

Patent No. 9,981,673
Petition for *Inter Partes* Review

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HUM INDUSTRIAL TECHNOLOGY, INC.
Petitioner

v.

AMSTED RAIL COMPANY, INC.
Patent Owner

Patent No. 9,981,673
Issue Date: May 29, 2018
Title: SYSTEM AND METHOD FOR MONITORING
RAILCAR PERFORMANCE

Inter Partes Review No. IPR2023-00539

**PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 9,981,673
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42**

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LISTING OF CLAIMS

U.S. Patent No. 9,981,673 (Claims 1–18 and 20–22)

Claim Designation	Claim Language
Claim 1 Preamble	A method of monitoring operational characteristics of a railcar comprising the steps of:
Limitation 1(a)	a. receiving data or processed information regarding said operational characteristic from one or more sensing units on said railcar, said sensing units monitoring an operational characteristic of said railcar;
Limitation 1(b)	b. applying a heuristic to said received data to determine deviations from nominal operating conditions;
Limitation 1(c)	c. assigning a severity level to said deviations from nominal operating conditions; and
Limitation 1(d)	d. determining an alarm condition based on said assigned severity level.
Claim 2	The method of claim 1 further comprising the initial step of establishing wireless communication with said one or more remote sensing units.
Claim 3	The method of claim 2 wherein said one or more remote sensing units form a mesh network.
Claim 4	The method of claim 2 wherein steps a-d are executed by a processing unit located on said railcar.
Claim 5	The method of claim 4 wherein said processing unit located on said railcar is a part of said mesh network.
Claim 6	The method of claim 2 further comprising the step of transmitting said alarm condition to a location remote from said railcar.

Claim 7	The method of claim 2 further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar.
Limitation 8(a)	The method of claim 2 further comprising the steps of: receiving data from a plurality of railcars;
Limitation 8(b)	applying a heuristic to said received data to determine deviations from nominal operating conditions;
Limitation 8(c)	assigning a severity level to said deviations from nominal operating conditions;
Limitation 8(d)	determining an alarm condition based on said assigned severity level;
Limitation 8(e)	transmitting said raised alarm to a display unit on a train of which said plurality of railcars are a part.
Limitation 9(a)	The method of claim 6 further comprising the steps of a. determining a recommended course of action based on said alarm condition; and
Limitation 9(b)	b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.
Claim 10 Preamble	A method of monitoring a temperature of a desired part of a railcar, comprising:
Limitation 10(a)	(a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part;
Limitation 10(b)	(b) determining the temperature of the desired part by use of the temperature sensed in step (a);
Limitation 10(c)	(c) determining if said temperature of the desired part is outside an acceptable range of temperatures; and

Limitation 10(d)	(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside an acceptable range.
Claim 11	A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, further comprising the step of determining the temperature of the ambient air, which temperature is used in the determination of step (b).
Claim 12	A method of monitoring a temperature of a desired part of a railcar in accordance with claim 10, wherein steps (a) through (d) are carried out by a single unit attached to said railcar.
Claim 13	The method of claim 1 wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said sensor units, a communication management unit, and a mobile or land base station.
Claim 14 Preamble	A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:
Limitation 14(a)	a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed on said railcar;
Limitation 14(b)	b. heuristically analyzing said received data to determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data; and
Limitation 14(c)	c. communicating the results of said analysis to an off-railcar location.

Limitation 15(a)	The method of claim 14 wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of: a. wirelessly receiving notice of said alarm condition from said sensing unit; and
Limitation 15(b)	b. communicating said alarm condition to an off-railcar location.
Limitation 16(a)	The method of claim 14 further comprising the steps of: a. making a determination of an alarm condition based on data received from two or more of said sensing units; and
Limitation 16(b)	b. communicating said alarm condition to an off-railcar location.
Claim 17	The method of claim 14 further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data.
Claim 18	The method of claim 14 further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.
Limitation 20(a)	The system of claim 14 further comprising the steps of: a. saving data received from said one or more sensing units in memory; and
Limitation 20(b)	b. comparing data received with said saved data to identify trends or deviations from normal readings of said data stored in memory.

Claim 21 Preamble	A method for monitoring the operation of a railcar comprising:
Limitation 21(a)	a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on said railcar;
Limitation 21(b)	b. communicating said collected data to a communication management unit;
Limitation 21(c)	c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data.
Limitation 22(a)	The method of claim 21 further comprising the steps of: assessing the collected data to determine if an alarm condition exists;
Limitation 22(b)	and wirelessly communicating said alarm condition to an off railcar location.

I. FORMALITIES

A. Mandatory Notices (37 C.F.R. § 42.8(a)(1))

1. Real Party in Interest (37 C.F.R. § 42.8(b)(1))

Petitioner Hum Industrial Technology, Inc. (“Hum” or “Petitioner”) is a real party-in-interest in this petition.

Dr. Brent Wilson, an employee of Hum who has been named as a separate defendant in *Amsted Rail Company, Inc. v. Hum Industrial Technology, Inc. et al*, Case No. 4:22-cv-00445-AGF (United States District Court for the Eastern District of Missouri), is also a real party-in-interest in this petition. *See* Section I.A.4, *infra*.

2. Designation of Lead and Backup Counsel (37 C.F.R. § 42.8(b)(3))

Lead Counsel	Backup Counsel
Eric J. Rakestraw, Reg. No. 68,740 HUSCH BLACKWELL LLP 190 Carondelet Plaza, Suite 600 St. Louis, MO 63105 (314) 480-1500 Telephone (314) 480-1505 Facsimile PTAB- ERakestraw@huschblackwell.com	Andrea L. Shoffstall, Reg. No. 75,426 HUSCH BLACKWELL LLP 1801 Wewatta Street, Suite 1000 Denver, CO 80202 303.749.7200 Telephone 303.749.7272 Facsimile PTAB- AShoffstall@huschblackwell.com
	Backup Counsel Daisy Manning Reg. No. 66,369 Husch Blackwell LLP 190 Carondelet Plaza, Suite 600 St. Louis, MO 63105 (314) 480-1500 Tel (314) 480-1505 Fax PTAB- DManning@huschblackwell.com

3. Notice of Service (37 C.F.R. § 42.8(b)(4))

Please direct all correspondence to lead counsel at the above address.

Petitioner also consents to email service at the above email addresses for lead and back-up counsel and hand delivery at the above addresses for lead and backup counsel.

4. Related Proceedings (37 C.F.R. § 42.8(b)(2))

U.S. Patent No. 9,981,673 is presently asserted in *Amsted Rail Company, Inc. v. Hum Industrial Technology, Inc. et al*, Case No. 4:22-cv-00445-AGF (United States District Court for the Eastern District of Missouri). The complaint (EX1011) was considered served pursuant to the Waiver of the Service of Summons dated June 14, 2022 (EX1012). Thus, this Petition is filed within one year after Hum was served with a complaint for infringement. Hum has not filed a separate civil action challenging the validity of the claims of the '673 Patent.

This petition is one of three petitions that Petitioner has filed concurrently, requesting *inter partes* review of U.S. Patents Nos. 9,365,223 B2, 9,981,673 B2, and 10,137,915 B2. Docket numbers for those P.T.A.B. proceedings are not yet available, but each of these petitions could affect, or be affected by, a decision in either of the other two proceedings.

B. Grounds for Standing (37 C.F.R. § 42.104(a))

Petitioner hereby certifies that the '673 Patent is available for *inter partes* review, and Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the Grounds identified in the petition.

C. Procedural Statements

This Petition is filed in accordance with 37 C.F.R. § 42.106(a). A Power of Attorney (37 C.F.R. § 42.10(b)) and Exhibit List (37 C.F.R. § 42.63(e)) are filed concurrently with this Petition. The fee is being paid via Deposit Acct. No. 11-0160. The United States Patent and Trademark Office is authorized to charge any fee deficiency, or credit any overpayment, to Deposit Acct. No. 11-0160.

II. INTRODUCTION

Hum Industrial Technology, Inc. ("Hum" or "Petitioner") respectfully requests that the Board institute *inter partes* review of U.S. Patent No. 9,981,673 ("the '673 Patent"), which is assigned to Amsted Rail Company, Inc. ("Amsted" or "Patent Owner").

The '673 Patent is directed to methods for monitoring operational parameters of a railcar (for example, the temperature of the railcar's wheel bearings). In this system, one or more sensor units are attached to the railcar to monitor areas of interest (for example, by placing a unit having a thermometer in close proximity to the wheel bearing). These sensor units wirelessly transmit their

collected data to a central node, called a “communication management unit” or “CMU,” mounted on the railcar. The CMU processes the sensor data using “heuristics” and, if a deviation from normal operating conditions is detected, it generates an alarm message. The alarm message is then transmitted upstream for review by a human operator who can take appropriate action.

None of this was new when the ’673 Patent was filed, and none of it was invented by Amsted. Railcar monitoring systems that collect sensor data, apply heuristics to detect deviations from expected conditions, and notify operators of any issues have been in widespread use for decades. *See* EX1016. Indeed, an identical system—which performs the same functions as the ’673 Patent, using the same components, in the same way—was publicly disclosed at least as early as 2007. *See* EX1005. Compared to the prior art, the ’673 Patent’s only contribution is using (slightly) different terminology to describe the same elements. There is nothing patentable here.

A petition for *inter partes* review must demonstrate “a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314(a). For the reasons discussed in further detail below, the Petition meets this threshold.

III. STATEMENT OF THE PRECISE RELIEF REQUESTED AND THE REASONS THEREFOR (37 C.F.R. § 42.22(a))

Petitioner respectfully requests a final written decision that claims 1–18 and 20–22 of the '673 Patent are invalid. Claims 1, 10, 14, and 21 are independent.

