacer with filter with lens	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:02

S71	89	S70 and (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:03
S72	0	S71 and S68	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:03
S73	23	S70 and S68	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:03
S74	486	CCD and lens and (bandpass near3 filter) and (spacer (passivation near3 layer))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:10
S75	496	(semiconductor near3 imaging near3 device).ti.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:12
S76	25839	S57 or S75	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:13
S77	0	S76 and S74	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:13
S78	8210	lens and ((bandpass color) near3 filter) and (spacer (passivation near3 layer))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:13
S79	27	S76 and S78	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:14
S80	6691	CCD with lens with (bandpass (band adj pass) filter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:24

S81	6	S80 with spacer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:24
S82	312	CCD with lens with (bandpass (band adj pass))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 19:25
S83	38	rail near3 seat near3 abrasion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/10/02 11:47
S84	38	(track rail) near3 seat near3 abrasion	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/10/02 11:47
S85	12006	(rail track) near3 (tilt tilting tilted slant slanted slanting)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/10/02 11:48
S86	5	S84 and S85	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/10/02 11:48
S87	3	"2674809".pn.	FPRS; EPO; JPO; DERWENT	OR	ON	2011/10/02 12:12
S88	1	1992-401013.NRAN.	DERWENT	OR	ON	2011/10/02 12:14
S89	8	("6615648"   "20060017911"   "20030140509"   "20040088891"   "4700223"   "20040122569"   "3562419"   "5245855"). PN.	US-PGPUB; USPAT; USOCR	OR	ON	2011/10/02 12:20

10/6/2011 8:00:38 PM

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**EAST Search History****EAST Search History (Interference)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L23	1	rail with seat with abrasion with light.clm.	US-PGPUB; USPAT; UPAD	OR	ON	2011/10/06 20:01
L24	1	rail with seat with abrasion with tilt.clm.	US-PGPUB; USPAT; UPAD	OR	ON	2011/10/06 20:01
S13	1249	determining with rail wirh road with bed with crossties.clm.	USPAT; UPAD	OR	OFF	2009/07/27 02:09
S14	0	determining with rail with road with bed with crossties.clm.	USPAT; UPAD	OR	OFF	2009/07/27 02:10

10/6/2011 8:02:35 PM

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Receipt date: 05/03/2010

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Page 1 of 1

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. 12/489,570
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: 06/23/2009	Group: 3617
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 1</i>	

**U.S. Patent Documents**

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	US 2006/0017911 A1	01/26/2006	Villar et al	356	4.01	06/30/2005
	A2	4,700,223	10/13/1987	Shoutaro et al	358	93	02/24/1986
	A3	3,562,419	02/09/1971	Beckmann et al	178	6	12/21/1967

**Foreign Patent Documents**

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1						
	B2						
	B3						

**Other Art (Including Author, Title, Date Pertinent Pages, Etc.)**

Exam. Init.	Ref. Des.	Citation
	C1	PCT International Search Report and Written Opinion dated April 22, 2010 for corresponding PCT/US2010/025004
	C2	

<b>EXAMINER:</b> /Juan Valentin/ (10/02/2011)	<b>DATE CONSIDERED:</b>
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*INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)*

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Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

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<b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		12489570	
	Filing Date		2009-06-23	
	First Named Inventor	John Nagle, et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		GREX.057CIP2	

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	1	20040122569	A1	2004-06-24	Bidaud			
	2	20040088891	A1	2004-05-13	Theurer			
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	1	10040139	DE		2003-03-07	DWA Deutsche Waggonbau GMBH		<input type="checkbox"/>

<b>Receipt date: 05/31/2011</b>  <b>INFORMATION DISCLOSURE STATEMENT BY APPLICANT</b> ( Not for submission under 37 CFR 1.99)	Application Number		12489570	12489570 - GAU: 2877
	Filing Date		2009-06-23	
	First Named Inventor	John Nagle, et al.		
	Art Unit			
	Examiner Name			
	Attorney Docket Number		GREX.057CIP2	

	2	2674809	FR		1992-10-09	Lorraine Laminage		<input type="checkbox"/>
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**NON-PATENT LITERATURE DOCUMENTS**

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 <sup>5</sup>
	1	Supplementary Search Report for European Application No. EP 05767776.7 dated 02 May 2011.	<input type="checkbox"/>

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

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12489570 - GAU: 2877

Page 1 of 2

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. Unassigned
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: Herewith	Group: 2877
U.S. Patent Documents <i>See Page 1</i>	Foreign Patent Documents <i>See Page 1</i>	Other Art <i>See Page 2</i>	

