

IPR2019-01581 U.S. Patent No. 8,081,320

PETITIONER'S DEMONSTRATIVES

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Villar et al.

(10) **Patent No.:** US 8,081,320 B2
(45) **Date of Patent:** Dec. 20, 2011

(54) **TILT CORRECTION SYSTEM AND METHOD
FOR RAIL SEAT ABRASION**

5,245,855 A 9/1993 Bangel et al. 73/8
6,615,648 B1 9/2003 Ferguson et al. 73/146
6,647,891 B2 * 11/2003 Hsu et al. 356/602
2007/0070307 11/2007 Hsu et al. 356/604

(75) Inventors: **Christopher M. Villar,**
(US); **John Anthony Na**
Park, TX (US); Steven C
Georgetown, TX (US)

(73) Assignee: **Georgetown Rail Equip**
Company, Georgetown,

(*) Notice: Subject to any disclaimer
patent is extended or as
U.S.C. 154(b) by 415 da

(21) Appl. No.: 12/489,570

(22) Filed: Jun. 23, 2009

(65) **Prior Publication Data**

US 2009/0319197 A1 Dec. 24, 2009

Related U.S. Application Data

(63) Continuation-in-part of application
filed on May 13, 2009, which is a con
of application No. 11/172,618, filed
now Pat. No. 7,616,329.

(60) Provisional application No. 60/584,7
30, 2004.

(51) **Int. Cl.**
G01B 11/24 (2006.01)

(52) **U.S. Cl.** 356/606; 238/264

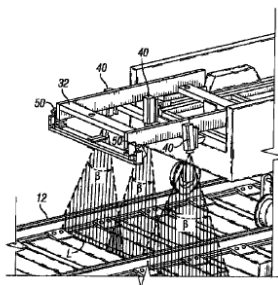
(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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17 Claims, 12 Drawing Sheets



Patent No.: US 8,081,320 B2
Date of Patent: Dec. 20, 2011

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

PCT International Search Report and Written Opinion dated Apr. 22,
2010 for corresponding PCT/US2010/025004.
Supplementary Search Report for European Application No. EP
05767776.7 dated May 2, 2011.

A system and method for determining rail seat abrasion on a
rail road track is disclosed. An inspection system comprises
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.

Claims 1-17 of the '320 Patent Are Unpatentable

**Ground 1: Claims 1-2, 5-7, 10-13, and 16-17
Unpatentable Over:**

Villar, Choros, Casagrande, and Szwilski: Slides 3-53

Ground 2: Claims 3, 8, and 14 Unpatentable Over:

**Villar, Choros, Casagrande, Szwilski, and Khattak:
Slides 54-66**

Ground 3: Claims 4, 9, and 15 Unpatentable Over:

**Villar, Choros, Casagrande, Szwilski, and Andersson:
Slides 67-76**

GROUND 1

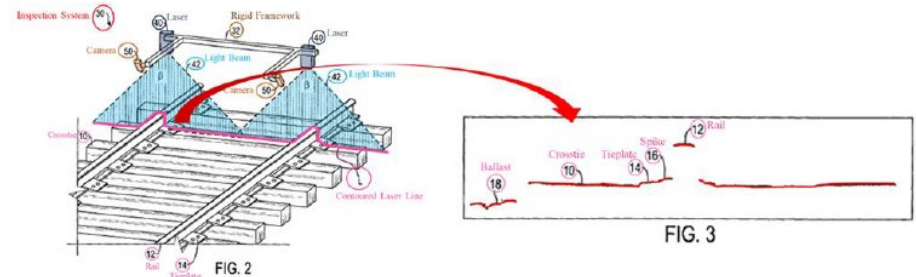
**Ground 1: Claims 1-2, 5-7, 10-13, and 16-17
Unpatentable Over:**

Villar, Choros, Casagrande, and Szwilski

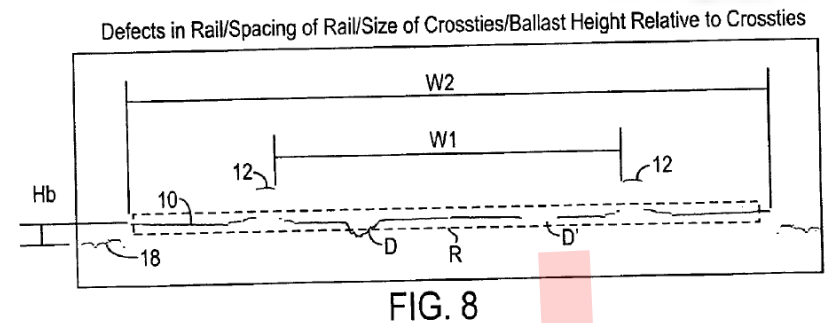
Undisputed that Villar's automated track inspection system generates and analyzes railroad track image data to determine track defects including, e.g., crosstie defects

'320 Patent

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



Villar, FIGS. 2, 3 (annotated).



[0051] In another example, the defects in the crossties 10 can be determined from the image data. As shown in FIG. 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

Choros

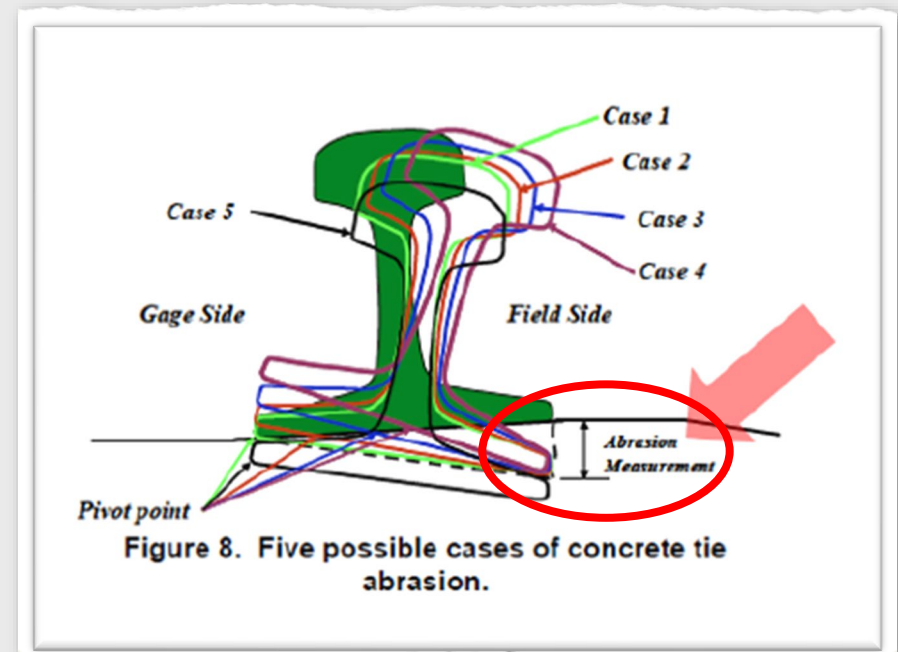
Undisputed that Choros determines the presence of rail seat abrasion (“RSA”) by measuring the vertical distance between the rail base and crosstie top surface heights

‘320 Patent

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

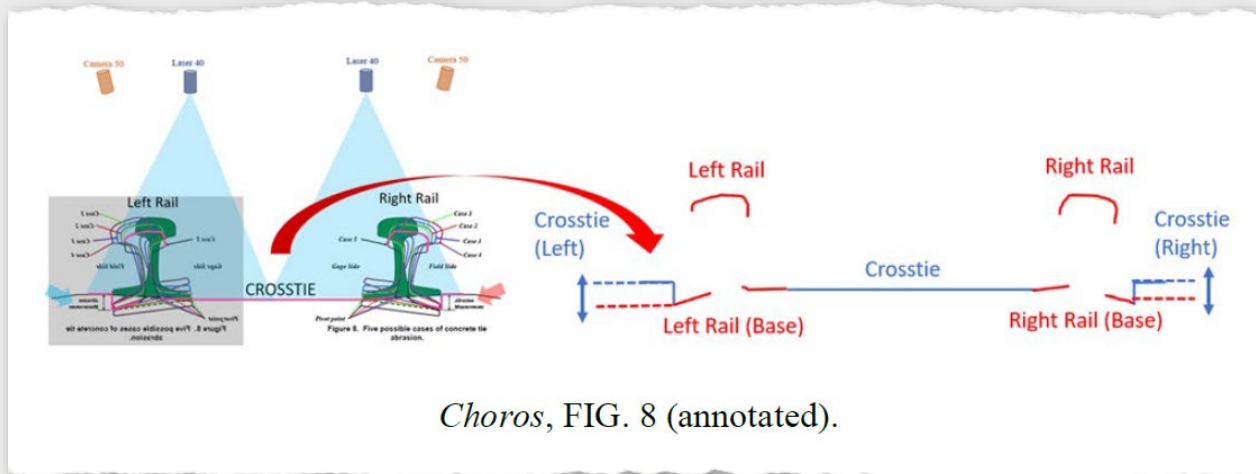
wherein, when determining whether rail seat abrasion is present, the at least one processor compensates for a tilt of the rail road track.



Choros, FIG. 8 (annotated)

Villar + Choros

Would have been obvious to implement Villar's automated railroad track inspection system with Choros' method of measuring RSA to automatically determine whether RSA is present along a railroad track



A POSITA would have been motivated to make the combination:

- To facilitate more frequent and accurate measurement of critical track parameters while avoiding time, accuracy, and safety issues associated with human inspectors
- In response to the FRA's initiatives to automate RSA detection following two high profile derailments in 2005 and 2006

Villar + Choros

Automation would have allowed for more frequent and accurate measurement of critical track parameters while avoiding time, accuracy, and safety issues associated with human inspectors.

Visual inspection for these defects is therefore necessary to eliminate these defects. Conventionally this inspection is done by humans. However, it is very difficult both to eliminate human error and increase productivity. Thus, automated inspection systems are required to achieve a high inspection rate and high reliability in inspection.

Ex-1026 (Kanade), 545-546

Accordingly, it is one object of the invention to provide an improved inspection vehicle for visual inspection of railroad tracks.

Another object of the invention is to provide an improved inspection vehicle and method of inspection which reduce the high costs currently associated with visual inspection.

Yet another object of the invention is to provide an improved inspection vehicle and method of inspection which permits travel over railroad tracks at speeds in excess of 25 mph.

Ex-1038 (Trosino), 3:26-34

With the foregoing arrangement, it can be seen that the vehicle of the present invention permits inspection of railroad track at a minimum speed of 30 miles per hour. The provision of the vision system, including the creation of video images of the track, storage of the images including anomalies, and manipulation of the stored images to adequately view the anomaly, permits inspection of the track at speeds greater than previously achieved in this type of inspection. The use of pattern recognition technology for this type of track inspection advantageously and uniquely provides automated inspection for various types of predictable track anomalies.

Trosino, 12:36-47

Villar + Choros

Automation would have allowed for more frequent and accurate measurement of critical track parameters while avoiding time, accuracy, and safety issues associated with human inspectors.

General Benefits of Automated Inspection. Automatic inspection is desirable because human inspectors are not always consistent evaluators of products. In fact, it has been reported that human visual inspection is, at best, 80% effective, and, furthermore, this effectiveness can only be achieved if a rigidly structured set of inspection checks is implemented [222].² The consistency associated with automated inspection should allow the level of quality to be predicted [108], however. Many inspection tasks are also time-consuming and/or boring for humans to perform. For instance, human visual inspection has been estimated to account for 10% or more of the total labor costs for manufactured products [133]. Human inspectors may also reject products based on the satisfaction of quotas rather than the actual defect levels [66]. Furthermore, some manufactured part defects are too subtle for detection by an unaided human [155]. In contrast, machine vision results in lower labor costs and improved quality. Finally, automated inspection allows objects to be inspected in environments unsafe for people.

Ex-1035 (Newman), 4

Villar + Choros

A POSITA would have been motivated in response to the FRA's initiatives following 2005/2006 high profile derailments.



Figure 1. Derailment site.