Petitioner requests *inter partes* review of the '673 Patent based on the following patents, all of which were filed, issued, or published prior to the earliest priority date of the '673 Patent, which is no earlier than June 19, 2012. The prior art relevant to this Petition includes: U.S. Patent Application Publication No. 2007/0152107 A1 to LeFebvre et al. (“LeFebvre”) (EX1005), published on July 5, 2007; U.S. Patent Application Publication No. 2011/0282540 A1 to Armitage et al. (“Armitage”) (EX1006), filed on May 11, 2011 and published on November 17, 2011; and U.S. Patent Application Publication No. 2007/0208841 A1 to Barone et al. (“Barone”) (EX1007), published on September 6, 2007.

LeFebvre and Barone are each prior art to the '673 Patent under 35 U.S.C. § 102(b). Armitage is prior art to the '673 Patent under at least 35 U.S.C. §§ 102(a) and 102(e).¹

This Petition further relies upon the Declaration of Steven Ricca (“Ricca Decl.” (EX1003); Ricca curriculum vitae (EX1004)), which is relevant to the skill,

¹ With respect to § 102(e): Armitage claims, and is entitled to, a provisional application filing date of May 11, 2010.

knowledge, and experience of a person having ordinary skill in the art (“PHOSITA”) at the time of the invention and how that person would have understood and applied the prior art. The statutory grounds on which the challenge is based are:

- (1) Claims 1–7, 10–18, and 20–22 are unpatentable under 35 U.S.C. § 103(a) over LeFebvre.
- (2) Claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over LeFebvre in view of Barone.
- (3) Claims 1, 2, 4, 6–11, and 13 are unpatentable under 35 U.S.C. § 103(a) over Armitage.
- (4) Claims 3, 5, 12–18, and 20–22 are unpatentable under 35 U.S.C. § 103(a) over Armitage in view of LeFebvre.

IV. U.S. PATENT NO. 9,981,673 (“THE ’673 PATENT”) (EX1001)

U.S. Patent Application No. 15/158,018 (“the ’018 Application”), which issued as the ’673 Patent, was filed on May 18, 2016. The ’018 Application is a continuation of U.S. Patent Application No. 13/842,427 (“the ’427 Application”), which issued as U.S. Patent No. 9,365,223, and was filed on March 15, 2013. The ’018 Application claims priority to U.S. Provisional Application No. 61/661,661, filed on June 19, 2012 (EX1013).

The '427 Application also claims to be a continuation-in-part of Application No. 12/861,713 (“the '713 Application,” EX1014), filed August 23, 2010. Each of the challenged claims, however, recite at least one limitation that was newly added in the '427 Application, and is neither disclosed in nor supported by the '713 Application.

<u>Independent Claim</u>	<u>Exemplary Limitation(s) Without Support in the '713 Application</u>
1	“applying a heuristic”; “assigning a severity level”
10	“sensing the temperature”; “a temperature sensor”
14	“heuristically analyzing said received data”; “a statistical analysis of said received data”
21	“analyzing said collected data by applying heuristics thereto”

Accordingly, the challenged claims are entitled to a priority date of June 19, 2012 at the earliest.

None of the references relied upon in this petition (LeFebvre, Armitage, Barone) were cited in a rejection during prosecution of the '673 Application. The first Office Action, issued June 29, 2017, rejected all pending claims over US 2008/0195265 (EX1008, “Searle”) in view of US 6,339,397 (EX1009, “Baker”).

EX1002, pp. 106–121.² In a response filed October 13, 2017 (EX1002, pp. 419–434), Amsted argued that Searle and Baker:

1. Failed to disclose “*assigning a severity level to said deviations from nominal operating conditions*” (*id.*, p. 425);
2. Failed to disclose “*sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part*” (*id.*, p. 428); and
3. Failed to disclose heuristically analyzing sensor data “to determine if an actual failure exists” *or* “to predict potential or imminent failures.” (*Id.*, p. 431.)

This argument resulted in a Notice of Allowability. EX1002, pp. 488–495.

The Office should not have allowed the ’673 Patent over Searle and Baker because, in fact, those two references disclose *all three* features that Amsted argued were missing from the rejection. Specifically:

1. As recognized in the Office Action, Baker discloses the assignment of “multiple alarm states,” including “high and low priority alarm alerts.” EX1002, p. 110.

² The Office Action also contained references to “Official Notice,” for example in the rejection of claims 37, 44, and 51. EX1002, p. 109. Unfortunately, the Office Action did not clearly identify which fact(s) the Office intended to take notice of.

2. As recognized in the Office Action, Searle uses a temperature sensor to measure the hub of the wheel and thus *infer* the temperature of the wheel bearing. *Id.*, p. 118.
3. Searle states that its system uses heuristics to, at a minimum, detect *actual failures* including “wheel damage, failure, and derailment.” EX1008, ¶ [0012].

In view of these disclosures, the Office should not have withdrawn the rejections over Searle and Baker. In any event, the references relied upon below (LeFebvre, Armitage, Barone) disclose the methods claimed by the '673 Patent with even greater clarity and detail than Searle or Baker.

V. BACKGROUND OF RAILCAR MONITORING SYSTEMS AND THE PRIOR ART RELIED UPON IN THIS PETITION

This challenge is based primarily on three prior art references: LeFebvre, Armitage, and Barone.

1. LeFebvre

LeFebvre is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1005, (57) Abstract; EX1003, ¶ 50.

LeFebvre's system utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors communicate wirelessly with a control unit located on the railcar. *Id.*

Data collected by the control unit is analyzed using heuristics to determine, for example, if a wheel bearing failure is approaching or imminent. EX1005, ¶¶ [0058]–[0059]; EX1003, ¶ 51. If a failure condition is detected, an alert is wirelessly transmitted to a data processing system in a remote location. EX1005, ¶¶ [0038], [0052]; EX1003, ¶ 51.

2. Armitage

Armitage discloses a “mobile railway car monitoring system [including] a plurality of sensor nodes coupled to an undercarriage portion of a railway car.” EX1006, ¶ [0004]; EX1003, ¶ 52. Figure 1 of Armitage depicts an exemplary embodiment with four sensor nodes 121–124 attached to a railcar 110. EX1006, ¶ [0012], Fig. 1; EX1003, ¶ 52.

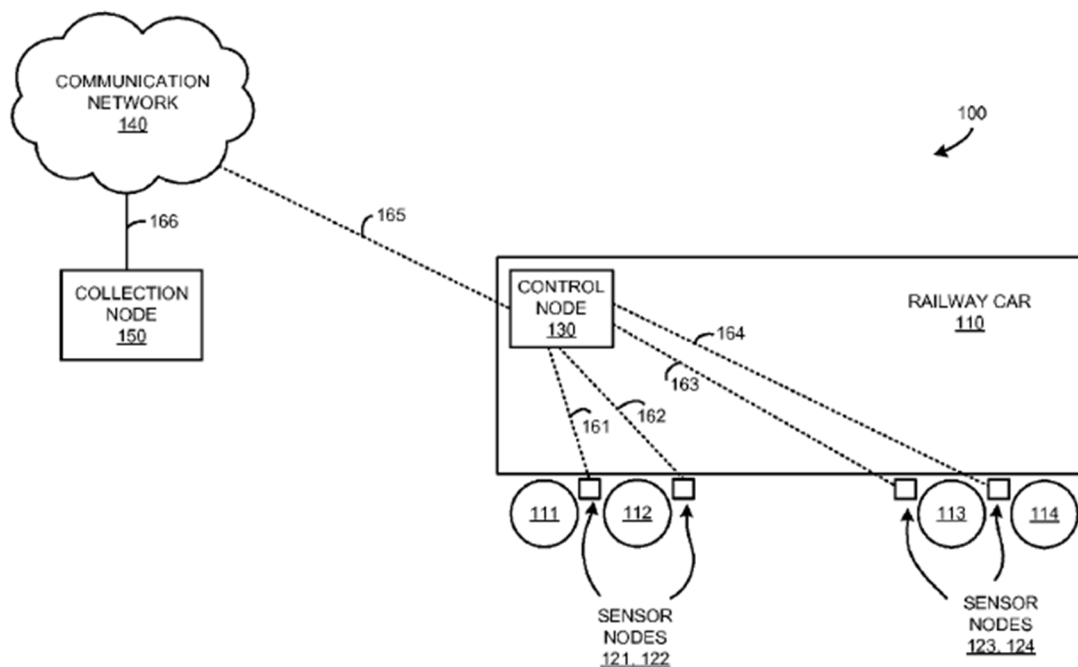


FIGURE 1

Armitage's "[s]ensor nodes 121-124 each include equipment to sense and report information about undercarriage elements of a railway car." EX1006, ¶ [0014]; EX1003, ¶ 53. Each sensor node "includes a sensor portion" that "could include thermometers" or "other sensing equipment and circuitry." *Id.* The system also includes a "control node" on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5.

Data collected by the control unit is analyzed using heuristics to determine, for example, if a component failure is approaching or imminent. EX1006, ¶ [0027]; EX1003, ¶ 54. If a failure condition is detected, an alert is wirelessly transmitted to a collection node in a remote location. EX1006, ¶ [0028]; EX1003, ¶ 54. Figure 2 of Armitage illustrates this process, and is reproduced below.