## U.S. Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	5,245,855	9/21/1993	Burgel et al.	73	8	

## Foreign Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1						
	B2						

## Other Art (Including Author, Title, Date Pertinent Pages, Etc.)

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	C2	

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## BIB DATA SHEET

CONFIRMATION NO. 1864

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.		
12/489,570	06/23/2009	356	2877	GREX.057CIP2		
<b>APPLICANTS</b> /JDVII/ Christopher M. Villar, Liberty Hill, TX; John Anthonty Nagle II, Cedar Park, TX; Steven C. Orrell, Georgetown, TX; <b>** CONTINUING DATA *****</b> /JDVII/ This application is a CIP of 12/465,473 05/13/2009 which is a CIP of 11/172,618 06/30/2005 PAT 7,616,329 which claims benefit of 60/584,769 06/30/2004 <b>** FOREIGN APPLICATIONS *****</b> /JDVII/ <b>** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** ** SMALL ENTITY **</b> 07/01/2009						
Foreign Priority claimed <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No 35 USC 119(a-d) conditions met <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Verified and /JUAN D VALENTIN/ Acknowledged Examiner's Signature		<input type="checkbox"/> Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
			TX	12	17	3
<b>ADDRESS</b> Zarian Midgley & Johnson PLLC University Plaza, 960 Broadway Ave., Suite 250 Boise, ID 83706 UNITED STATES						
<b>TITLE</b> Tilt Correction System and Method for Rail Seat Abrasion						
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**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)

Parsons Behle & Latimer  
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Boise, ID 83706

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## **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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/489570	06/23/2009	Christopher M. Villar	GREX.057CIP2	1864

TITLE OF INVENTION: TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
Nonprovisional	Yes	\$ 870	\$ 300	\$1,170	01/12/2012
EXAMINER		ART UNIT	CLASE-SUBCLASS		
Valentin, Juan D		2877	356-606000		

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 03-02 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 Parsons Behle & Latimer

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 has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Georgetown Rail Equipment Company

Georgetown, Texas

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

- ☒ Issue Fee  
☒ Publication Fee (No small entity discount permitted)  
☐ Advanced Order - # of Copies \_\_\_\_\_

4b. Payment of Fee(s):

- ☐ A check in the amount of the fee(s) is enclosed.  
☒ Payment by credit card. Form PTO-2038 is attached.  
☒ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number 500581.

5. **Change in Entity Status** (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27 (g)(2).

The Directory of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above. NOTE: The Issue Fee and publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Rexford A Johnson/

Date November 2, 2011

Typed or printed name Rexford A. Johnson

Registration No. 57664

This collection of information 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 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, 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.

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Electronic Patent Application Fee Transmittal				
Application Number:		12489570		
Filing Date:		23-Jun-2009		
Title of Invention:		TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION		
First Named Inventor/Applicant Name:		Christopher M. Villar		
Filer:		Rexford A. Johnson/Marjorie Dugdale		
Attorney Docket Number:		GREX.057CIP2		
Filed as Small Entity				
Utility under 35 USC 111(a) Filing Fees				
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	870	870
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1170

<b>Electronic Acknowledgement Receipt</b>	
<b>EFS ID:</b>	11323570
<b>Application Number:</b>	12489570
<b>International Application Number:</b>	
<b>Confirmation Number:</b>	1864
<b>Title of Invention:</b>	TILT CORRECTION SYSTEM AND METHOD FOR RAIL SEAT ABRASION
<b>First Named Inventor/Applicant Name:</b>	Christopher M. Villar
<b>Customer Number:</b>	67559
<b>Filer:</b>	Rexford A. Johnson/Marjorie Dugdale
<b>Filer Authorized By:</b>	Rexford A. Johnson
<b>Attorney Docket Number:</b>	GREX.057CIP2
<b>Receipt Date:</b>	02-NOV-2011
<b>Filing Date:</b>	23-JUN-2009
<b>Time Stamp:</b>	18:14:03
<b>Application Type:</b>	Utility under 35 USC 111(a)

### **Payment information:**

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$1170
RAM confirmation Number	4646
Deposit Account	
Authorized User	

### **File Listing:**

<b>Document Number</b>	<b>Document Description</b>	<b>File Name</b>	<b>File Size(Bytes)/ Message Digest</b>	<b>Multi Part /.zip</b>	<b>Pages (if appl.)</b>
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1	Issue Fee Payment (PTO-85B)	024_GREX057CIP2_IssFeeXml.pdf	144253 aca04052fa27be7f7f1b45b27e36541105e712ad	no	1
<b>Warnings:</b>					
<b>Information:</b>					
2	Fee Worksheet (SB06)	fee-info.pdf	32178 8c444149f4db856a4e958ecb10d65b5a96cd52d0	no	2
<b>Warnings:</b>					
<b>Information:</b>					
<b>Total Files Size (in bytes):</b>			176431		
<p>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.</p> <p><b><u>New Applications Under 35 U.S.C. 111</u></b>          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.</p> <p><b><u>National Stage of an International Application under 35 U.S.C. 371</u></b>          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.</p> <p><b><u>New International Application Filed with the USPTO as a Receiving Office</u></b>          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.</p>					