Ex-1018 (National Transportation Safety Board, NTSB), 2

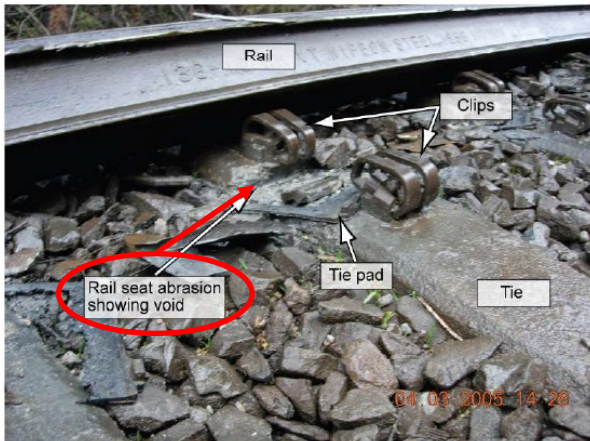


Figure 4. Rail rollover and rail seat abrasion at derailment site.

NTSB, 9



National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.: DCA-05-FR-010
Location: Home Valley, Washington
Date: April 3, 2005
Time: 9:35 a.m., Pacific daylight time¹
Railroad: BNSF Railway Company
Property Damage: \$854,000
Injuries: 30
Fatalities: None
Type of Accident: Amtrak passenger train derailment

The Accident

On April 3, 2005, about 9:35 a.m., westbound Amtrak (National Railroad Passenger Corporation) passenger train No. 27, consisting of a single locomotive unit and four passenger cars, derailed at milepost (MP) 58.56² on the BNSF Railway Company's (BNSF's) Northwest Division. The train was traveling 60 mph on single main line track when it derailed as it was traveling through a cut section of the Columbia River Gorge on the north side of the Columbia River near Home Valley, Washington. The train remained upright; however, the cars came to rest leaning up to approximately 35° against the outside curved embankment. (See figure 1.) There were 106 passengers and 9 Amtrak employees on board. Thirty people (22 passengers and 8 employees) sustained minor injuries; 14 of those people were taken to local hospitals. Two of the injured passengers were kept overnight for further observation; the rest were released. Track and equipment damages, in addition to clearing costs associated with the accident, totaled about \$854,000.

The derailment occurred during daylight hours. The weather was cloudy with mist and intermittent rain. The temperature was about 45° F with 8 mph southeast winds.

On the day of the accident, westbound Amtrak passenger train No. 27 was scheduled to travel from Pasco, Washington, to Portland, Oregon, a distance of about 232 miles. The engineer performed a running air brake test at 6:35 a.m. before departing Pasco. The engineer noted nothing remarkable during the test.

¹ All times in this brief are Pacific daylight time.

² MP 58.56 is on the Fallbridge Subdivision.

NTSB/RAB-06/03

NTSB, 1

A POSITA would have been motivated in response to the FRA's initiatives following 2005/2006 high profile derailments.

III. RSAC Track Safety Standards Working Group

The Track Safety Standards Working Group (Working Group) was formed on February 22, 2006. On October 27, 2007, the Working Group formed two subcommittees: the Rail Integrity Task Force and the Concrete Crosstie Task Force (CCTF). Principally in response to NTSB recommendation R-06-19,⁶ the

Working Group directed the CCTF to consider improvements in the Track Safety Standards related to fastening of rail to concrete crossties. The Working Group specified that the CCTF do the following: (1) Provide background information regarding the amount and use of concrete crossties in the U.S. rail network; (2) review minimum safety requirements in the Federal Track Safety Standards for crossties at 49 CFR 213.109 and 213.335, as well as relevant American Railway Engineering and Maintenance-of-Way Association (AREMA) concrete construction

specifications; (3) understand the science (mechanical and compressive forces) of rail seat failure on concrete ties; (4) develop a performance specification for all types of crosstie material for FRA Class 2 through 5 main line track; (5) develop specifications for missing or broken concrete fastener and crosstie track structure components and/or establish wear limits for rail seat deterioration and rail fastener integrity; and (6) develop manual and automated methods to detect rail seat failure on concrete ties.

The CCTF met on November 26–27, 2007; February 13–14, 2008; April 16–17, 2008; July 9–10, 2008; and November 19–20, 2008. The CCTF's findings were reported to the Working Group on November 19, 2008. The Working Group reached a consensus on the majority of the CCTF's work and forwarded a proposal to RSAC on December 10, 2008. RSAC voted to approve the Working Group's recommended text, which provided the basis of the NPRM.

GREX Challenges That Villar In View of Choros Render Obvious the RSA Limitation In Claim 1

'320 Patent

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

GREX's RSA Arguments Fail:

1. **Petition Relies on Villar, Not Choros, for the Claimed Processor.**
2. **One Would Have Been Motivated to Combine Villar and Choros.**
3. **Villar Does Not Teach Away From Automating RSA.**

Petition Relies on Villar, Not Choros, for the Claimed Processor

rail seat abrasion is present or measuring it. *Id.* Choros does not disclose or suggest a processor (let alone an image processor), or a processor that analyzes a railroad track image to measure distances of any kind (let alone the vertical distance between the rail base and the cross tie top surface heights), or a processor that determines or measures rail seat abrasion. *Id.*

PO Response, 8

Petition relies on Villar, not Choros for the claimed processor.

Petersen teaches away from appellant's invention. Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of [**20] references. *In re Keller*, 642 F.2d 413, 425, 208 U.S.P.Q. (BNA) 871, 881 (CCPA 1981). Thus, Petersen

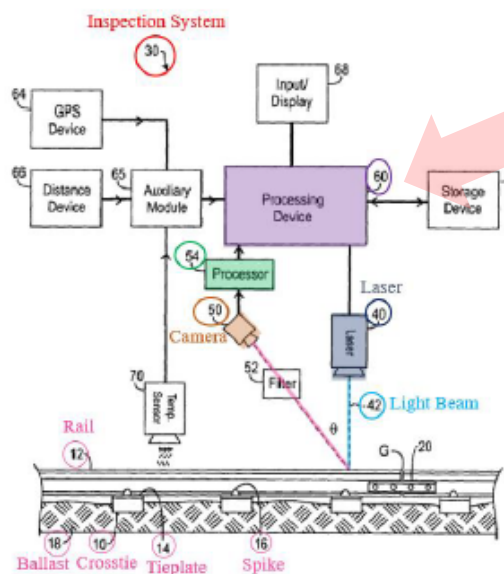


FIG. 1

Villar, FIG. 1 (annotated)

In re Merck & Co., Inc., 800 F.2d 1091 (Fed. Cir. 1986)

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

machine vision, like Villar.” Ex-2001, ¶52. As he explains, “[i]t is not trivial or obvious to write an algorithm to implement a manual method because” “implementing even the simplest concept into machine vision is very difficult and time consuming.” A special amount of invention and creativity is necessary to write and implement such an algorithm.” *Id.* “For that reason, combining the technique

PO Response, 9

GREX's argument is incorrect and contrary to the record evidence:

- Purported difficulties of automating inspection tasks are contradicted by record evidence demonstrating automating manual inspections tasks were well-known before 2009.
- Villar automates tie plate cut, which GREX's CEO and technical advisor testified involve a similar analysis to RSA.

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

Purported difficulties of automating inspection tasks are contradicted by record evidence demonstrating automating manual inspections tasks were well-known before 2009.

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Ex-1026 (Kanade), 545-546

With the foregoing arrangement, it can be seen that the vehicle of the present invention permits inspection of railroad track at a minimum speed of 30 miles per hour. The provision of the vision system, including the creation of video images of the track, storage of the images including anomalies, and manipulation of the stored images to adequately view the anomaly, permits inspection of the track at speeds greater than previously achieved in this type of inspection. The use of pattern recognition technology for this type of track inspection advantageously and uniquely provides automated inspection for various types of predictable track anomalies.

Ex-1038 (Trosino), 12:36-47

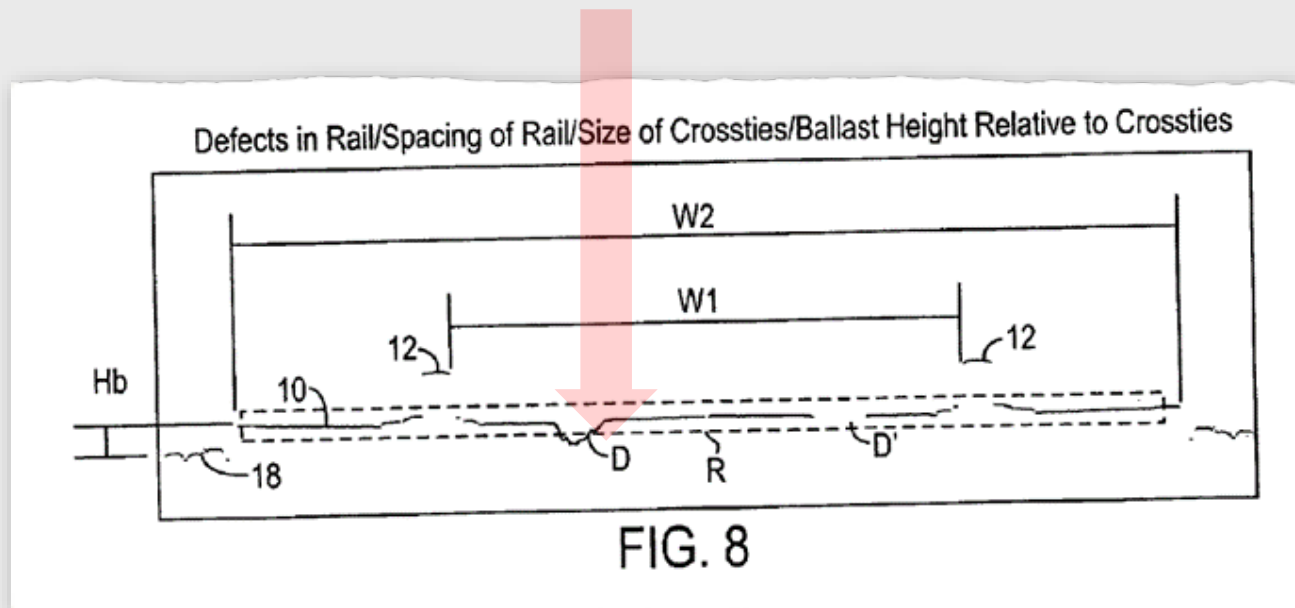
General Benefits of Automated Inspection. Automatic inspection is desirable because human inspectors are not always consistent evaluators of products. In fact, it has been reported that human visual inspection is, at best, 80% effective, and, furthermore, this effectiveness can only be achieved if a rigidly structured set of inspection checks is implemented [222].² The consistency associated with automated inspection should allow the level of quality to be predicted [108], however. Many inspection tasks are also time-consuming and/or boring for humans to perform. For instance, human visual inspection has been estimated to account for 10% or more of the total labor costs for manufactured products [133]. Human inspectors may also reject products based on the satisfaction of quotas rather than the actual defect levels [66]. Furthermore, some manufactured part defects are too subtle for detection by an unaided human [155]. In contrast, machine vision results in lower labor costs and improved quality. Finally, automated inspection allows objects to be inspected in environments unsafe for people.

Ex-1035 (Newman), 4

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

Purported difficulties of automating inspection tasks are contradicted by record evidence demonstrating automating manual inspections tasks were well-known before 2009.

Villar automates manual inspection tasks
including crosstie defects



One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

Villar contemplates using other known suitable image processing tools and software, including algorithms to determine or detect “other measurable aspects of railroad track.”

device for determining location data. The measurable aspects that can be determined by the disclosed system include but are not limited to: the spacing between crossties, the angle of ties with respect to rail, cracks and defects in surface of ties, missing tie plates, misaligned tie plates, sunken tie plates, missing fasteners, damaged fasteners, misaligned fasteners, worn or damaged insulators, rail wear, gage of rail, ballast height relative to ties, size of ballast stones, and a break or separation in the rail. The system includes one or more algorithms for determining these measurable aspects of the railroad track.

Villar, ¶8

[0043] 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 known in the art for analyzing the image data can be used with the disclosed inspection system and associated methods. Accordingly, the disclosed inspection system and associated methods are not intended to be limited to the measurable aspects and particular techniques described herein.