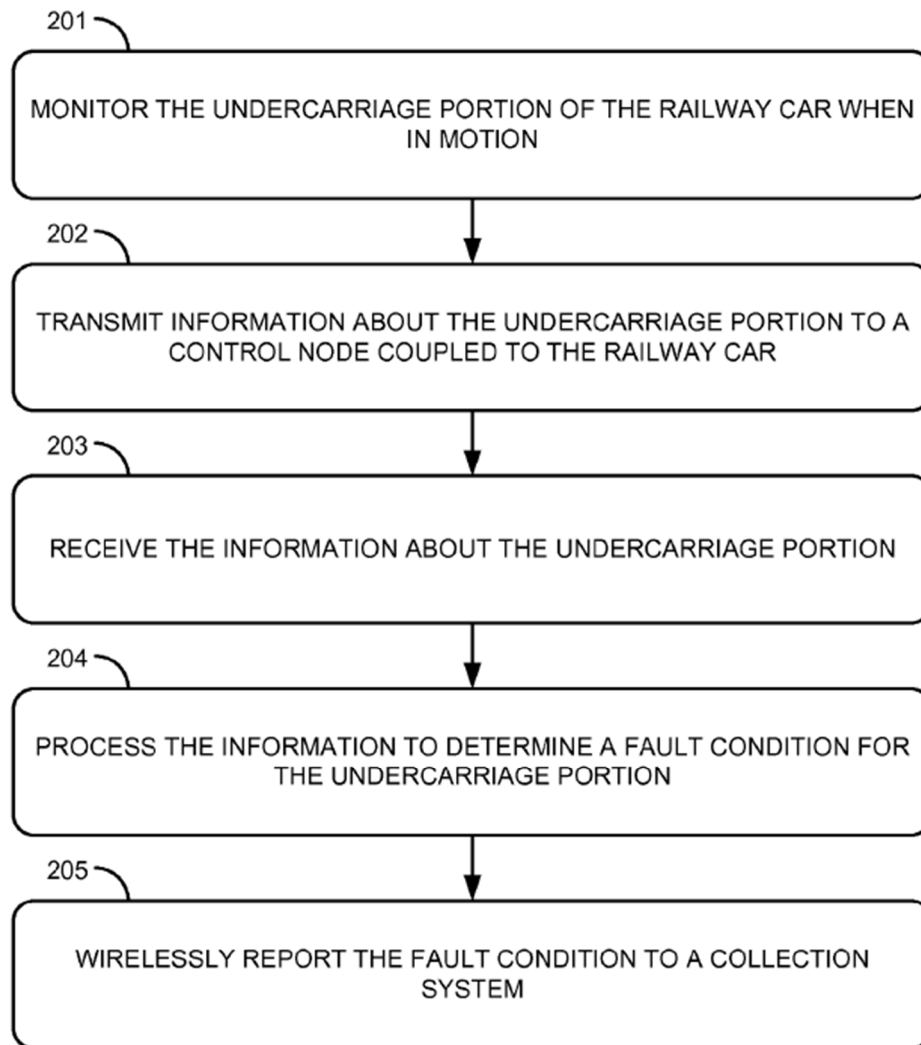


FIGURE 2

3. Barone

Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract; EX1003, ¶ 55.

Barone's system utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors are connected using a wireless mesh network. *Id.*; EX1003, ¶ 55.

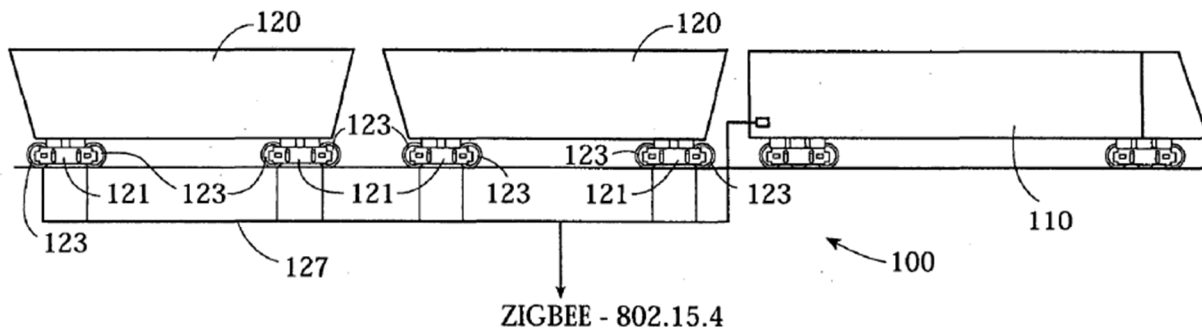
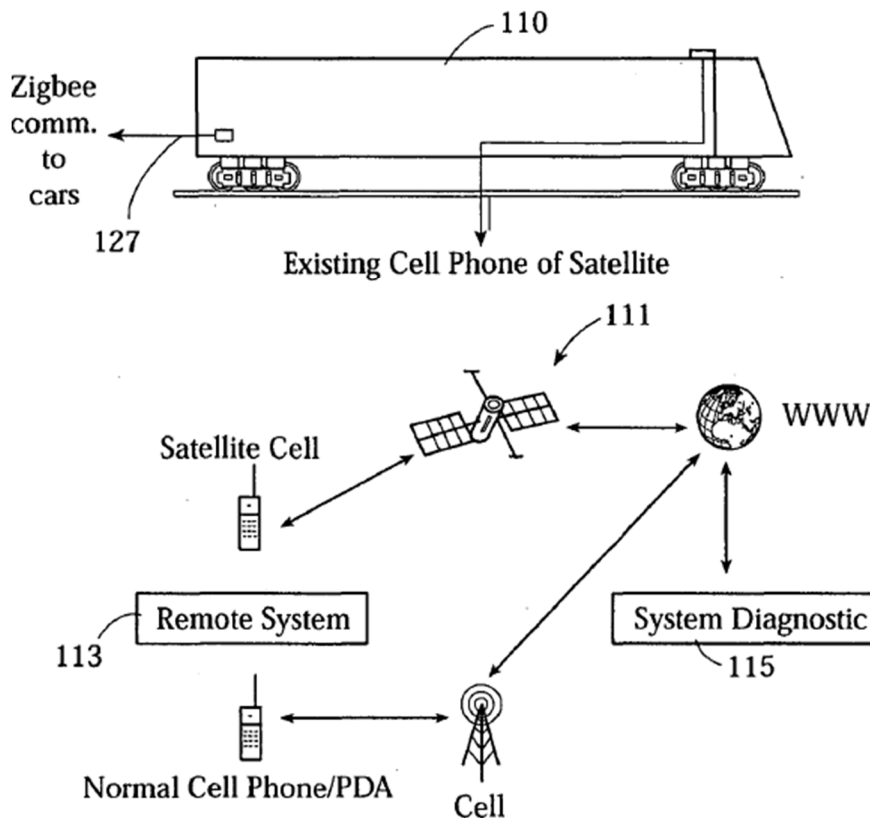


FIG. 1

EX1007, Fig. 1. The collected data is analyzed using heuristics to determine, for example, if a wheel bearing failure is approaching or imminent. EX1007,

¶¶ [0201]–[0220]; EX1003, ¶ 56. If a failure condition is detected, an alert (including the underlying data) is communicated to the locomotive and/or to a central monitoring station in a remote location. EX1007, ¶ [0045]; EX1003, ¶ 56.

Figure 2 of Barone is illustrative, and is reproduced below.



VI. A PERSON HAVING ORDINARY SKILL IN THE ART

The prior art and the Ricca Declaration demonstrate that a PHOSITA, at the time the '673 Patent was filed, would have been a person with at least a B.S. degree in electrical or mechanical engineering or a related field with at least two years' experience designing monitoring systems for railcar components, or monitoring systems for similar industrial equipment with rotating components. Less work experience could be compensated by a higher level of education, such as a master's degree, and vice versa. EX1003, ¶ 45.

VII. CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(b)(3)

Unless otherwise addressed herein, the terms of the unexpired '673 Patent's claims are to be given their plain and ordinary meaning, as understood by one of ordinary skill in the art, in view of the '673 Patent's specification. *See* 37 C.F.R. § 42.100(b); 83 FR 51340; *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

Petitioners do not believe any construction would have an impact on the invalidity analyses set forth herein. *See HTC Corp. v. Cellular Communications Equip., LLC*, 877 F.3d 1361, 1367–68 (Fed. Cir. 2017) (affirming the Board absent an express construction of a term). Based on the evidence below and the prior art's description of the claimed elements being similar to that of the '673 Patent specification, Petitioners submit that there are no formal claim constructions necessary in this proceeding because “claim terms need only be construed to the extent necessary to resolve the controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011) (internal quotations omitted).

VIII. DISCRETION UNDER § 325(d)

The Board uses a two-prong test to determine whether it will deny institution under 35 U.S.C. § 325(d). Under the first prong, the Board determines whether the same or substantially the same prior art or arguments were previously considered by the USPTO. *Advanced Bionics LLC v. MED-EL Elektromedizinische Geräte*

GmbH, IPR2019-01469, Paper 6 (PTAB Feb. 13, 2020) (Precedential). Barone was not considered by the examiner. LeFebvre and Armitage were each cited in an IDS, but were not relied upon in rejecting the claims. Grounds based on a reference cited in an IDS but not considered at any length should not serve as the basis for denying institution under 35 U.S.C. § 325(d). *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17-18 (PTAB Dec. 15, 2017) (Precedential).

Nor are the references cited herein substantially the same as the references considered during prosecution. For example, the two primary references herein (LeFebvre and Armitage) are **both** directed to railcar monitoring systems that, *inter alia*, apply heuristics to collected sensor data **both** “to determine if an actual failure exists” **and** “to predict potential or imminent failures.” Thus, the prior art relied upon herein teaches the very limitation found by the examiner to be missing from the prior art, which is highly persuasive evidence supporting a decision to institute trial.³ *Vestas-American Wind Technology, Inc. v. General Electric Co.*, IPR2018-01015, slip op. at 23-24 (Paper 9) (PTAB Nov. 14, 2018); *see Becton, Dickinson*

³ The remaining points of distinction that Amsted identified during prosecution, discussed in Section IV above with respect to Searle and Baker, are also disclosed by one or more of the cited references as explained in detail below.

and Co. v. B. Braun Melsungen AG, IPR2017-01586, slip op. at 17-18 (Paper 8) (PTAB Dec. 15, 2017) (informative).