Receipt date: 12/10/2009

12489570 - GAU: 2877  
Page 1 of 1

Form PTO-1449 (modified)		Atty. Docket No. 11042.0098.CPUS02	Serial No. 12/489,570
List of Patents and Publications for Applicant's  INFORMATION DISCLOSURE STATEMENT  (Use several sheets if necessary)		Applicant Christopher M. Villar et al.	
		Filing Date: 06/23/2009	Group: 3617
U.S. Patent Documents See Page 1	Foreign Patent Documents See Page 1	Other Art See Page 1	

## U.S. Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Name	Class	Sub Class	Filing Date of App.
	A1	6,615,648	09/09/2003	Ferguson et al	73	146	12/22/1998

## Foreign Patent Documents

Exam. Init.	Ref. Des.	Document Number	Date	Country	Class	Sub Class	Translation Yes/No
	B1	JP 2000/221146 A1	08/11/2000	Japan			Yes (Abstract)
	B2	RU 2142892	12/20/1999	Russia			Yes (Abstract)
	B3	SU 1418105	08/23/1988	Russia			No

Change(s) applied  
to document.

/G.H./

11/9/2011

## Other Art (Including Author, Title, Date Pertinent Pages, Etc.)

Exam. Init.	Ref. Des.	Citation
	C1	Decision on Grant, dated October 22, 2009, for corresponding Russian patent application No. 2007103331.
	C2	

EXAMINER: /Juan Valentin/ (10/02/2011) | DATE CONSIDERED:

EXAMINER: INITIAL IF REFERENCE CONSIDERED, WHETHER OR NOT CITATION IS IN CONFORMANCE WITH MPEP609; DRAW LINE THROUGH CITATION IF NOT IN CONFORMANCE AND NOT CONSIDERED. INCLUDE COPY OF THIS FORM WITH NEXT COMMUNICATION TO APPLICANT.

## INFORMATION DISCLOSURE STATEMENT — PTO-1449 (MODIFIED)

DM\_US:22967205\_1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /J.V./



## UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/489,570	12/20/2011	8081320	GREX.057CIP2	1864

67559 7590 11/30/2011  
Parsons Behle & Latimer  
University Plaza, 960 Broadway Ave., Suite 250  
Boise, ID 83706

### 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 415 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):

Christopher M. Villar, Liberty Hill, TX;  
John Anthony Nagle II, Cedar Park, TX;  
Steven C. Orrell, Georgetown, TX;

AO 120 (Rev. 08/10)

<b>TO:</b> <b>Mail Stop 8</b> <b>Director of the U.S. Patent and Trademark Office</b> <b>P.O. Box 1450</b> <b>Alexandria, VA 22313-1450</b>	<b>REPORT ON THE</b> <b>FILING OR DETERMINATION OF AN</b> <b>ACTION REGARDING A PATENT OR</b> <b>TRADEMARK</b>
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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 Eastern District of Texas - Tyler Division on the following

☐ Trademarks or ☒ Patents. ( ☐ the patent action involves 35 U.S.C. § 292.);

DOCKET NO. 6:18-cv-377	DATE FILED 7/27/2018	U.S. DISTRICT COURT Eastern District of Texas - Tyler Division
PLAINTIFF Georgetown Rail Equipment Company		DEFENDANT Tetra Tech Canada, Inc.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 7,616,329	11/10/2009	Georgetown Rail Equipment Company
2 8,081,320	12/20/2011	Georgetown Rail Equipment Company
3 9,441,956	9/13/2016	Georgetown Rail Equipment Company
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY <input type="checkbox"/> Amendment <input type="checkbox"/> Answer <input type="checkbox"/> Cross Bill <input type="checkbox"/> 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



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY.DOCKET NO./TITLE	REQUEST ID
12/489,570	06/23/2009	Christopher M. Villar	20009.057US03	74580

## Acknowledgement of Loss of Entitlement to Entity Status Discount

The entity status change request below filed through Private PAIR on 10/26/2018 has been accepted.

### CERTIFICATIONS:

#### Change of Entity Status:

☒ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be notification of loss of entitlement to small or micro entity status, as applicable.

This portion must be completed by the signatory or signatories making the entity status change in accordance with 37 CFR 1.4(d)(4).

Signature:	/Rexford A. Johnson/
Name:	Rexford A. Johnson
Registration Number:	57664