Villar, ¶43

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

[0055] In other examples, missing tie plates, misaligned tie plates, or sunken tie plates can be detected from the image data. Referring to FIG. 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 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.

Villar, ¶55

Villar automates tie plate cut...

...which GREX's CEO and technical advisor testified involve a similar analysis to RSA.

16 And so what's going on in the rail seat is
17 equally as important for both wood ties and concrete
18 ties. We just refer to the one measurement as plate
19 cutting because there's a tie plate there, and then the
20 other measurement we refer to as rail seat abrasion.
21 There's no tie plate. But it's the same, similar type of
22 analysis.

Ex-1043 (Grissom deposition, 85:16-22.

11 A No, but rail seat abrasion is similar to plate
12 cut. In concrete ties, it's similar to plate cut on
13 wooden ties.

Ex-1044 (Kainer deposition), 29:11-13.

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

However, the FRA rules do not provide the motivation Petitioner describes. Ex-2001, ¶62. The FRA rules Petitioner references did not come into effect until November 8, 2011, over two years after the '320 patent's effective filing date. See Ex-1017 at 1. They thus provided no impetus to a POSITA in the relevant

PO Response, 14-15

GREX's argument is incorrect and contrary to the record evidence:

- Ignores the RSA initiatives and proposals promulgated by the FRA following the 2005/2006 high-profile derailments
- Contradicts testimony from GREX's CEO regarding the derailments and subsequent industry push to automate RSA detection

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

GREX ignores evidence from October 27, 2007, discussing formation of the CCTF and its objective developing manual and automated methods to detect rail seat failure on concrete ties.

III. RSAC Track Safety Standards Working Group

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One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

GREX ignores the December 10, 2008, evidence demonstrating the RSAC's approval of a "concrete tie rule" proposing use of automated inspection systems to determine RSA.

DRAFT

RAILROAD SAFETY ADVISORY COMMITTEE (RSAC)

Minutes of Meeting
December 10, 2008
Washington, D.C.

BY VOICE VOTE, THE RSAC APPROVES PROPOSED RULE TEXT FOR 49 CFR PART 213, AS IT PERTAINS TO CONCRETE CROSSTIES, AS PRESENTED.

Ex-1021 (RSAC, Minutes of Meeting), 1, 19

§213.234 Automated Inspection of Track Constructed with Concrete Crossties:

Ex-1041 (RSAC, Proposed Concrete Tie Draft Rule Text for RSAC Vote), 4, 5

- (d) The automated inspection measurement system of concrete crossties must be capable of determining exceptions to §213.109(e)(4) of this part.

§213.109 Crossties.

- (e) Concrete crossties counted to satisfy the requirements set forth in the table in paragraph (c) , of this section shall not be:
- (4) Deteriorated or abraded at any point under the rail seat to a depth of ½ inch or more.

Ex-1041, 1-3

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

Even Choros discusses the impact of the derailments and the FRA's initiatives and proposals, making RSA detection a priority.

ABSTRACT

Concrete tie rail seat abrasion/deterioration (RSA) has been an issue since the inception of concrete ties. As a result of recent derailments involving abraded concrete ties on curved track, the Federal Railroad Administration set up a task force to study abrasion/deterioration mechanisms and develop automated detection methods using existing research vehicles. A portion of this study

Choros, 7

The need to measure and control rail seat abrasion on concrete ties has become apparent with two recent Amtrak derailments. Methods to detect areas that have excessive rail seat abrasion and present a safety issue are under investigation by FRA. Data collected on geometry cars is considered as an alternative method for identifying critical locations. However, for these

Choros, 11

One Would Have Been Motivated to Make the Combination (Despite GREX's Conclusory Arguments to the Contrary)

GREX's argument contradicts testimony from its CEO regarding the derailments and subsequent industry push to automate RSA detection.

24 And somewhere around 2006, 2007, there were a
25 couple of derailments related to that failure mode, and
1 it became a significant industry push to identify areas
2 that had rail seat abrasion. And thus it was added to

Ex-1043, 39:24-40:2.

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

An additional reason why a POSITA would not have combined Villar and Choros is that, as Dr. Bovik explains, “Villar expressly teaches away from the manual measurement and visual inspection disclosed in Choros.” *Id.*, ¶55. Villar

PO Response, 10

**Villar does not discourage automating RSA,
rather, Villar encourages it.**

[**4] A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. The

In re Gurley, 27 F.3d 551, 553 (Fed. Cir. 1994)

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

Implementing Villar's inspection system to determine the presence of RSA would simply be an extension of Villar's own automated track inspection teachings relating to increasing railroad safety.

Villar appreciates the need to regularly inspect track components, including crossties, for deterioration.

To manage the logistics of crosstie replacement and to quantify the need for new crossties, railroad inspectors attempt to grade the condition of crossties and the fastener system on a regular basis. This grading is most often done with a visual inspection to identify crossties and fasteners that are rotten, broken, split, or worn to an extent that their serviceable life is at its end. The process of visual inspection is quite time consuming. In practice, inspection of the track

Villar, ¶14

Recognizing the time-consuming nature of manual inspection, Villar concedes that automating manual inspection tasks, including identifying crosstie defects, were well-known.

condition of the ballast, and gage of the rail. As with the grading of crossties, inspecting these aspects of rail can also be time consuming. Systems are known in the art for inspecting rails. For example, OmniSurveyor3D® by Omnicom Engineering of the United Kingdom is a system for surveying the infrastructure on railways. Also, ENSCO, Inc. of Minnesota provides a Laser Gage Measurement System for measuring the gage of rail using lasers.

Villar, ¶16

niques 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

Villar, ¶43

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

[0055] In other examples, missing tie plates, misaligned tie plates, or sunken tie plates can be detected from the image data. Referring to FIG. 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 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.

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20 other measurement we refer to as rail seat abrasion.
21 There's no tie plate. But it's the same, similar type of
22 analysis.

Ex-1043 (Grissom deposition, 85:16-22.

11 A No, but rail seat abrasion is similar to plate
12 cut. In concrete ties, it's similar to plate cut on
13 wooden ties.

Ex-1044 (Kainer deposition), 29:11-13.

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

Here, Choros discloses a manual technique in which a person visually locates the rail seat, and then physically determines or measures, and visually observes the amount of, rail seat abrasion, while Villar expressly teaches “overcoming” or

PO Response, 12

Wrong Test

A POSITA would not have sought physical or bodily incorporation of Choros' visual manual inspection of crossties into Villar.

the card.³ However, we have consistently held, as the Board recognized, that “[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.” *In re Keller*, 642 F.2d 413, 425 (CCPA 1981); see also *In re Mouttet*, 686 F.3d 1322, 1333 (Fed. Cir. 2012).

MCM Portfolio LLC v. Hewlett-Packard Co., 812 F.3d 1284, 1294 (Fed. Cir. 2015)

Instead, the combined teachings of Villar and Choros would have suggested to implement Villar's automated track inspection system to determine whether RSA is present by measuring the vertical distance between rail base and crosstie top surface heights, as taught by Choros.

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

Choros appreciates the use of both manual (visual) and automated inspection methods.

warranted at this time. As measurement methodologies improve, either from automated inspection vehicles or hand held devices, then the curve given in Figure 9 and values in Table 2 can be adjusted to reflect the new field data.

Choros, 13

ABSTRACT

Concrete tie rail seat abrasion/deterioration (RSA) has been an issue since the inception of concrete ties. As a result of recent derailments involving abraded concrete ties on curved track, the Federal Railroad Administration set up a task force to study abrasion/deterioration mechanisms and develop automated detection methods using existing research vehicles. A portion of this study

Choros, 7

The need to measure and control rail seat abrasion on concrete ties has become apparent with two recent Amtrak derailments. Methods to detect areas that have excessive rail seat abrasion and present a safety issue are under investigation by FRA. Data collected on geometry cars is considered as an alternative method for identifying critical locations. However, for these

Choros, 11

Villar Does Not Teach Away From Automating RSA (Despite GREX's Conclusory Arguments to the Contrary)

crosstie. Ex-2001, ¶59. Accordingly, rather than suggesting automated determination of RSA, Choros instead emphasizes the importance of using visual inspection and manual measurement to determine the existence of RSA. *Id.*

PO Response, 13

Choros only contemplates using inspectors (and, only in addition to geometry cars) because of the lack of “availability of existing geometry cars.”

The need to measure and control rail seat abrasion on concrete ties has become apparent with two recent Amtrak derailments. Methods to detect areas that have excessive rail seat abrasion and present a safety issue are under investigation by FRA. Data collected on geometry cars is considered as an alternative method for identifying critical locations. However, for these measurements to be reliable the required frequency of inspections may be too high based on the availability of existing geometry cars. A simpler method is being considered for field forces, either FRA or railroad inspectors, to evaluate a site once it has been detected by a geometry car or during a visual inspection by an inspector. One such a method is to use “an abrasion measurement gauge” to measure the void between the rail and tie. This value then can be converted to an additional displacement to be added to the track gage

Choros, 11

Casagrande and Szwilski

Well-known to compensate for track tilt

'320 Patent

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

78. In my opinion, it would have been obvious to one of ordinary skill in the art to compensate for a tilt of a railroad track when determining whether RSA is present along the railroad track. It was well-known that a rail in the field may be slanted, tilted, canted, and/or banked at curves at some angle away from vertical either by design or due to the load of passing trains in some track portions. It was also well-known at the relevant time to compensate for this tilt of a railroad track when determining a railroad track component defect, as evidenced by, e.g., Casagrande (Ex-1008) and Szwilski (Ex-1009).

Ex-1004, ¶178

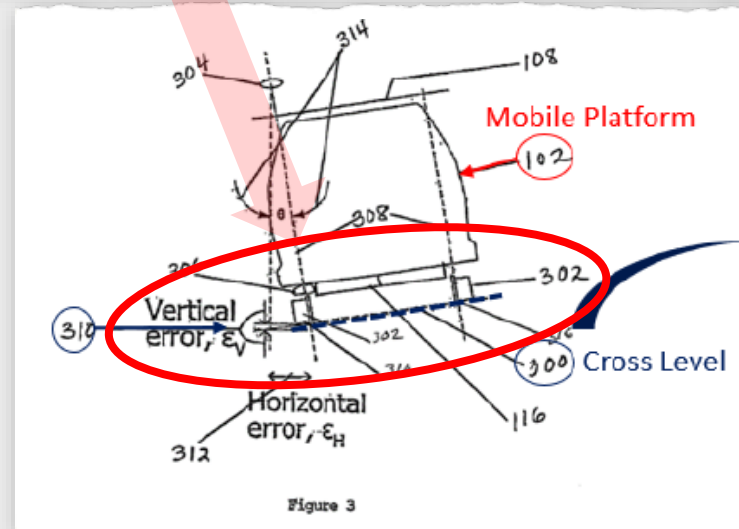


Figure 3

Szwilski, FIG. 3 (annotated)

Casagrande

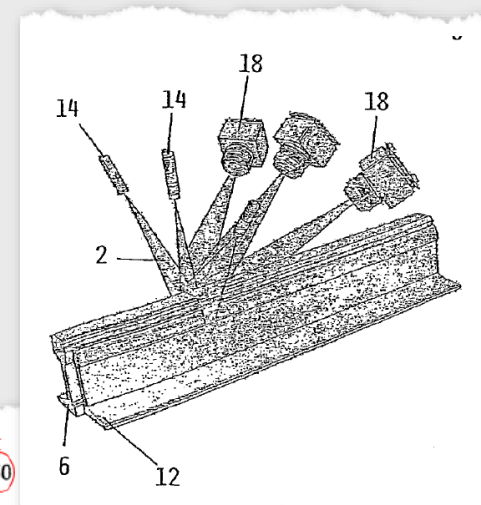
Casagrande's mobile railroad track surveying apparatus uses image-capturing technology to calculate various parameters of track geometry, including vertical alignment.