Because the prior art and arguments presented herein are not the same or substantially similar to those considered by the Examiner, the second prong of *Advanced Bionics* does not apply.

IX. DISCRETION UNDER § 314(a)

The Office’s June 21, 2022 Memorandum⁴ (“Guidance Memo”) states that “the PTAB will not discretionarily deny institution of an IPR or PGR in view of parallel district court litigation where a petitioner stipulates not to pursue in a parallel district court proceeding the same grounds as in the petition or any grounds that could have reasonably been raised in the petition.” Guidance Memo at 7. In accordance with this guidance, Hum has offered Amsted a stipulation that, if IPR is instituted, it will not pursue in the District Court Litigation any ground raised or that could have been reasonably raised in an IPR with respect to claims 1–18 and 20–22 of the ’673 Patent. EX1017.

⁴ *Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation*, available at www.uspto.gov/sites/default/files/documents/interim_proc_discretionary_denials_aia_parallel_district_court_litigation_memo_20220621_.pdf.

X. GROUND FOR UNPATENTABILITY

Petitioner requests cancellation of the challenged claims on the following Grounds:

A. Ground 1: Claims 1–7, 10–18, and 20–22 are unpatentable under 35 U.S.C. § 103(a) over LeFebvre.

As explained in detail below, a PHOSITA would understand that LeFebvre discloses every element of claims 1–7, 10–18, and 20–22. Petitioner believes these claims are anticipated by LeFebvre under 35 U.S.C. § 102.

LeFebvre, however, does not *expressly* state that all disclosed limitations are part of a single embodiment. Petitioner has therefore elected to present this ground under 35 U.S.C. § 103. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019) (“a disclosure that anticipates under § 102 also renders the claim invalid under § 103”) (cleaned up). *See also* EX1003, ¶¶ 66–69.

1. Independent Claim 1

a. Claim 1 Preamble⁵

This preamble merely describes an intended use of the system, which does not instill patentable weight. *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d

⁵ Because Petitioner includes the full claim language of the '673 Patent in the Listing of Claims, Petitioner does not reproduce the full claim language here. The Board is encouraged to reference the Listing of Claims to see the full claim language.

1298, 1305 (Fed. Cir. 1999); *see also Rowe v. Dror*, 112 F.3d 473, 478 (Fed. Cir. 1997); MPEP 2111.02(II); EX1003, ¶ 70.

To the extent that the preamble is limiting, LeFebvre discloses “a monitoring system for railroad trains and the like, and more particularly a system that uses an instrumented roller bearing adapter pad to detect the occurrence and cause of poor performance at wheel set, truck, freight car or train level.” EX1005, ¶ [0001]; EX1003, ¶ 71.

b. Limitation 1(a)

LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads 16, each of which comprises one or more sensors that measure operational parameters of the railcar. EX1005, ¶¶ [0019], [0023], [0052], EX1003, ¶ 72. The sensors may comprise, for example, one or more temperature sensors. EX1005, (57) Abstract, ¶¶ [0021], [0033], [0058]. A PHOSITA would understand that LeFebvre’s instrumented pad is a “sensing unit” in the parlance of the ’673 Patent. EX1003, ¶ 72.

Each instrumented pad 16 is a separate device that is mounted on the railcar. Specifically, each pad is mounted upon the upper surface of a wheel bearing adapter 4, as shown in Fig. 4. EX1005, ¶ [0019]; EX1003, ¶ 73.

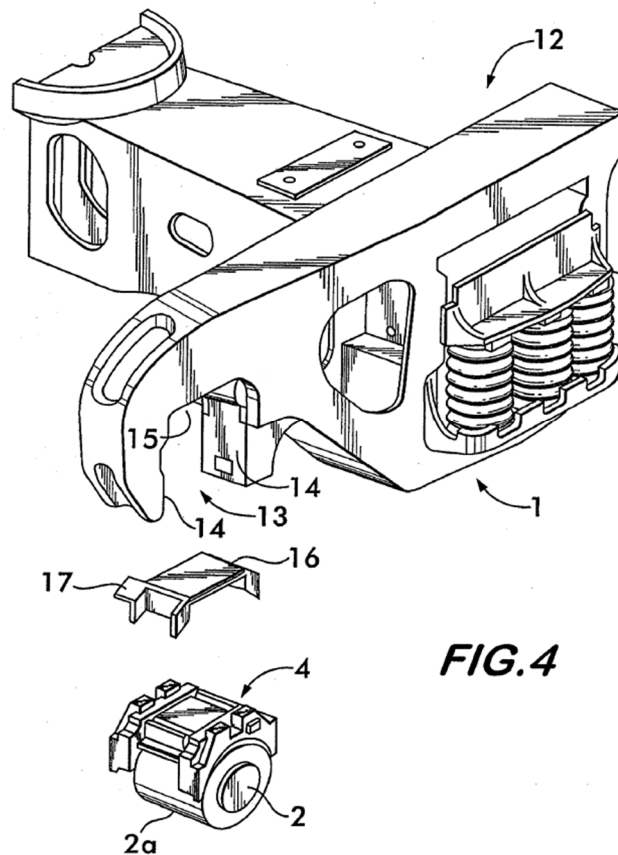
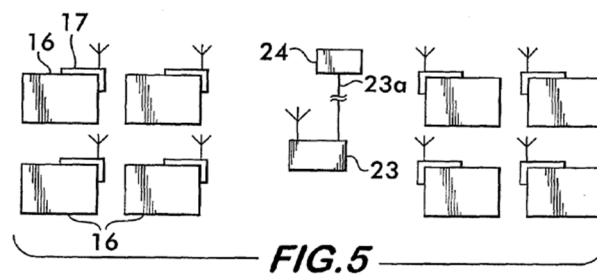


Figure 5 of LeFebvre depicts an exemplary embodiment with a plurality of instrumented pads 16, where each instrumented pad is attached to a different wheel bearing adapter. EX1005, ¶ [0039], Fig. 5; EX1003, ¶ 74.



Each instrumented pad 16 communicates wirelessly with a data control unit 23, which is mounted on the railcar body. EX1005, ¶ [0024]; Fig. 5; EX1003, ¶ 75.

LeFebvre's data control unit therefore receives data from the instrumented pads (i.e., sensing units), as required by Limitation 1(a). The data control unit also performs steps (b)–(d) of claim 1, as discussed in further detail below.

c. Limitation 1(b)

LeFebvre's data control unit uses “inference engine techniques” (i.e., heuristics) to analyze the data it receives from the instrumented pads. EX1005, ¶¶ [0036], [0056], [0095]; EX1003, ¶ 77.

“As an aggregator of information, [the data control unit] is programmed to compare information from all of the trucks on the railcar and draws inferences from them as to the status of the car, for example, the data control unit uses inference engine techniques to identify unsatisfactory behavior such as swaying, bouncing or even partial derailment.” EX1005, ¶ [0036]. “Given that more than one instrumented pad may report misbehavior, then the components of the inference engine in the data control unit take responsibility for making assessments for the whole truck and ultimately for the freight car.” EX1005, ¶ [0056].

LeFebvre teaches that heuristics can be applied to the collected data to infer the presence of numerous conditions, including bearing defects (EX1005, ¶¶ [0058]–[0059]), wheel defects (*id.*, ¶ [0060]), wheel derailment (*id.*, ¶ [0061]), truck hunting (*id.*, ¶ [0062]), displaced roller bearing adapters (*id.*, ¶ [0064]), and brake performance and status (*id.*, ¶ [0065]), among others. EX1003, ¶ 79. For

example, LeFebvre teaches that the data control unit may detect a wheel derailment condition by looking for a high frequency, periodically repeating load and “a similar signal from both wheels in the wheel set.” EX1005, ¶¶ [0060]–[0061]. Similarly, the data control unit may detect track defects by “monitoring the vertical loads in the instrumented pads and comparing these between wheel sets.” *Id.*, ¶ [0066]. LeFebvre even discloses simple heuristics to monitor brake performance and status: “excessively high brake loads indicating brakes may cause wheels to bind, excessively low brake loads indicating the brakes are not working properly.” *Id.*, ¶ [0065]. All of these are examples of well-known heuristics that would have been familiar to a PHOSITA. EX1003, ¶ 79.

d. Limitation 1(c)

LeFebvre’s system does not generate an alert for every detected deviation from nominal operating conditions. EX1003, ¶ 80. To the contrary, LeFebvre teaches that the instrumented pad should report an error to the data control unit ***only*** if a deviation is detected ***and*** “the magnitude is sufficient to cause alarm.” EX1005, ¶ [0055]. Likewise, the data control unit determines whether the railcar components “are behaving ***sufficiently poorly*** that a report to the central data handling location or owner or operator or locomotive is needed. If so, then the report can be sent.” *Id.*, ¶ [0095].

Additionally, LeFebvre claims a “method of monitoring performance of [railcars]” that includes “identifying performance behavior derived from said signals *considered to be sufficient to cause alarm* and communicating to the prime mover messages identifying *only the performance behavior sufficient to cause alarm.*” EX1005, claim 28 (emphasis added). Similarly, the system described in LeFebvre’s claim 9 includes “means for communicating to said remote receiver *only values indicative of critical departures of the performance criteria* for a particular sensor in a particular railcar.” EX1005, claim 9 (emphasis added). *See also id.*, Claims 12 and 21.

A PHOSITA would therefore understand that LeFebvre’s system distinguishes between (a) deviations from expected operating conditions that *are not* severe enough to raise an alarm; and (b) deviations that *are* severe enough to raise an alarm. EX1003, ¶ 82.