[0030] The front end unit **20** and the rear end unit **30** each comprises, for each rail **6**, a triangulation reading device, which with the corresponding reading device of the central unit **10** is able, with the predetermined frequency, to read at three longitudinally spaced-apart points of each rail the two characteristic coordinates of the point at that instant, i.e. the vertical coordinate, measured on the top of the horizontal surface of the rail, and the horizontal coordinate, measured on the inner vertical wall of the rail head. These two coordinates, which as stated are read at three longitudinally spaced-apart points, enable the processor unit to calculate the various parameters of the track geometry, and in particular:

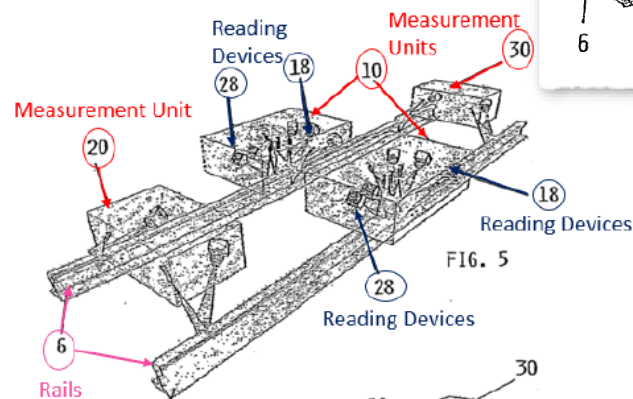
- [0031] the gauge,
- [0032] the radius of curvature,
- [0033] the horizontal alignment,
- [0034] the vertical alignment,
- [0035] the skew.

[0011] Another object of the invention is to measure the geometry parameters of the rails, including their difference in height.

Casagrande, ¶¶30-35, 11



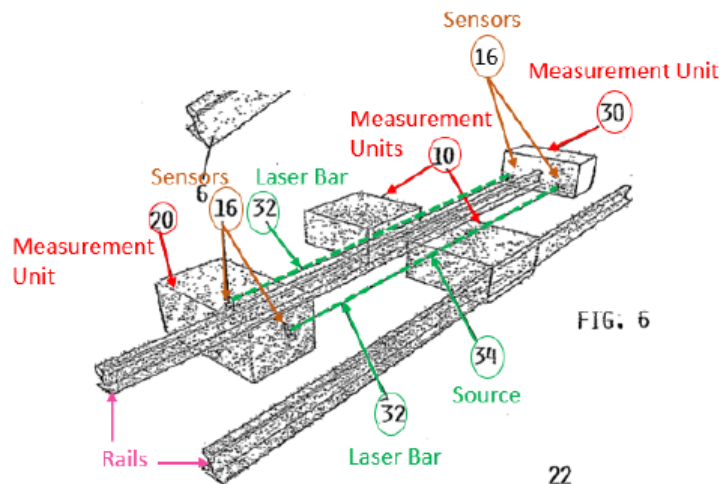
Casagrande, FIG. 3



Casagrande, FIG. 5 (annotated).

Casagrande

Casagrande's apparatus automatically compensates measured rail profile position data for vertical alignment measurement errors due to "elastic deformation of the railway or tramway carriage."



Casagrande, FIG. 6 (annotated).

[0036] FIG. 6 shows schematically the principle of compensation for the errors due to elastic deformation of the railway or tramway carriage. With this, the position in height of each triangulation reading device located in the two end measurement units 20 and 30 is monitored by a laser bar 32 emitted by a source 34 positioned in the central measurement unit 10 and received by a sensor 16 positioned in the end measurement unit 20, 30 and able to constitute a precise alignment of the points of measurement. Lack of alignment results in a signal which by means of suitable software is able to automatically compensate the resultant measurement errors.

Casagrande, ¶136

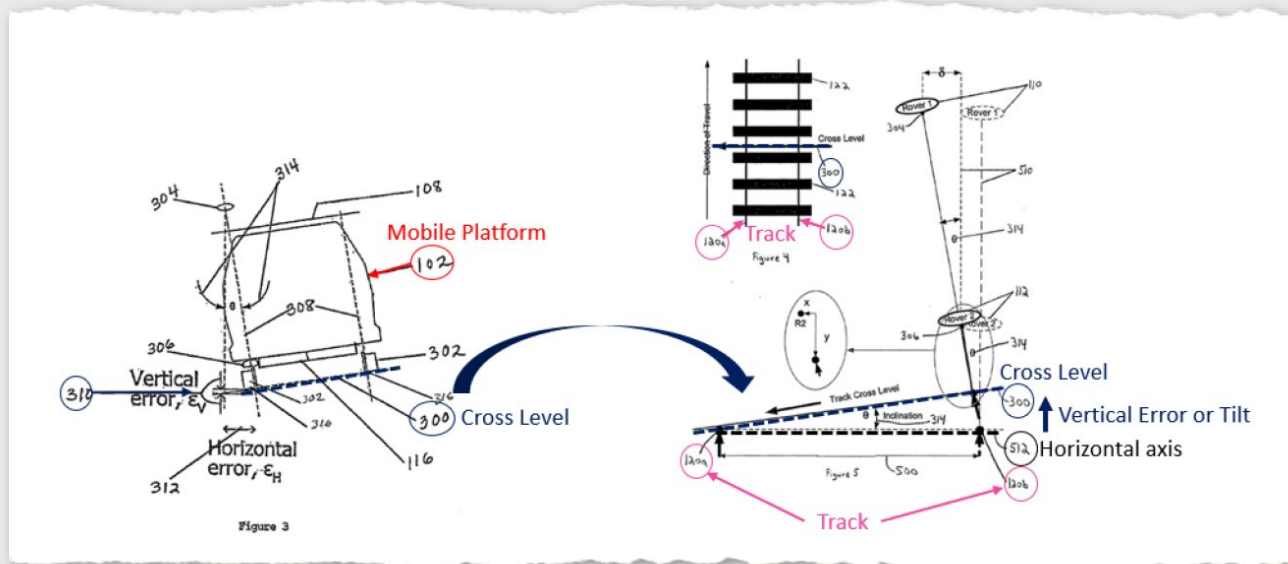
Villar/Choros + Casagrande

As Dr. Papanikolopoulos explains:

82. It would have been obvious to one of ordinary skill at the relevant time to have implemented *Villar* and *Choros*' automated RSA railroad track inspection vision system with *Casagrande*'s tilt compensation software to automatically compensate measurements of imaged railroad track components for any vertical alignment errors associated with the deformation of the railway or vehicle-mounted vision system, as taught by *Casagrande*. In my opinion, one of ordinary skill in the art would have understood that, when *Villar*'s inspection system measures the height of components as viewed as the distance from the camera to that component, an adjustment would need to be made to compensate for the tilt of the track—and thus the tilt of the machine vision inspection system—when the track was banked, such as going around a curve.

Ex-1004 (Declaration of Nikos Papanikolopoulos, Ph.D.), ¶182

Szwilski's mobile railroad track surveying and monitoring apparatus using image-capturing technology to obtain railroad track component position data.

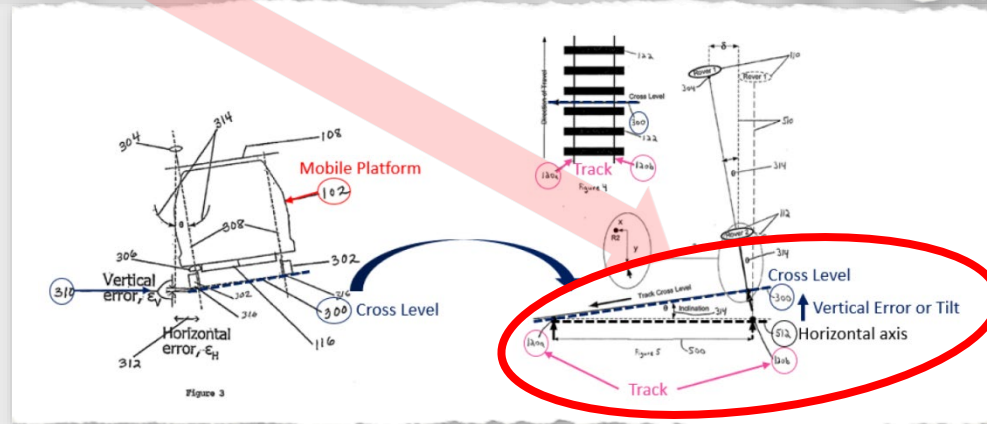


Szwilski, FIGS. 3, 5 (annotated)

As Szwilski's platform travels along inspecting rails, it determines and corrects imaged railroad component position data for vertical track errors.

The use of a first and second rover 110, 112 in the system uniquely comprises the means to determine whether there is track inclination perpendicular to the track 120a,b (also known as Cross-level inclination) necessary for accurate three dimensional data position of the rail 120b that is generated by step 212 of the rail 120b being surveyed. FIG. 3 shows a cross-section view of a preferred mobile platform 102 and demonstrates the vertical error 310 and horizontal error 312 due to track inclination. Track inclination is often expressed in inches (of lift) or degrees. Position data of the rail will not be accurate if there is inclination of the track 120a,b, unless the vertical error 310 and the horizontal error 312 is accounted for in step 212. As depicted in FIGS.

Szwilski, 16



Szwilski, FIGS. 3, 5 (annotated)

Szwilski's tilt corrections "include, but are not limited to, determining rail displacement 234 or other rail 120a,b defects and for even non-railroad applications."

processed for any number of modeling applications. Modeling applications include, but are not limited to, determining rail displacement 234 or other rail 120a,b defects and for even non-railroad applications.

Szwilski, 20

As Dr. Papanikolopoulos explains:

87. Therefore, in light of *Szwilski*'s teachings extending vertical tilt compensation corrections to "other rail [] defects," it would have been obvious and well within the skill of one of ordinary skill in the art, in my opinion, to implement *Villar* and *Choros*' automated RSA railroad track inspection system to account for vertical track inclination errors to accurately represent the imaged railroad component position data when determining whether a well-known "rail [] defect[]," such as RSA, is present on the railroad track. The combination would have yielded the claimed subject matter.

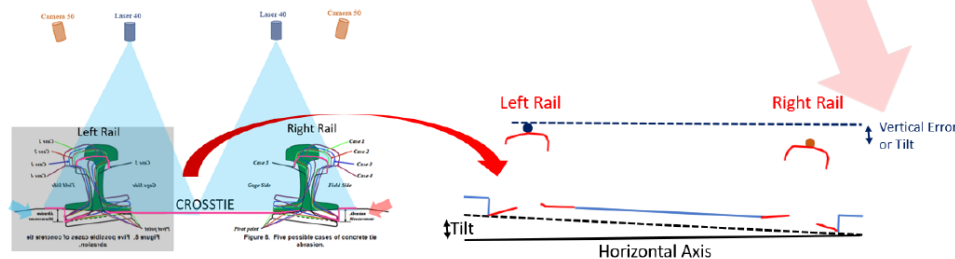
Ex-1004, ¶187

Villar/Choros + Casagrande/Szwilski

The cited references also render obvious claim 1's "at least one processor compensat[ing] for a tilt of the railroad track," to the extent it requires determining the railroad track tilt from the image representative of a profile of the scanned track.

91. Accordingly, as shown below in annotated FIG. 8, in my opinion, it would have been obvious to one of ordinary skill in the art to further implement Villar's processing device 60 to determine the vertical error or tilt (navy arrow, right) of the track from the image by analyzing the "vertical coordinate, measured on the top of the horizontal surface" of each of the left rail (navy dot) and right rail (orange dot), as taught by Casagrande. Casagrande ¶¶[0030], [0034]. And further to Casagrande and Szwilski's teachings, when determining whether RSA is present along the railroad track, Villar's system would compensate the RSA measurement for any vertical alignment error.

Ex-1004, ¶91



Choros, FIG. 8 (annotated).