LeFebvre’s data control unit therefore performs the step recited in Limitation 1(c): it assesses the severity of detected deviations, and categorizes the deviations according to their level of severity. EX1003, ¶ 83. And as explained in further detail below, the data control unit transmits an alarm message to a remote receiver if, and *only* if, the deviation is severe enough to warrant an alarm.

e. Limitation 1(d)

In LeFebvre's system, the data control unit is ultimately responsible for determining whether an alarm message should be generated:

The data control unit then performs the assessments described above for the inference engine to check if the freight car, its trucks or wheels or axles are behaving *sufficiently poorly* that a report to the central data handling location or owner or operator or locomotive is needed. If so, then the report can be sent.

EX1005, ¶ [0095] (emphasis added). EX1003, ¶ 84.

If the detected condition is sufficiently severe that an alarm is warranted, the data control unit will send an alarm message upstream (i.e., to the locomotive and/or a remote data handling location). *Id. See also* EX1005, ¶ [0056] ("When serious trouble is inferred, then messages are sent via the communications link 23a, 24 to the locomotive, etc."); EX1003, ¶ 85.

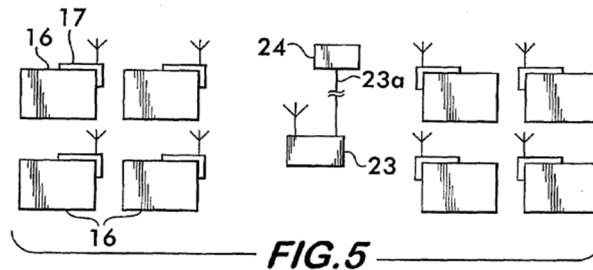
LeFebvre therefore discloses or renders obvious every element of independent claim 1. EX1003, ¶ 86.

2. Dependent Claim 2

In LeFebvre's system, the instrumented pads (i.e., the remote sensing units) communicate wirelessly with the data control unit (i.e., the processing unit).

EX1005, ¶¶ [0024], [0031]; EX1003, ¶ 87.

More particularly, LeFebvre discloses a system wherein the instrumented pads and the data control unit on each railcar form a wireless mesh network, in which each instrumented pad is capable of exchanging data with each other instrumented pad and with the data control unit. EX1003, ¶ 87.



For example, “[i]n the embodiment shown in FIG. 5, each instrumented pad **16** has its own microprocessor and radio. This arrangement is intended to use a protocol for networking which allows the messages to be passed between pads on their way to and from the digital communications unit **23**.” EX1005, ¶ [0039]; Fig. 5. The wireless networking protocol may be a mesh networking protocol conforming to the IEEE802.15.4 standard, such as Zigbee. EX1005, ¶ [0031]. The IEEE802.15.4 standard protocol “allow[s] the instrumented pads and data control units to establish a network of connections without external intervention.” EX1005, ¶ [0032]; EX1003, ¶ 88.

LeFebvre therefore discloses or renders obvious every element of claim 2. EX1003, ¶ 89.

3. Dependent Claim 3

See Section X.A.2; EX1003, ¶ 90.

4. Dependent Claim 4

LeFebvre's data control unit is mounted on the railcar and performs each step (a)–(d) of claim 1. *See* Sections X.A.1.b–X.A.1.e; EX1003, ¶ 91. Specifically, each data control unit comprises a microprocessor that carries out each step (a)–(d). *See* Section X.A.17.

5. Dependent Claim 5

See Section X.A.2; EX1003, ¶ 92.

6. Dependent Claim 6

LeFebvre discloses that the data control unit (i.e., a processing unit) is capable of transmitting data and alarm messages to a remote location. *See* Section X.A.1.e; EX1003, ¶ 93.

“[T]he data control unit 23 passes messages on to the communications device 24 for onward transmission to the locomotive or to other remote receivers.” EX1005, ¶ [0038]. For communication with remote sources, the communications device may comprise, for example, “a cellular or satellite radio system.” EX1005, ¶ [0025]. The remote receiver may be, for example, a “remote data handling service” (EX1005, ¶ [0052]) or a “central data handling location” (*id.*, ¶ [0095]). *See also* EX1003, ¶ 94.

LeFebvre therefore discloses or renders obvious every element of claim 6.
EX1003, ¶ 95.

7. **Dependent Claim 7**

LeFebvre discloses that the data control unit (i.e., a processing unit) is capable of transmitting data and alarm messages to a remote location. *See* Section X.A.1.e; Section X.A.6. EX1003, ¶ 96.

In LeFebvre’s system, an alarm message sent to the remote receiver includes associated data (i.e., “signals” or “values”) collected from one or more sensors, that indicate the presence of the severe condition or failure being reported.
EX1003, ¶ 97. *See*, for example:

- EX1005, Claim 9 (“communicating to said remote receiver only ***values*** indicative of critical departures of the performance criteria for a particular sensor in a particular railcar”);
- *Id.*, Claim 12 (“logic circuitry ... for communicating ***values derived by said sensors*** to a remote location, said values being communicated only upon a determination by the logic circuitry that the values are indicative of a potential operating failure”);
- *Id.*, Claim 21 (“identifying vibration levels indicative of potential failure and communicating ***said signals of vibration level*** indicative of potential failure to said remote location.”).

Each of these passages states that an alarm message sent to a remote receiver (e.g., to a central data handling location) will include associated data collected from one or more sensors—specifically, data that indicates the presence of an actual or imminent failure condition that is severe enough to warrant an alarm. EX1003, ¶ 98.

LeFebvre therefore discloses or renders obvious every element of claim 7. EX1003, ¶ 99.

8. Independent Claim 10

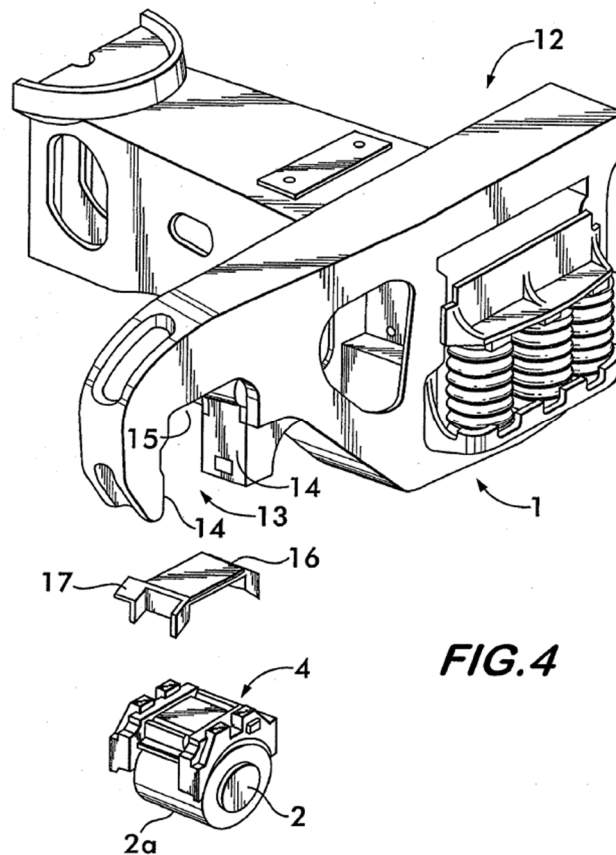
a. Claim 10 Preamble

See Section X.A.1.a; EX1003, ¶ 100.

b. Limitations 10(a) and 10(b)

As discussed above, LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads 16, each of which can comprise one or more temperature sensors. *See* Section X.A.1.b; EX1003, ¶ 101. The temperature sensor can be used, for example, to monitor the temperature of a wheel bearing associated with the instrumented pad. EX1005, ¶¶ [0033], [0058].

As shown in Figure 4, LeFebvre's instrumented pad 16 measures the temperature of wheel bearing adapter 4, which can be used to infer the temperature of wheel bearing 2a. EX1005, ¶ [0019], Fig. 4; EX1003, ¶ 102.



See also EX1005, ¶ [0020] (“Each bearing transmits the ... heat that it may generate through the adapter to the pad”). LeFebvre therefore discloses sensing the temperature of a part of the railcar (i.e., the bearing adapter **4**) other than the desired part (i.e., the wheel bearing **2a**) by use of a temperature sensor in thermal communication with said other part (i.e., the bearing adapter **4**). EX1003, ¶ 103.

Similarly, LeFebvre’s claim 8 states that “the temperature responsive sensor is *disposed adjacent to the bearing.*” *Id.*, Claim 8 (emphasis added). A PHOSITA would therefore understand that, while not measuring the wheel bearing directly,

LeFebvre’s temperature sensor measures an adjacent portion of the railcar (i.e., “a part of the railcar than the desired part”) that is used to infer the temperature of the wheel bearing itself (i.e., “the desired part”). EX1003, ¶ 104.

Consistent with LeFebvre’s disclosure, a PHOSITA would understand that direct attachment to a wheel bearing is typically impractical because a wheel bearing is a moving component. EX1003, ¶ 105. Rather, a PHOSITA would understand that, conventionally, the temperature of a rotating mechanical component (e.g., a wheel bearing) is measured indirectly by attaching a temperature sensor to a nearby, stationary component that is in thermal communication with the rotating component. *Id.* This arrangement is commonplace in industry and would be familiar to any PHOSITA. *Id.*, ¶¶ 105–106 (citing EX1018).

Accordingly, to the extent not expressly disclosed by LeFebvre, a PHOSITA would have been motivated to attach the temperature sensor to a stationary component of the railcar adjacent to the wheel bearing (rather than to the wheel bearing itself) because this arrangement is mechanically simple, conventional, and easier to implement than attaching to the bearing directly. EX1003, ¶ 107.

c. Limitation 10(c)

LeFebvre teaches that the temperature of the wheel bearing should be monitored to determine if it is outside an acceptable range. EX1003, ¶ 108. “[I]t is

important for safety that a bearing does not become overheated.” EX1005, ¶ [0033]. To accomplish this goal, “[a] temperature sensor in instrumented pad 16 monitors relative changes in temperature against other bearings and provides an alarm threshold.” EX1005, ¶ [0058].

d. Limitation 10(d)

LeFebvre teaches that an alarm message is generated if a monitored parameter, such as temperature, is outside the expected range and the magnitude of the deviation is sufficient to cause alarm. *See* Section X.A.1.e; EX1003, ¶ 109.