GREX Challenges That Villar In View of Choros, Casagrande, and Szwilski Render Obvious the TC Limitations In Claim 1

'320 Patent

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

GREX's Tilt Correction Arguments Fail:

1. GREX's individual attacks on Casagrande fail.
2. GREX's individual attacks on Szwilski fail.

GREX's Individual Attacks on Casagrande Fail

However, Casagrande does not disclose or suggest “determining whether rail seat abrasion is present,” as the first part of element [f] requires. Ex-2001, ¶69. Although Casagrande discloses some rail related measurements that its system can make, it conspicuously fails to mention rail seat abrasion. *See id.* (citing Ex-1008,

PO Response, 18

Petition relies on Casagrande's tilt compensation teachings—not to determine whether RSA is present.

not to “determine[e] whether [RSA] is present.” As the Petition explains, it would have been obvious to implement Villar and Choros' automated RSA track inspection system with Casagrande's tilt compensation software to automatically compensate imaged railroad component position data (and parameters of the track geometry based the imaged profile data) for railway or tramway carriage vertical alignment (or tilt) errors, when determining the presence of a defect, such as RSA. Petition, 46-50 (citing Casagrande, ¶¶9-12, 30-36; Ex-1004, ¶¶82-84).

Pet. Reply, 12

digital timing in a cardiac pacer....” But one cannot show non-obviousness by attacking references individually where, as here, the rejections are based on combinations of references. *In re Young*, 56 CCPA 757, 403 F.2d 754, 159 USPQ 725 (1968). Moreover, as set

In re Keller, 642 F.2d 413 (CCPA 1981)

GREX's Individual Attacks on Casagrande Fail

Casagrande does not compensate for rail “tilt.” On its face, Casagrande never discusses tilt, nor does it disclose or suggest a way to compensate for tilt. Ex-2001, ¶72; Ex-1008, ¶¶[0007]-[0043]. As stated above, Casagrande compensates only for measurement errors caused by “oscillations” or “elastic deformation” of the
“vehicle,” “railway carriage,” or “tramway carriage.” Also, to the extent that, by

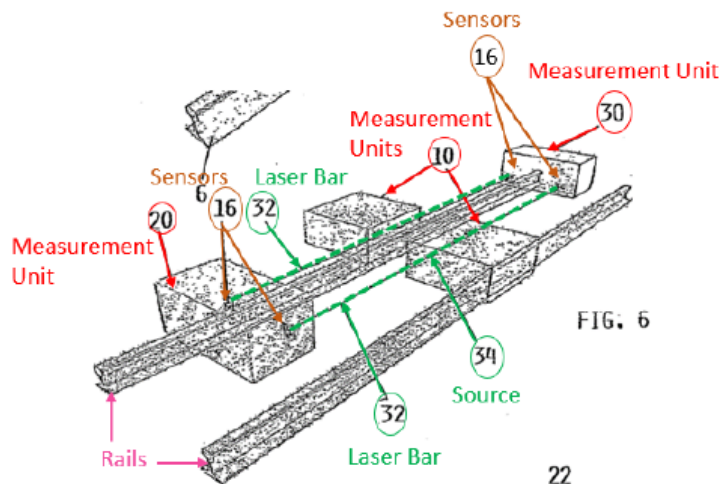
PO Response, 21

GREX's Argument Fails:

1. **Casagrande's system automatically compensates imaged position data for vertical alignment measurement errors due to vertical deviation of the railway and/or tramway carriage.**
2. **Track tilt impacts train tilt, which impacts alignment of Casagrande's measurement units.**
3. **Szwilski's platform determines and corrects imaged railroad component position data for vertical track inclination errors.**

GREX's Individual Attacks on Casagrande Fail

Casagrande's system automatically compensates imaged position data for vertical alignment measurement errors due to vertical deviation of the railway and/or tramway carriage.



Casagrande, FIG. 6 (annotated).

[0036] FIG. 6 shows schematically the principle of compensation for the errors due to elastic deformation of the railway or tramway carriage. With this, the position in height of each triangulation reading device located in the two end measurement units 20 and 30 is monitored by a laser bar 32 emitted by a source 34 positioned in the central measurement unit 10 and received by a sensor 16 positioned in the end measurement unit 20, 30 and able to constitute a precise alignment of the points of measurement. Lack of alignment results in a signal which by means of suitable software is able to automatically compensate the resultant measurement errors.

Casagrande, ¶36

GREX's Individual Attacks on Casagrande Fail

As Dr. Papanikolopoulos testifies:

81. According to *Casagrande*, any “[l]ack of alignment results in a signal which by means of suitable software is able to automatically compensate the resultant measurement errors.” *Id.* In my opinion, one of ordinary skill in the art would understand that because *Casagrande*’s apparatus measures any lack of alignment of “the position in height of each triangulation reading device located in the two end measurement units 20 and 30,” the system detects a vertical alignment error between each triangulation reading device caused by, e.g., a vertical deviation of the railway and/or tramway carriage. *Id.*, ¶[0036] (emphasis added).

Ex-1004, ¶81

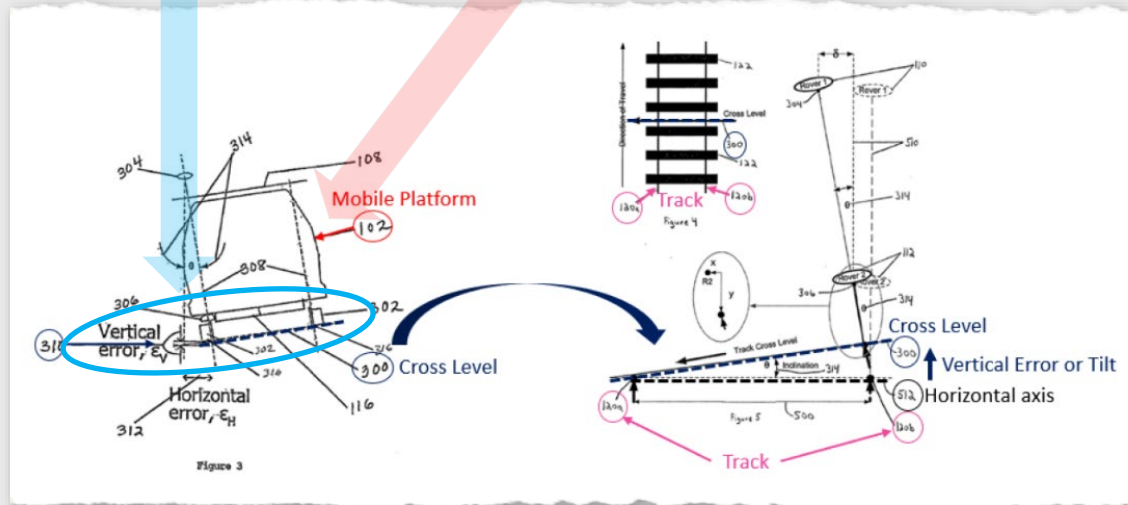
vehicle-mounted vision system, as taught by *Casagrande*. In my opinion, one of ordinary skill in the art would have understood that, when *Villar*’s inspection system measures the height of components as viewed as the distance from the camera to that component, an adjustment would need to be made to compensate for the tilt of the track—and thus the tilt of the machine vision inspection system— when the track was banked, such as going around a curve.

Ex-1004, ¶82

42

GREX's Individual Attacks on Casagrande Fail

Track tilt impacts **train tilt**, which impacts alignment of measurement units.



Szwilski, FIGS. 3, 5 (annotated)

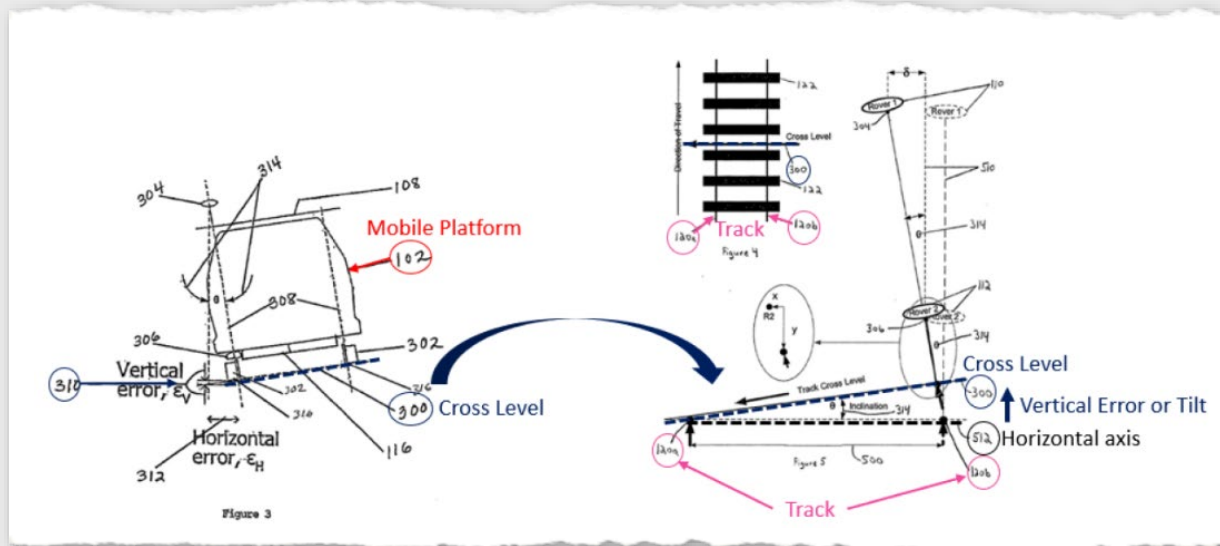
As also recognized by GREX:

regardless of whether rail tilt is caused by deviation of one rail or both rails, a vehicle riding the rails will tilt, Casagrande's measurement units will tilt to the same degree,

PO Sur-Reply, 16

GREX's Individual Attacks on Casagrande Fail

Szwilski's platform determines and corrects imaged railroad component position data for vertical track inclination errors.



Szwilski, FIGS. 3, 5 (annotated)

GREX's Individual Attacks on Casagrande Fail

Moreover, as Dr. Bovik explains, Casagrande is incapable of measuring or compensating for “tilt of the railroad track” as element [f] requires. Ex-2001, ¶73. If, because of a curve or bend in the track, the track is tilted to one side, any vehicle traveling on the tracks—including Casagrande’s vehicle, railway carriage, or tramway carriage carrying the measurement units—will lean or tilt because it is riding on the track rails. *Id.* Because the entire vehicle or carriage tilts, each measurement unit mounted on the vehicle or carriage will likewise tilt the same as the vehicle, which means that such a tilt will not disturb the alignment between the front, middle, and back measurement units as monitored by the laser bar 32 and sensors 16. *Id.* Consequently, Casagrande’s system will not even notice or register

PO Response, 21-22

Vertical deviation of a single rail relative to normal (and the opposite rail) may simply lead to the side of a vehicle on the deviated rail to tilt relative to normal—not the entire vehicle.

GREX's Individual Attacks on Casagrande Fail

'320 patent explains that an angular tilt L4 of a crosstie 10 associated with a curved track may tilt "slightly to the left" such that the height of the right rail 12 is slightly taller than left rail 12.

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.

'320 Patent, 13:2-10

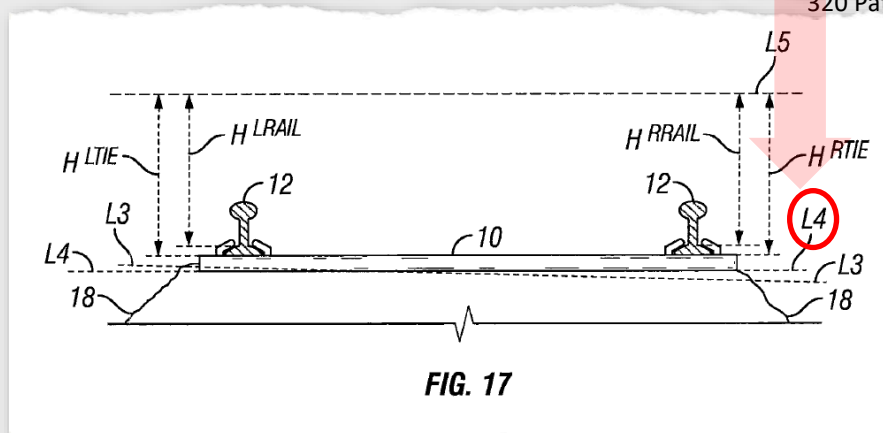


FIG. 17

'320 Patent, FIG. 17

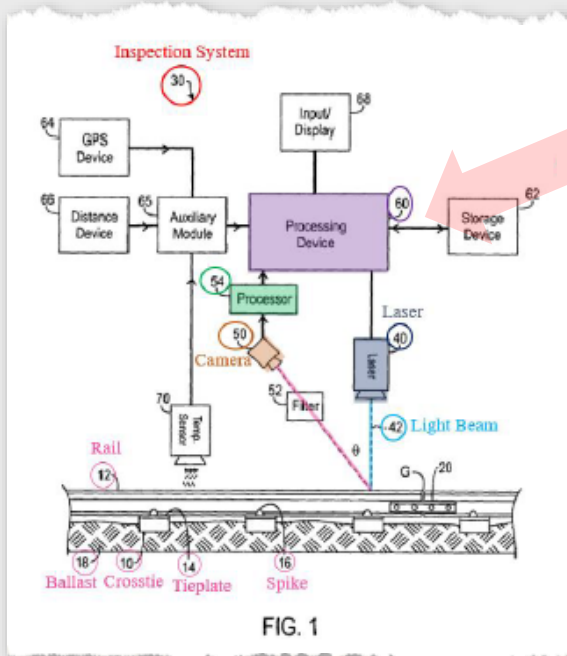
GREX's Individual Attacks on Szwilski Fail

In any event, even if Szwilski's disclosure in this regard somehow suggests combining Szwilski with Villar and Choros, Szwilski nevertheless does not disclose element [f]. Ex-2001, ¶79. Element [f] is a step performed by "at least one processor" as part of "analyzing the at least one image" "of a profile of at least a portion of the rail road track" as recited in elements [b], [c], and [d]. Szwilski's

PO Response, 21

Petition relies on Villar, not Szwilski for "the at least one processor" recitation of claim 1[f] (as well as claim 1[b], 1[c], and 1[d]'s recitations).

Petersen teaches away from appellant's invention. Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of [**20] references. *In re Keller*, 642 F.2d 413, 425, 208 U.S.P.Q. (BNA) 871, 881 (CCPA 1981). Thus, Petersen



Villar, FIG. 1 (annotated)

In re Merck & Co., Inc., 800 F.2d 1091 (Fed. Cir. 1986)

GREX's Individual Attacks on Szwilski Fail

More importantly, however, another reason why the purported combination falls short, as Dr. Bovik explains, is that “Szwilski’s measurements are unrelated to the position of the rail seats, and thus cannot be used to obtain element [f].” Ex-

PO Response, 26

Wrong Test

the card.³ However, we have consistently held, as the Board recognized, that “[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference; nor is it that the claimed invention must be expressly suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.” *In re Keller*, 642 F.2d 413, 425 (CCPA 1981); see also *In re Mouttet*, 686 F.3d 1322, 1333 (Fed. Cir. 2012).

MCM Portfolio LLC v. Hewlett-Packard Co., 812 F.3d 1284, 1294 (Fed. Cir. 2015)

Petition does not rely upon or propose bodily incorporating Szwilski’s specific systems and processes to determine RSA.

Szwilski’s teachings regarding vertical tilt compensation corrections and extending those corrections to “other rail [] defects,” would have suggested to a POSITA to implement Villar and Choros’ automated RSA railroad track inspection system to account for vertical track inclination errors to accurately represent the imaged railroad component position data when determining whether a well-known “rail [] defect[],” such as RSA, is present.

GREX's Individual Attacks on Szwilski Fail

Moreover, Dr. Bovik further opines that a POSITA would not have looked to or implemented Szwilski to compensate for railroad track tilt in determining rail seat abrasion because Szwilski's system is far too inaccurate. Ex-2001, ¶81. Szwilski

PO Response, 27

Petition is not relying on Szwilski to determine RSA, but instead for its imaged rail defect tilt compensation teachings.

To accurately represent the position of the rail being surveyed, *Szwilski's* system determines the presence of any vertical 310 tilt error (navy dashed line, FIGS. 3, 5) relative to horizontal (black dashed line) and corrects position coordinate data of the imaged component to account for the tilt. *Szwilski*, 16. And *Szwilski* recognizes that tilt corrections “include, but are not limited to, determining rail displacement 234 or other rail 120a,b defects and for even non-railroad applications.” *Id.*, 20 (emphasis added).

Ex-1004, ¶86

digital timing in a cardiac pacer....” But one cannot show non-obviousness by attacking references individually where, as here, the rejections are based on combinations of references. In re Young, 56 CCPA 757, 403 F.2d 754, 159 USPQ 725 (1968). Moreover, as set

In re Keller, 642 F.2d 413 (CCPA 1981)

GREX's Individual Attacks on Casagrande and Szwilski Fail

In any event, in Dr. Bovik's opinion, "even if a POSITA had sufficient reason to combine the references, the combination lacks element [f]'s features." Ex-2001, ¶88. As set forth above, neither Casagrande nor Szwilski disclose or suggest any capability for making measurements relating to the rail seats, and thus both are incapable of compensating for a tilt in the railroad track in making that determination, as element [f] requires. *Id.* As further described above, even putting

PO Response, 31

Again, the Petition relies upon Casagrande and Szwilski's teachings of compensating imaged rail defect measurements for railway or vehicle tilt—not the RSA determination. The teachings of the combination render obvious claim 1[f].

Petersen teaches away from appellant's invention. Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of [**20] references. *In re Keller*, 642 F.2d 413, 425, 208 U.S.P.Q. (BNA) 871, 881 (CCPA 1981). Thus, Petersen

In re Merck & Co., Inc., 800 F.2d 1091 (Fed. Cir. 1986)

GREX Challenges That the Cited References Render Obvious the TCF and Delta Limitations In Claim 2

'320 Patent

2. A system as defined in claim 1, wherein 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.

Further, contrary to Petitioner's argument (*id.*), Villar, Choros, Casagrande, and Szwilski do not disclose or suggest claim 2 for another reason. None of the references disclose or suggest the use of any "tilt correction factor" or an "actual delta" for the rail bases, as elements [c] and [d] of claim 2 require. Ex-2001, ¶91. In fact, the Petition does not allege any of the references disclose or suggest "determining a tilt correction factor." Petition at 55. Specifically, neither Casagrande nor Szwilski (the references on which Petitioner relies for tilt compensation) use those terms or any similar term, or disclose or suggest the application of any similar concept. See Ex-1008; Ex-1009. Accordingly, claim 2

PO Response, 32

GREX's Arguments Fail:

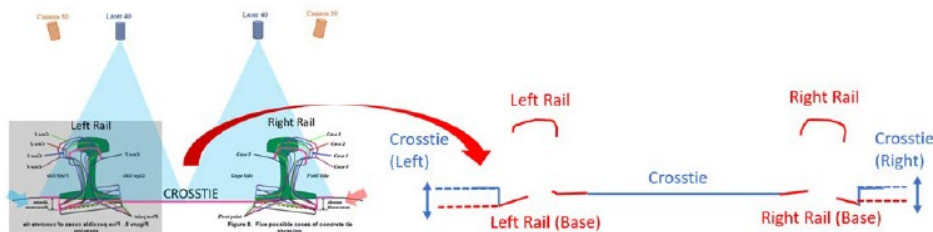
1. The combination renders obvious the claimed tilt correction factor and delta limitations.
2. The Petition incorporates claim 1[e] and [f]'s analysis into the analysis of claim 2[c] and 2[d], respectively.

Villar, Choros, Casagrande, and Szwilski Render Obvious Claim 2 (Despite GREX's Conclusory Arguments to the Contrary)

The Petition incorporates claim 1[e] and [f]'s analysis into the analysis of claim 2[c] and 2[d], respectively.

Claim 2[d]: “determining an actual delta for the right and left rail bases; and”

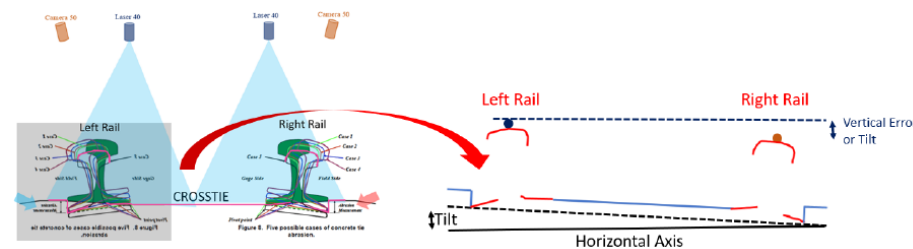
As discussed above regarding claim 1[e], *Villar* and *Choros* render obvious an automated RSA railroad inspection vision system for determining each rail base and crosstie top surface height, and the distances between the left rail base and crosstie heights, and the right rail base and crosstie heights. Ex-1004, ¶97. Because *Villar* and *Choros*' RSA railroad inspection vision system determines the distance or difference between the left rail base and crosstie heights, and the right rail base and crosstie heights, *Villar*'s system determines an “actual delta” for the right and left rail bases. Ex-1004, ¶97.



Choros, FIG. 8 (annotated).

Claim 2[c]: “determining a tilt correction factor;”

As discussed above regarding claim 1[f], *Villar*, *Choros*, *Casagrande*, and *Szwilski* render obvious an automated RSA railroad inspection vision system for determining the vertical alignment or tilt of the rails and compensating an RSA measurement for any vertical alignment or tilt error. Ex-1004, ¶95. One of ordinary skill in the art would have thus understood that the value used to compensate the RSA measurement for any vertical alignment or tilt error would constitute the claimed “tilt correction factor.” Ex-1004, ¶95.



Choros, FIG. 8 (annotated).

Villar, Choros, Casagrande, and Szwilski

Render Obvious Claims 5-7, 10-13, and 16-17

GREX does not separately argue the patentability of claims 5-7, 10-13, and 16-17

5. A system as defined in claim 2, wherein the step of determining the actual delta is 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.

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;
- (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. A method as defined in claim 7, wherein step (d) is accomplished based upon the 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 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 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:

- 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.

16. A method as defined in claim 13, wherein the step of determining the actual delta is 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.

GROUND 2

Ground 2: Claims 3, 8, and 14 Unpatentable Over:

Villar, Choros, Casagrande, Szwilski, and Khattak

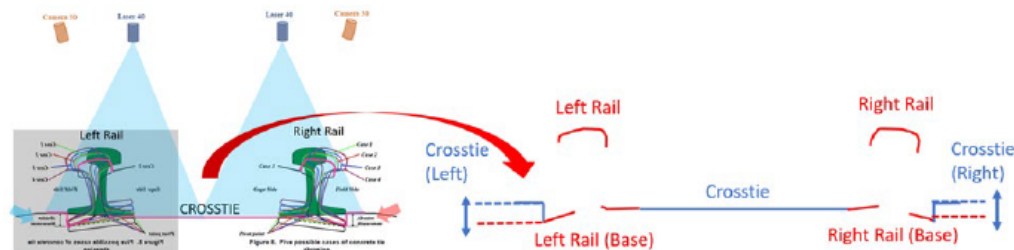
'320 Patent

3. A system as defined in claim 2, 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.

Villar, Choros, Casagrande, Szwilski, and Khattak

Render Obvious Claim 3

123. Accordingly, it would have been obvious to one of ordinary skill in the art, in my opinion, to implement *Villar's* system to identify and assess the rail base and crosstie top surface height contours via contour line-fitting and orientation comparison algorithms by determining the left and right rail base and crosstie heights by determining and comparing vertical pixel counts in the image for the left and right rail base heights (blue dashed lines) and left and right crosstie heights (red dashed lines), as shown below in annotated FIG. 8. Implementing *Villar's* system in this way would simply provide another track component defect for *Villar's* vision system to automatically identify and correct in furtherance of increasing railroad safety.



Choros, FIG. 8 (annotated).

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

the cited paragraphs of Villar do not mention the term “pixel,” let alone the counting of pixels or using pixel counts for determining either these or other height measurements. Ex-1005 at ¶¶[0047], [0050], [0052], [0055]. Rather, these portions of Villar discuss using best fit or curve fitting techniques, edge detecting techniques, and line fitting techniques to determine the distances or heights involved. *Id.*; Ex-2001, ¶111.