LeFebvre therefore discloses or renders obvious every element of independent claim 10. EX1003, ¶ 110.

9. Dependent Claim 11

LeFebvre discloses that the railcar may comprise a second temperature sensor for monitoring the ambient air temperature. EX1005, ¶ [0037]; EX1003, ¶ 111. Specifically, LeFebvre discloses that “if desired, detectors of factors such as ambient temperature and humidity (rain, snow and icing) can be built into the communication device 24 or the data control unit 23.” EX1005, ¶ [0037].

LeFebvre teaches that the ambient temperature measurement is incorporated into the “distributed inference engine,” which performs statistical analysis of the collected data. EX1005, ¶ [0037]. LeFebvre also discloses that information about the ambient temperature is sent from the data control unit to the instrumented pads.

EX1005, ¶ [0093]. Based upon this disclosure, a PHOSITA would have understood that LeFebvre's system uses the ambient temperature to calibrate the temperature data received from the sensors, as required by claim 11. EX1003, ¶ 112.

More generally, a PHOSITA would understand that information about ambient temperature is useful to calibrate readings from temperature sensors, particularly in an outdoor environment. EX1003, ¶ 113. The only plausible reason that LeFebvre's system would collect information about ambient temperature, and then transmit it to the instrumented pads (*see* EX1005, ¶ [0093]), is for precisely this purpose. EX1003, ¶ 113.

LeFebvre, in view of the general knowledge possessed by a PHOSITA, therefore discloses or renders obvious every element of dependent claim 11. EX1003, ¶ 114.

10. Dependent Claim 12

Each step (a) through (d) of claim 10 is carried out by LeFebvre's instrumented pad. EX1003, ¶ 115.

- Limitations 10(a) and 10(b): The instrumented pad can include a temperature sensor, as discussed extensively above. *See, e.g.*, Sections X.A.1.b and X.A.8.b; EX1003, ¶ 116.
- Limitation 10(c): LeFebvre's instrumented pad includes a microprocessor unit (EX1005, ¶ [0021]), and can use heuristics to

determine the presence of an alarm condition. EX1005, ¶¶ [0054]–[0055]; EX1003, ¶ 117. Specifically, each instrumented pad collects measurements, structures those measurements as a time series, and uses an inference engine (i.e., heuristics) to perform statistical analysis of the measurements and detect actual or potential issues (e.g., excessive bearing temperature). EX1005, ¶¶ [0054], [0058]; EX1003, ¶ 117. *See* Section X.A.8.c.

- Limitation 10(d): If an issue is detected by the instrumented pad, and “the magnitude is sufficient to cause alarm,” an alarm message with the relevant data is passed upstream to the data control unit. EX1005, ¶ [0055]; EX1003, ¶ 118. *See* Section X.A.8.d.

LeFebvre therefore discloses or renders obvious every element of dependent claim 12. EX1003, ¶ 119.

11. Dependent Claim 13

LeFebvre utilizes a “distributed inference engine” to process and analyze the data collected from sensors on each railcar. EX1005, ¶ [0053]. Specifically, LeFebvre’s system “share[s] the essential functions between the microprocessors at the instrumented pads and at the data control unit 23.” *Id.* “[P]art of the data analysis is done at the pads and only relevant information is transmitted to the data control unit from the pads for further analysis and recognition of faults.” *Id.*

A PHOSITA would therefore understand that in LeFebvre’s system, a first pass analysis of sensor data—corresponding to steps (a)–(d) of claim 10, as discussed above in Section X.A.10—is conducted by the instrumented pads (specifically, by multiple instrumented pads located on each railcar). EX1003, ¶ 121. If a potential fault condition is detected, the relevant data is passed upstream to the data control unit, where further analysis is conducted. *Id.* LeFebvre therefore discloses a system wherein data analysis is conducted by at least two different event engines, one of which is located on the instrumented pads, and another of which is located on the data control unit. *Id.* These two systems work in tandem to form what LeFebvre calls a “distributed inference engine.” EX1005, ¶ [0053]; EX1003, ¶ 121.

Additionally, in LeFebvre’s system, each railcar is equipped with a data control unit that transmits data and alarm messages to a remote receiver. *See* Sections X.A.6 and X.A.7; EX1003, ¶ 121. The remote receiver may be, for example, a base station located in the locomotive or a central data handling location. EX1005, ¶¶ [0003], [0038], [0052], [0095]. As discussed above, an alarm message sent to the remote receiver includes associated data (i.e., “signals” or “values”) collected from one or more sensors, that indicate the presence of the severe condition or failure being reported. *See* Section d X.A.7; EX1003, ¶ 97.

LeFebvre therefore discloses a remote receiver that carries out at least step (a) of claim 1.

Accordingly, LeFebvre discloses, or at least renders obvious, an embodiment wherein each of steps (a)–(d) are carried by a plurality of instrumented pads; each of steps (a)–(d) are carried out by a data control unit; and step (a) is additionally carried out by a remote receiver, thereby meeting the limitations of claim 13. EX1003, ¶ 122.

12. Independent Claim 14

a. Claim 14 Preamble

See Section X.A.1.a. A PHOSITA would understand that LeFebvre’s data control unit is a “communication management unit” that performs each step required by claim 14, as explained in detail below. EX1003, ¶ 123.

b. Limitation 14(a)

LeFebvre discloses a railcar monitoring system comprising a plurality of instrumented pads (i.e., sensing units), each of which comprises one or more sensors that measure operational parameters of the railcar. *See* Section X.A.1.b; EX1003, ¶ 124. Each instrumented pad communicates wirelessly with a data control unit mounted on the railcar body. *Id.*

If an issue is detected by the instrumented pad, and “the magnitude is sufficient to cause alarm,” a message with the relevant data is passed upstream to

the data control unit. EX1005, ¶ [0055]. LeFebvre's data control unit is a "processing unit" in the parlance of the '673 Patent. EX1003, ¶ 125.

LeFebvre manages the power consumption of its instrumented pad by periodically placing the device into a low-power, or "standby," state. EX1005, ¶¶ [0034]–[0035]; EX1003, ¶ 126. "[I]n operation, the microprocessor on an instrumented pad 16 is normally in a passive, low power state, but is programmed to switch on briefly periodically." EX1005, ¶ [0034]. "[S]hould the pads detect indications of fault or impending failure, the microprocessor on the pad may be programmed to switch on the radio which it controls and send an appropriate message via the radio to the data control unit 23." *Id.*, ¶ [0035]. "In the absence of such a problem, the pad microprocessor follows its given schedule which would normally result in its being in a low powered state most of the time." *Id.*

The microprocessor awakens at periodic intervals to process sensor data and, if appropriate, initiate a radio transmission. EX1005, ¶ [0034]; *see also* EX1005, Claim 22 ("each pad having an associated microprocessor, each microprocessor being programmed to a periodically active state to scan the sensed data for indications of potential failure"); EX1003, ¶ 127.

c. Limitation 14(b)

In LeFebvre's system, the data control unit acts as an "aggregator of information", collecting data from each of the instrumented pads on the railcar.

EX1005, ¶¶ [0036], [0056], [0095]. The data control unit then uses “inference engine techniques” (i.e., heuristics) to analyze the collected data. EX1005, ¶¶ [0036], [0056], [0095]. *See also* Section X.A.1.c; EX1003, ¶ 128.

For example, LeFebvre discloses the use of heuristics, based upon data collected from one or more sensor units, to determine the existence of *actual* failure conditions. EX1005, ¶¶ [0058]–[0066]; EX1003, ¶ 129. For example, heuristics may be used to identify the existence of wheel damage such as “a flat spot or shelled wheel tread,” EX1005, ¶ [0060], or a wheel derailment. EX1005, ¶ [0061].

LeFebvre also discloses the use of heuristics, based upon data collected from one or more sensor units, to predict *potential or imminent* failures based upon a statistical analysis of the collected data. EX1005, ¶¶ [0058]–[0066]; EX1003, ¶ 130. For example, LeFebvre discloses that heuristics may be used to identify “long term trends” in wheel bearing temperature, “avoiding a potential bearing burn off and possible derailment.” EX1005, ¶ [0058]. LeFebvre additionally discloses that “[s]pecific bearing defects can be inferred from frequency spectrum analysis.” EX1005, ¶ [0059]. LeFebvre teaches that “identifying a failing bearing in its early stages is important in preventative maintenance programs.” *Id.*

d. Limitation 14(c)

LeFebvre discloses that the data control unit (i.e., processing unit) is capable of transmitting data and alarm messages to a remote location. *See* Section X.A.6; EX1003, ¶ 131.

LeFebvre therefore discloses or renders obvious every element of independent claim 14. EX1003, ¶ 132.

13. Dependent Claim 15

a. Limitation 15(a)

LeFebvre's instrumented pad collects data from its associated sensors, analyzes the collected data using heuristics, determines whether an alarm should be raised, and (if necessary) sends an alarm message upstream to the data control unit. *See* Section X.A.10; EX1003, ¶ 133. The instrumented pad and the data control unit communicate wirelessly. *See* Sections X.A.2 and X.A.12.b; EX1003, ¶ 134.

b. Limitation 15(b)

See Section X.A.12.d; EX1003, ¶ 135.

LeFebvre therefore discloses every element of dependent claim 15. EX1003, ¶ 136.

14. Dependent Claim 16

a. Limitation 16(a)

LeFebvre's data control unit aggregates data from a plurality of instrumented pads, and uses heuristics to analyze the aggregated data and determine if an alarm should be raised. *See* Section X.A.12.c; EX1003, ¶ 137.

b. Limitation 16(b)

If the detected condition is sufficiently severe that an alarm is warranted, the data control unit will send an alarm message upstream (i.e., to the locomotive and/or a remote data handling location). *See* Section X.A.1.e; EX1003, ¶ 138.