PO Response, 36

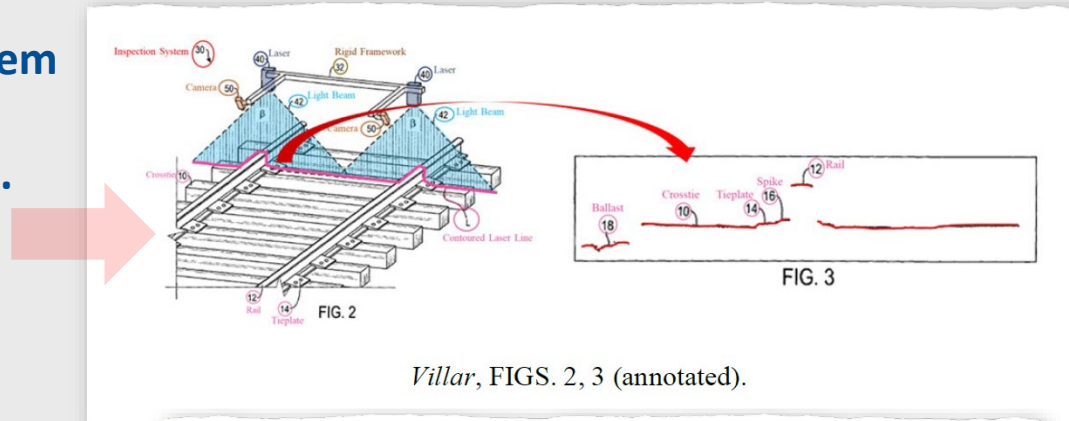
GREX's Pixel Arguments Fail:

1. Villar's system generates track images that include “a plurality of pixels given X-Y coordinates.”
2. Villar analyzes generated images for pixels indicating the presence of a railroad track component.
3. Villar uses orientation comparison algorithms to measure and compare height contours of imaged components, which would include determining vertical pixel counts.
4. GREX's arguments are further contradicted by record evidence confirming Villar's pixel measurement technique.

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

Villar's system generates track images that include "a plurality of pixels given X-Y coordinates"

Villar's automated track inspection system generates images representative of a profile of a portion of a railroad track.



Villar, FIGS. 2, 3 (annotated).

And each image includes "pixels given X-Y coordinates," showing the height contour of the imaged components along the track .

[0035] With the beams 42 projected onto the irregular surface of the track and viewed at an angle, the projected line L shown in FIG. 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 FIG. 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

Villar, ¶135

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

Villar, claim 11

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

To identify track components, Villar analyzes the images for “pixels” indicating presence of a railroad track component.

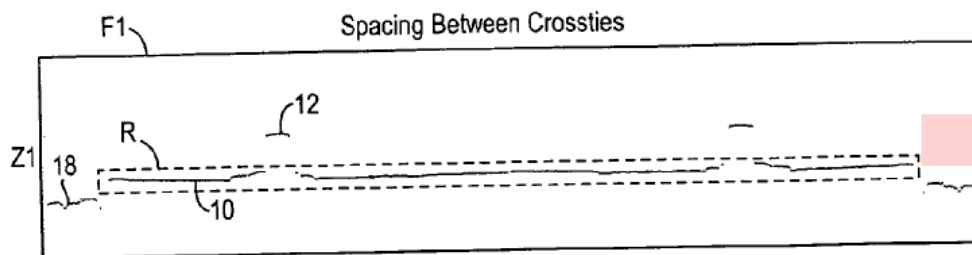


FIG. 4A

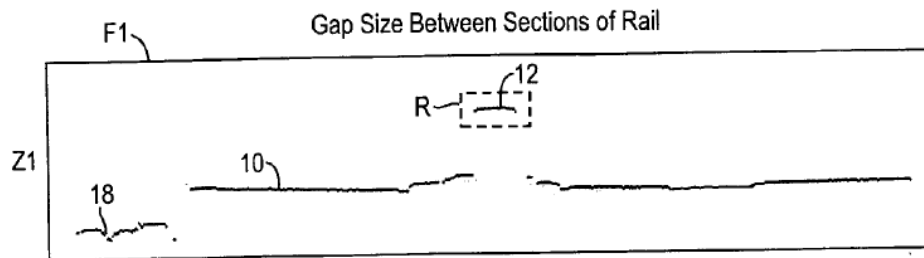


FIG. 6A

[0046] 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 FIG. 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.

[0049] 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 FIG. 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 crosstie.

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

Villar uses orientation comparison algorithms to measure and compare height contours of imaged components, which would include determining vertical pixel counts.

Villar discloses identifying rail wear by determining a “measurable distance,” LD between level L and reference level L2—levels representing the respective height contours of the imaged pixel coordinates of the rail and tie plate in frame F1

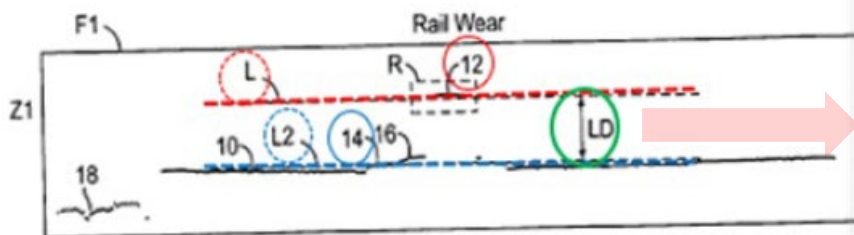


FIG. 7A

Villar, FIG. 7A (annotated).

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. FIG. 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

niques 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

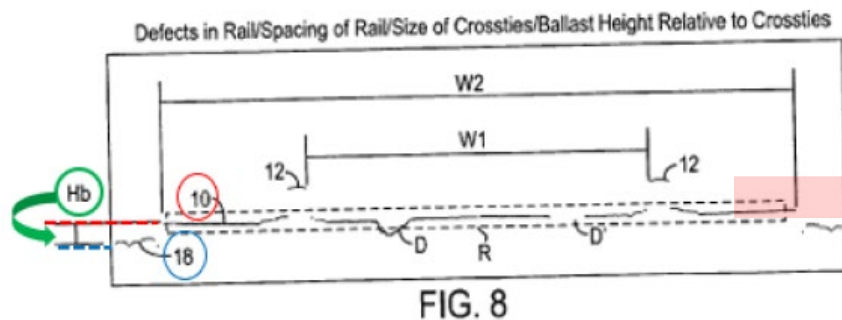
Villar, ¶150

Villar, ¶43

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

Villar uses orientation comparison algorithms to measure and compare height contours of imaged components, which would include determining vertical pixel counts.

Villar discloses determining height of ballast 18 relative to crosstie 10 by determining the height **Hb** of the imaged ballast height contour relative to the crosstie height contour



Villar, FIG. 8 (annotated).

[0053] In another example, the height of ballast 18 relative to the crosstie 10 can be determined from the image data. In **FIG. 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 **Hb** 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.

Villar, ¶53

niques 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

Villar, ¶43

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

Villar uses orientation comparison algorithms to measure and compare height contours of imaged components, which would include determining vertical pixel counts.

As Dr. Papanikolopoulos explains:

121. Once *Villar's* system identifies contours of railroad track components in the image, it next assesses the components for defects via contour line-fitting and orientation comparison algorithms. *Villar*, ¶¶[0050], [0052], [0047]. In my opinion, one of ordinary skill in the art would understand that *Villar's* system accomplishes these and other line-fitting and orientation comparison algorithms through determining and comparing the vertical pixel counts of the imaged contoured railroad track components. In one embodiment, for example, shown

Ex-1004, ¶121

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

GREX and its expert's conclusory statements are further contradicted by record evidence confirming Villar's pixel measurement technique.

Determining length, width, and size of imaged surface distress features via frame pixel data

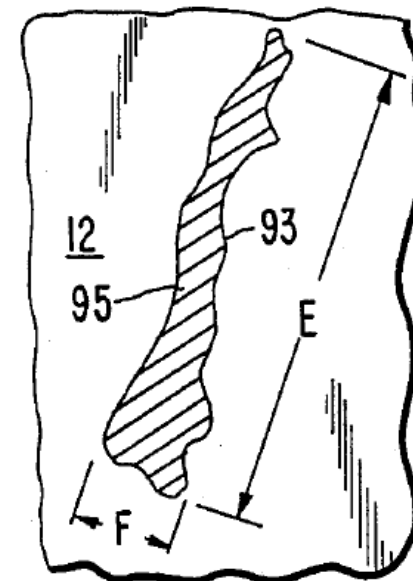
to adjust or calibrate the raw pixel accordingly. As previously stated the apparatus is designed with an approximate 0.1 of an inch/pixel resolution. However

gator cracks, D Cracks, potholes, or the like. As illustrated in FIG. 9, the size and shape circuit 92 measures the distance E and F of a particular feature and applies an aspect ratio to determine whether it is a longitudinal or a transverse crack. The size and shape circuit 92 determines the locations of the boundaries or edges 93 of each distress feature.

In step 141, it is determined whether any significant distress features are located in the section. In step 141, the number of contiguous feature pixels is compared to a preset value to initially determine feature area size.

step 143, an evaluation is made to determine the X-Y locations of the boundaries of the found feature. In step 144, the pixels adjacent to the boundary are re-

FIG. 9



Khattak, FIG. 9

Khattak, 6:36-37, 11:1-7, 13:54-57, 13: 63-65

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

GREX and its expert's conclusory statements are further contradicted by record evidence confirming Villar's pixel measurement technique.

Determining ΔH , and defect parameters S_h , S_l , S_b , and broken length, W by "counting" pixels

3.3.3. Evaluation of the Waveform

The final process is the evaluation of a waveform. This is done by checking several parameters. In calculating these parameters, a particular evaluation zone is set up for each parameter, as shown by the rectangles in

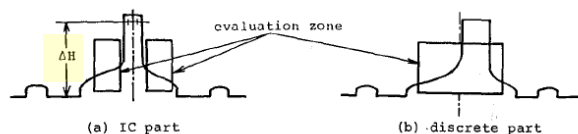


Figure 7: Establishment of Evaluation Zone. (a) IC Part; (b) Discrete Part

Figure 7, and the counting is done only in these zones. For dual in-line IC

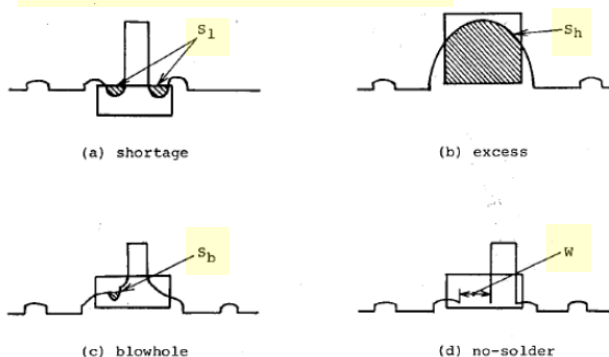


Figure 8: Parameters for Judgment. (a) shortage; (b) excess; (c) blowhole; (d) no-solder

Showing distributions of parameters S_h , S_l and S_b determined via pixel count

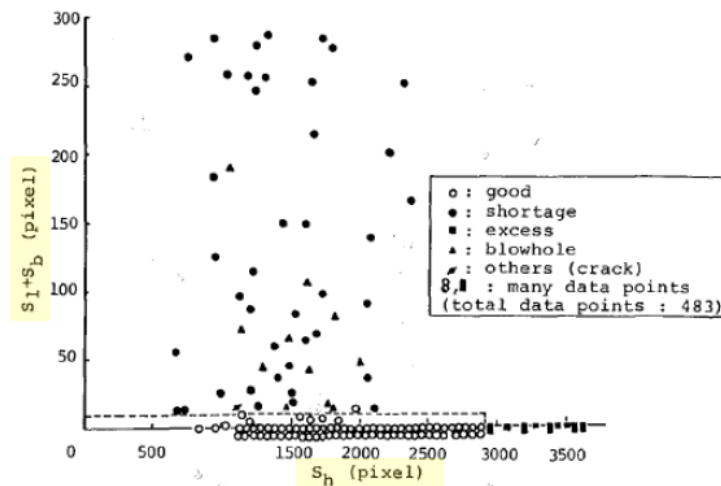


Figure 14: Distribution of Parameter Values for Various Types of Defects. (IC Parts)

Ex-1026, 558

Ex-1026 (Kanade), 553-554

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

GREX and its expert's conclusory statements are further contradicted by record evidence confirming Villar's pixel measurement technique.