15. Dependent Claim 17

LeFebvre manages the power consumption of its instrumented pad by periodically placing the device into a low-power, or "standby," state. *See* Section X.A.12.b; EX1003, ¶ 140.

16. Dependent Claim 18

See Section X.A.2; EX1003, ¶ 142.

17. Dependent Claim 20

a. Limitation 20(a)

LeFebvre discloses that each data control unit contains a microprocessor. EX1005, ¶ [0024]; EX1003, ¶ 143.

Although not expressly stated by LeFebvre, a PHOSITA would understand that each data control unit includes memory, which is used to store data received

from the instrumented pads. EX1003, ¶ 144. Specifically, LeFebvre discloses that the data control unit receives data from instrumented pads located on the same railcar, analyzes the collected data using heuristics, determines whether an alarm should be raised, and (if necessary) sends an alarm message upstream to the locomotive or a remote location. *See* Section X.A.1; EX1003, ¶ 144. A PHOSITA would understand that data received from the instrumented pads is stored in some form of memory (e.g., in RAM or on a hard drive) on the data control unit until it is processed by the data control unit's microprocessor. EX1003, ¶ 144.

Additionally, as discussed in detail below in Limitation 20(b), LeFebvre discloses heuristics that involve comparing currently collected data against *data collected during a previous time period*, which would necessarily be stored in memory on the data control unit. EX1003, ¶ 145.

b. Limitation 20(b)

LeFebvre discloses heuristics that involve comparing currently collected data against stored data collected during a previous time period. EX1003, ¶ 146.

For example, LeFebvre teaches that the condition of a wheel bearing may be determined by “monitor[ing] relative changes in temperature against other bearings and provid[ing] an alarm threshold or long term trends to link to bearing condition.” EX1005, ¶ [0058]. To identify “relative changes in temperature” or to

generate a “long term trend,” currently collected data is compared with data collected during an earlier time period. EX1003, ¶ 147.

LeFebvre therefore discloses every element of dependent claim 20. EX1003, ¶ 148.

18. Independent Claim 21

a. Claim 21 Preamble

See Section X.A.1.a; EX1003, ¶ 149.

b. Limitation 21(a)

See Section X.A.12.b; EX1003, ¶ 150.

c. Limitation 21(b)

See Section X.A.12.b; EX1003, ¶ 151. LeFebvre’s data control unit is a “communication management unit” in the parlance of the ’673 Patent. *Id.*

d. Limitation 21(c)

See Section X.A.12.c; EX1003, ¶ 152.

LeFebvre therefore discloses every element of dependent claim 21. EX1003, ¶ 153.

19. Dependent Claim 22

a. Limitation 22(a)

See Section X.A.14.a; EX1003, ¶ 154.

b. Limitation 22(b)

See Section X.A.14.b; EX1003, ¶ 155.

B. Ground 2: Claims 8 and 9 are unpatentable under 35 U.S.C. § 103(a) over LeFebvre in view of Barone.

A PHOSITA would have found it obvious to combine the disclosures of LeFebvre and Barone. Both references describe systems for wirelessly monitoring railcars, and utilize nearly identical components that function in a similar way.

EX1003, ¶ 157. Specifically:

- Like LeFebvre, Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract; EX1003, ¶ 158.
- Like LeFebvre, Barone utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors are connected using a wireless mesh network. *Id.*; EX1003, ¶ 159. In both references, the wireless mesh network preferably conforms to the IEEE 802.15.4 “Zigbee” standard. EX1007, ¶ [0086]; EX1003, ¶ 159.
- Like LeFebvre, Barone also discloses that the collected data is analyzed to determine, for example, if a wheel bearing failure is approaching or imminent. EX1007, ¶¶ [0201]–[0220]; EX1003, ¶ 160.
- And, like LeFebvre, Barone discloses that if a failure condition is detected, an alert (including the underlying data) is communicated to

the locomotive and/or to a central monitoring station in a remote location. EX1007, ¶ [0045]; EX1003, ¶ 161.

A PHOSITA therefore would have understood that LeFebvre and Barone are analogous art. EX1003, ¶ 162. A PHOSITA would have been motivated to combine the teachings of LeFebvre and Barone for the reasons discussed in detail below with respect to each challenged claim.

1. Dependent Claim 8

a. Limitation 8(a)

In LeFebvre's system, each railcar is equipped with a data control unit that transmits data and alarm messages to a remote receiver. *See* Section X.A.6; EX1003, ¶ 165. The remote receiver may be, for example, a base station located in the locomotive or a central data handling location. EX1005, ¶¶ [0003], [0038], [0052], [0095].

LeFebvre therefore discloses a remote receiver—located either in the locomotive or at an off-train location—that receives data from a plurality of data control units (each of which is associated with a different railcar). EX1003, ¶ 166.

b. Limitation 8(b)

LeFebvre describes heuristics that may be applied to collected data by the instrumented pads and/or the data control units. EX1003, ¶ 167. LeFebvre, however, does not expressly disclose that heuristics can be applied to data

collected from multiple railcars (e.g., at remote receiver located in the locomotive or a central data handling location).

Both LeFebvre and Barone disclose numerous heuristics for analyzing sensor data and detecting severe conditions that may warrant a high level alarm. *See* Section X.A.1.c; EX1007, ¶¶ [0037]–[0041]; EX1003, ¶ 168. A PHOSITA would have been motivated to modify LeFebvre’s system by applying heuristics to sensor data collected at a remote receiver, whether in the locomotive or at a central data handling location, for at least two reasons.

First, because each data control unit has access to data from only a single railcar, but the remote receiver collects data from *multiple* railcars, the remote receiver has the ability to detect dangerous conditions that could not be observed by any single data control unit. EX1003, ¶ 169. As an illustrative example: an issue with the braking system on a *single* railcar may be only a minor concern, but a braking issue affecting *multiple* railcars could be *catastrophic*. *Id.* This condition could not be observed by any single data control unit, but could be easily observed by a remote receiver with access to data collected from multiple railcars. *Id.* It therefore would have been obvious for a PHOSITA to apply heuristics at a remote receiver (i.e., in the locomotive or at a central data handling location) to detect potentially serious issues involving multiple railcars, and to raise an alarm if any such issues are detected. *Id.*

Second, a remote receiver—whether located in the locomotive, or in a central data handling location—will have access to significantly greater data storage, memory, and processing resources than any unit located on a railcar (e.g., a sensor unit or CMU). For example, a remote receiver located in the locomotive, as described in Barone, has access to both “an abundance of electrical power” and “the existing locomotive computer processor” (EX1007, ¶¶ [0087], [0088], [0269]). Likewise, by the filing date of the ’673 Patent, the benefits of analyzing data collected at a central location had become well-known in the industry. For example, Azzaro recognized—as early as 2000—that “[w]ith today's advances in computing technology, the large amount of data collected from a fleet of locomotives can be properly aggregated and analyzed.” EX1010, 2:24–34. EX1003, ¶ 170. A PHOSITA would therefore understand that, compared to a data control unit or a sensor node, a remote receiver has the ability to conduct more computationally intensive types of heuristics.

For example, Barone discloses that its system “monitors bearing temperature, bearing vibration, bearing acoustic signature, wheel impact load, and car hunting and reports critical situations back to the central monitoring station, thus allowing continuous monitoring and true trending data analysis.” EX1007, ¶ [0045] (emphasis added); EX1003, ¶ 171. “Trending analysis” is a type of heuristic that has been “widely acclaimed” for the “vastly improved failure

prediction capability” that it provides. EX1007, ¶ [0042]; EX1003, ¶ 171. Barone performs “trending analysis” on data aggregated from multiple railcars at its central monitoring station, and it would have been obvious to implement this type of analysis in LeFebvre’s system as well. EX1003, ¶ 171.

For all of these reasons, a PHOSITA would have been motivated to apply heuristics to the data aggregated at LeFebvre’s remote receiver (i.e., data collected from multiple railcars), in order to detect conditions that are impractical or impossible to detect at the data control unit (which has access to data from only a single railcar). EX1003, ¶ 172.

c. Limitations 8(c) and 8(d)

As discussed above, LeFebvre’s system distinguishes between (a) deviations from expected operating conditions that *are not* severe enough to raise an alarm; and (b) deviations that *are* severe enough to raise an alarm. *See* Section X.A.1.d; EX1003, ¶ 173. Alarm messages are generated only when the detected deviation is severe enough to warrant an alarm. *See* Section X.A.1.e; EX1003, ¶ 173.

For the same reasons discussed in LeFebvre and summarized above, it would have been obvious for a PHOSITA to apply these same principles when analyzing data aggregated from multiple CMUs (e.g., at a remote receiver located in the locomotive). EX1003, ¶ 174.

d. Limitation 8(e)

LeFebvre discloses a remote receiver in the locomotive that displays alarm conditions raised by the data control unit. EX1003, ¶ 175. LeFebvre’s Claim 23, for example, is directed to “a receiver located in the locomotive for communication of said signals to crew members located within the locomotive.” EX1005, Claim 23. *See also* EX1005, ¶ [0095].

More generally, LeFebvre teaches that alarm messages regarding severe conditions, such as wheel or bearing failure, should be communicated to the locomotive as quickly as possible—in time for the locomotive operators to take action to stop the train and prevent further (potentially catastrophic) damage. EX1003, ¶ 176; EX1005, ¶¶ [0003], [0052], [0061] (“Identifying when a wheel set has derailed prevents a possible full derailment and possible catastrophic consequences.”). *See also id.*, ¶ [0095].