Using imaged pixel positions and "COUNT" functions to determine true object position, geometrical features, and other parameters from imaged pixel data

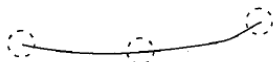


Figure 6.3 Extracting geometrical features from a cross section of the range image.

```
LFFILL R(<thresh_line>)          /* get position of left edge */
lpos = 256 - COUNT
LEDGE
LD (1XX) A                        /* shift right two steps */
LD (1XX) A
LDI (00X) A                       /* expand right four steps */
LDI (00X) A
LDI (00X) A
LDI (00X) A
ST A, R(<mask>)
lval = 0
for (i=0; i<8; i++) {             /* read and sum bit planes */
    LD R(<range_bit_i>)
    AND R(<mask>)
    lval += COUNT * 2i
}
lval = lval / 5
```

```
ledge r0          ; How many objects?
n = COUNT
for (i=0;i<n;i++) {
    lscan r0       ; Select leftmost pixel in leftmost object
    rfill a        ;
    p = COUNT      ; Start position
    mark r0        ; Mark leftmost object
    l = COUNT      ; Length of object
    xor r0         ; Remove this object in line
    st a,r0        ; Store line in r0
}
```

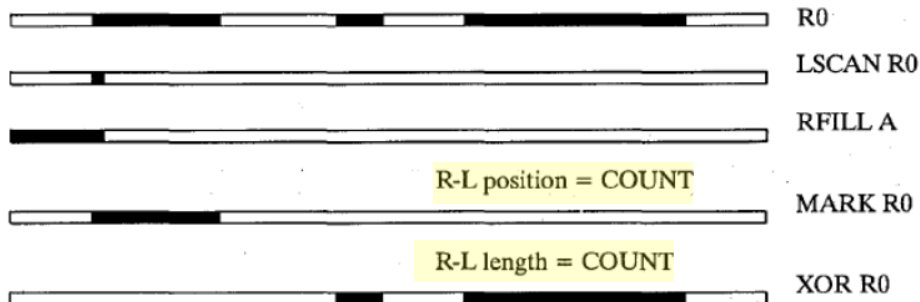


Figure 5.12. R-L coding in MAPP

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claim 3 (Despite GREX's Conclusory Arguments to the Contrary)

GREX's expert recognized the well-known pixel measurement technique in 2008.

Automated Region of Interest Detection of Spiculated Masses on Digital Mammograms

Rana Jahanbin¹, Mehul P. Sampat², Gautam S. Muralidhar¹,
Gary J. Whitman³, Alan C. Bovik⁴, Mia K. Markey¹

¹The University of Texas Department of Biomedical Engineering, Austin, TX, USA

²Center for Neurological Imaging, Brigham and Women's Hospital, Boston, MA, USA

³The University of Texas M. D. Anderson Cancer Center, Houston, TX, USA

⁴Department of Electrical and Computer Engineering, The University of Texas at Austin, TX, USA
{rana_jahanbin, gautam, mia.markey}@mail.utexas.edu, mehul.sampat@ieee.org

We asked an experienced radiologist to measure the physical parameters of spiculated lesions for 37 cases. We used the ROI Manager plugin of NIH ImageJ (<http://rsb.info.nih.gov/ij/>) to enable a user, with minimal training, to place markers at specific locations, and compute the pixel distance between the markers. The radiologist measured the length of the spicules and width of the spicules at their base (where the spicules meet the mass). The radiologist also measured the major axis of the central mass region of each lesion. Finally, the radiologist counted the number of spicules for each mass and this quantity is used to compute angular density. Since the resolution of the images is known, the pixel measurements can be converted into physically meaningful quantities (e.g., mm).

Ex-1045, 1-2

Villar, Choros, Casagrande, Szwilski, and Khattak Render Obvious Claims 8 and 14

GREX does not separately argue the patentability of claims 8 and 14.

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.

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.

GROUND 3

Ground 3: Claims 4, 9, and 15 Unpatentable Over:

Villar, Choros, Casagrande, Szwilski, and Andersson

Andersson

'320 Patent

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.

The second, and subsequent times that the train runs over a certain route, the previously measured and stored curve geometry for curves within a certain track section is used to calculate, and in advance, in a special calculating unit, correct reference values for tilting of the car body for curves within the track section. This calculation is made as a function of the position of the train, and of its various cars, along the track within the track section.

Andersson, 5:66-6:6

Villar, Choros, Casagrande, Szwilski, and Andersson

Render Obvious Claim 4

As Dr. Papanikolopoulos testifies:

136. Accordingly, in my opinion, it would have been obvious to one of ordinary skill in the art to have implemented *Villar* and *Choros*' automated RSA railroad track inspection vision and tilt correction system (as taught by *Casagrande* and *Szwilski*) with a standard tilt correction factor, as taught by *Andersson*, to pre-emptively compensate imaged measurements for known vertical alignment tilt errors associated with an upcoming track geometry. This would allow for faster image processing of the data and thus, faster identification of potential RSA issues. This enhanced data image processing would operate to protect the vehicle, optimize image processing (including faster identification of potential RSA issues), and enhance operational safety.

Ex-1004, ¶136

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

Accordingly, unlike the “tilt correction factor,” the “standard tilt correction factor” is not merely based on the simple error in vertical height measurements based on tilt of the railway, but instead factors in “variations in vehicle suspension” and “rail height placement standards,” among other “factors unrelated to rail seat abrasion.” Ex-2001, ¶121. Accordingly, claim 4 at a minimum requires the use of another factor, one that is distinct from the “tilt correction factor” required by claim 2, and thus compensates for the tilting not caused by a tilt in the railway. *Id.* Also, because it is a “standard” factor, and stated to be a fixed number (“0.12”) in the specification, the factor is a fixed factor applied to all curves and other parts of the railway. *Id.*

PO Response, 37

GREX's Standard TCF Argument Fails:

1. No record evidence requires claim 4's standard TCF to be a distinct value from claim 2's TCF.
2. No record evidence requires limiting the standard TCF to “variations in vehicle suspension” and “rail height placement standards,” among other “factors unrelated to rail seat abrasion.”

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

Claim 4 drafted broadly to only require “a standard tilt correction factor.”

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.



on tilt of the railway, but instead factors in “variations in vehicle suspension” and “rail height placement standards,” among other “factors unrelated to rail seat abrasion.” Ex-2001, ¶121. Accordingly, claim 4 at a minimum requires the use of

Nothing in the claim's plain language:

- Requires limiting the standard TCF to “variations in vehicle suspension” and “rail height placement standards,” among other “factors unrelated to rail seat abrasion.”
- Precludes the standard TCF from being a sub-category of claim 1's tilt correction factor, such as
 - one developed to pre-emptively compensate imaged measurements for known vertical alignment tilt errors associated with upcoming track geometries.

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

The '320 specification likewise provides no disclaimer or definition mandating GREX's interpretation.

The tilt phenomena is more clearly described in reference to the profile image depicted in FIG. 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.

Simply refers to an “exemplary embodiment” describing a tilt correction factor incorporated into algorithms to adjust for tilt caused by variations in vehicle suspension, rail height placement stands, and other factors unrelated to rail seat abrasion

'320 Patent, 12:63-13:17

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

(emphasis original); *see id.* at 75; Ex-1004, ¶¶134, 136. To the contrary, Andersson does not disclose a “standard tilt correction factor” as recited in claim 4. As Dr. Bovik explains, “Andersson does not disclose a standard tilt correction factor, let alone one distinct from a tilt correction factor.” Andersson discloses measuring the

see Ex-1011 at 3:45–6:18. Thus, “Andersson discloses a database of individual tilt corrections, one for each curve, along a section of track rather than a standard tilt correction factor that is applied to every curve.” Ex-2001, ¶122.

PO Response, 41

Neither the claim's plain language nor the specification require applying the same standard tilt correction factor along each section of the track.

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

That the specification provides a single-value tilt correction factor that was “[a]ccordingly” determined following the “example” of a single curve within a track does not require GREX’s interpretation to be read into the claim.

The tilt phenomena is more clearly described in reference to the profile image depicted in FIG. 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.

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claim 4 (Despite GREX's Conclusory Arguments to the Contrary)

combination. Because Andersson measures and stores the tilt in each curve, that measured tilt, and any compensation based on that tilt, includes any tilting in the railway caused by uneven heights of the rails, rail seat abrasion, and other physical conditions in the railway that, based on Petitioner's contention, the systems used in Casagrande and/or Szwilski measure and/or use as compensation for tilt as well. The additional use of the compensation employed by Andersson would thus act to overcompensate for all these other overlapping factors that cause any tilting in the railway, such as those caused by uneven heights of the rails, rail seat abrasion, or other physical conditions in the railway." Ex-2001, ¶125. Claim 4 is patentable for

PO Response, 43

Implementing a standard tilt correction factor, as taught by Andersson, would operate to pre-empt—not overcompensate—imaged measurements for known vertical alignment tilt errors associated with upcoming track geometries.

Villar, Choros, Casagrande, Szwilski, and Andersson Render Obvious Claims 9 and 15

GREX does not separately argue the patentability of claims 9 and 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.

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.

Claims 1-17 Are Unpatentable

Choros is Prior Art

Choros is Prior Art

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Prevention of Derailments due to Concrete Tie Rail Seat Deterioration

Choros is Prior Art

Declaration of Rachel J. Watters on Authentication of Publication

I, Rachel J. Watters, am a librarian, and the Director of Wisconsin TechSearch (“WTS”), located at 728 State Street, Madison, Wisconsin, 53706. WTS is an interlibrary loan department at the University of Wisconsin-Madison. I have worked as a librarian at the University of Wisconsin library system since 1998. I have been employed at WTS since 2002, first as a librarian and, beginning in 2011, as the Director. Through the course of my employment, I have become well informed about the operations of the University of Wisconsin library system, which follows standard library practices.

This Declaration relates to the dates of receipt and availability of the following:

Choros, J., Coltman, M. N., & Marquis, B. (2007, January). Prevention of derailments due to concrete tie rail seat deterioration. In ASME/IEEE 2007 Joint Rail Conference and Internal Combustion Engine Division Spring Technical Conference (pp. 173-181). American Society of Mechanical Engineers.

Standard operating procedures for materials at the University of Wisconsin-Madison Libraries. When a volume was received by the Library, it would be checked in, stamped with the date of receipt, added to library holdings records, and made available to readers as soon after its arrival as possible. The procedure normally took a few days or at most 2 to 3 weeks.

Exhibit A to this Declaration is true and accurate copy of the front matter of the ASME/IEEE 2007 Joint Rail Conference and Internal Combustion Engine Division

Declaration of Rachel J. Watters on Authentication of Publication

Spring Technical Conference (2007) publication, which includes a stamp on the verso page showing that this book is the property of the General Library System at the University of Wisconsin-Madison. Exhibit A also includes an excerpt of pages 173 to 181 of that volume, showing the article entitled *Prevention of derailments due to concrete tie rail seat deterioration* (2007).

Attached as Exhibit B is the cataloging system record of the University of Wisconsin-Madison Libraries for its copy of the *Prevention of derailments due to concrete tie rail seat deterioration* (2007) publication. As shown in the “Receiving date” field of this Exhibit, the University of Wisconsin-Madison Libraries owned this book and had it cataloged in the system as of July 11, 2007.

Members of the interested public could locate the ASME/IEEE 2007 Joint Rail Conference and Internal Combustion Engine Division Spring Technical Conference (2007) publication after it was cataloged by searching the public library catalog or requesting a search through WTS. The search could be done by title, author, and/or subject key words. Members of the interested public could access the publication by locating it on the library’s shelves or requesting it from WTS.