Barone’s system also includes a remote receiver in the locomotive. EX1007, ¶¶ [0087]–[0089]; EX1003, ¶ 177. The remote receiver processes data from the sensor nodes “and displays reports of the data to users in the locomotive itself.” *Id.*, ¶ [0089]. It has the ability to raise “an audible alarm” to alert the locomotive operators of “especially urgent conditions.” *Id.*, ¶¶ [0088], [0089]. To whatever extent this limitation is not expressly disclosed by LeFebvre, a PHOSITA would have been motivated to include a base unit in the locomotive that displays data and

alarm messages to alert locomotive operators of “especially urgent conditions” as disclosed in Barone. EX1003, ¶ 177.

LeFebvre, in view of Barone, therefore discloses or renders obvious every element of claim 8. EX1003, ¶ 178.

2. Dependent Claim 9

a. Limitation 9(a)

LeFebvre does not expressly state that its alarm message includes a “recommended course of action.”

A PHOSITA, however, would understand that the *entire purpose* of LeFebvre’s system is to identify railcar components in need of repair or replacement, thereby providing an opportunity to take corrective action before a catastrophic failure occurs. EX1003, ¶ 180. *See* EX1005, ¶ [0059] (“Identifying a failing bearing in its early stages is important in preventative maintenance programs.”); *id.*, ¶ [0060] (“Monitoring wheel impacts may allow an owner to schedule a wheel change out before it is identified by a trackside Wheel Impact Load Detector resulting in unscheduled maintenance.”); *id.*, ¶ [0061] (“Identifying when a wheel set has derailed prevents a possible full derailment and possible catastrophic consequences.”); *id.*, ¶ [0064] (“This provides information about what caused the displacement as well as drawing attention to an urgent maintenance need to avoid damage to the roller bearing.”)

More generally, in the context of a railcar monitoring and alarm system, indicating the recommended action that should be taken in response to an alarm is a conventional, obvious feature that provides clear advantages. EX1003, ¶ 181. For example, Barone states that “[t]he locomotive computer system, responsive to that data then generates an appropriate alarm or *indication to prompt a human user to take remedial action.*” EX1007, ¶ [0191] (emphasis added). *See also* EX1007, ¶ [0036] (“If the estimated time to bearing failure permits, a maintenance action can be scheduled. If failure is estimated to be imminent, the train can be diverted or stopped before catastrophic bearing failure and derailment.”). To whatever extent this limitation is not expressly disclosed by LeFebvre, a PHOSITA would have been motivated to modify LeFebvre’s alarm messages to “prompt a human user to take remedial action” as disclosed in Barone. EX1003, ¶ 181.

b. Limitation 9(b)

See Section X.B.1.d, *supra*. EX1003, ¶ 182.

LeFebvre, in view of Barone, therefore discloses or renders obvious every element of dependent claim 9. EX1003, ¶ 183.

C. Ground 3: Claims 1, 2, 4, 6–11, and 13 are unpatentable under 35 U.S.C. § 103(a) over Armitage.

As explained in detail below, a PHOSITA would understand that Armitage discloses every element of claims 1, 2, 4–11, and 13. Petitioner believes these claims are anticipated by Armitage under 35 U.S.C. § 102.

Armitage, however, does not *expressly* state that all disclosed limitations are part of a *single embodiment*. See EX1006, ¶ [0059] (“Those skilled in the art will appreciate variations from these embodiments that fall within the scope of the invention. Those skilled in the art will also appreciate that the features described above can be combined in various ways to form multiple embodiments.”).

Petitioner has therefore elected to present this ground under 35 U.S.C. § 103. See *Realtime Data*, 912 F.3d at 1373 (“a disclosure that anticipates under § 102 also renders the claim invalid under § 103”) (cleaned up). See also EX1003, ¶¶ 184–187.

1. Independent Claim 1

a. Claim 1 Preamble

This preamble merely describes an intended use of the system, which does not instill patentable weight. *Pitney Bowes, Inc.*, 182 F.3d at 1305; see also *Rowe*, 112 F.3d at 478; MPEP 2111.02(II); EX1003, ¶ 188.

To the extent that the preamble is limiting, Armitage discloses “a mobile railway car monitoring system” that includes “a plurality of sensor nodes ...

configured to monitor the undercarriage portion of the railway car.” EX1006, 57 (Abstract). The sensor nodes comprise, for example, temperature sensors. EX1006, ¶ [0014]; EX1003, ¶ 189.

Armitage’s system is extremely similar to that of the ’673 Patent. EX1003, ¶ 190. Compare Figure 1 of Armitage:

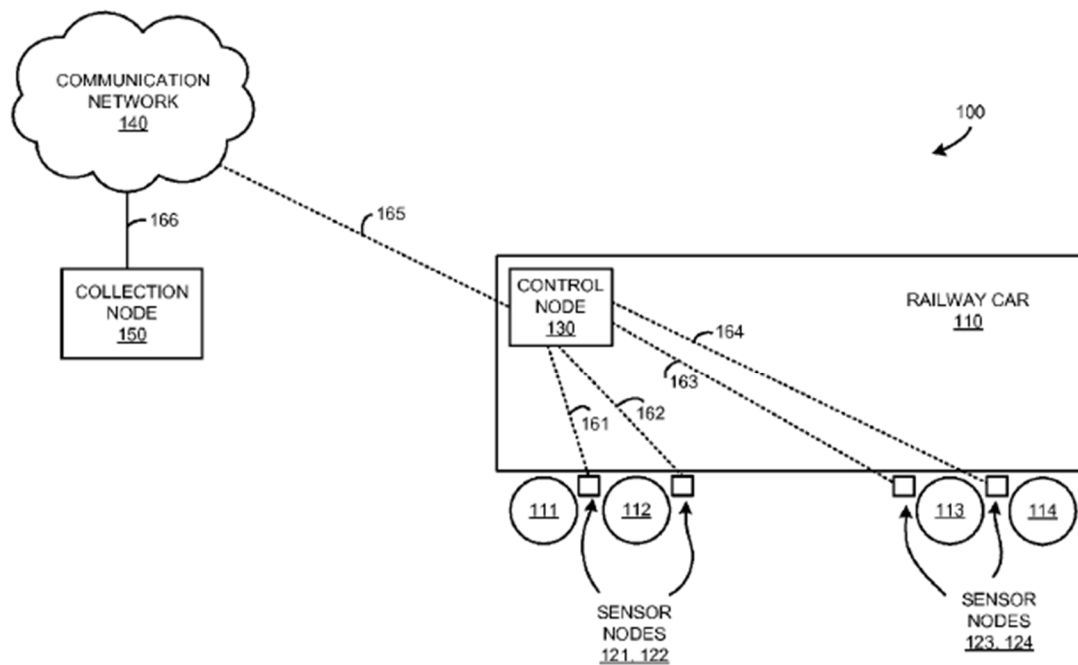
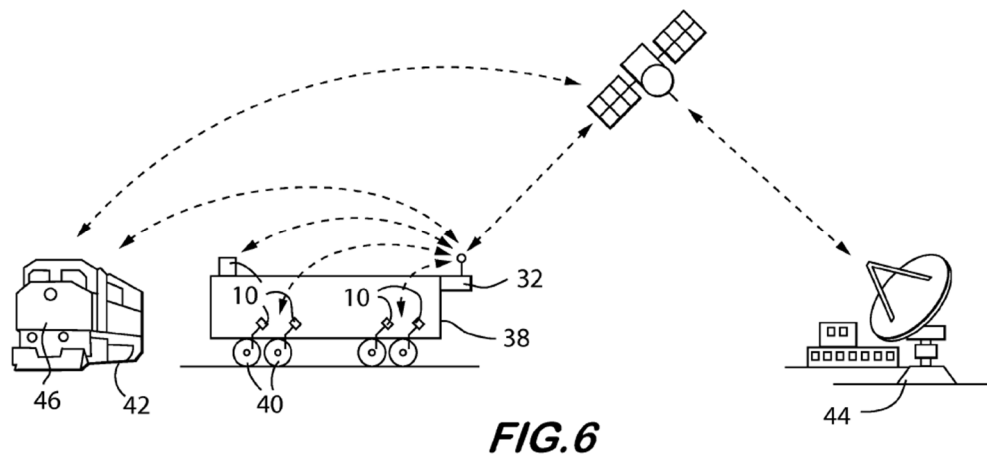


FIGURE 1

with Figure 6 of the ’673 Patent (below).



b. Limitation 1(a)

Armitage discloses a “mobile railway car monitoring system . . . [including] a plurality of sensor nodes coupled to an undercarriage portion of a railway car.” EX1006, ¶ [0004]. Figure 1 of Armitage depicts an exemplary embodiment, with four sensor nodes 121–124 attached to a railcar 110. EX1006, ¶ [0012], Fig. 1; EX1003, ¶ 191.

The sensor nodes are separate from one another, and each node is attached to a separate undercarriage element of the railcar. EX1003, ¶ 192. In the exemplary embodiment of Figure 1, “sensor node 121 is coupled to undercarriage element 111, sensor node 122 is coupled to undercarriage element 112, sensor node 123 is coupled to undercarriage element 113, and sensor node 124 is coupled to undercarriage element 114.” EX1006, ¶ [0012].

“Sensor nodes 121-124 each include equipment to sense and report information about undercarriage elements of a railway car.” EX1006, ¶ [0014].

Each sensor node “includes a sensor portion” that “could include thermometers” or “other sensing equipment and circuitry.” *Id.*

Figure 3 of Armitage depicts an exemplary embodiment similar to that of Figure 1, but with ***eight*** sensor nodes 320–327 attached to a railcar 310—specifically, one node attached to each wheel assembly. EX1006, ¶¶ [0033]–[0034], Fig. 3. Sensor nodes 320–327 have the same features described above for nodes 121–124. EX1006, ¶ [0033]; EX1003, ¶ 193.

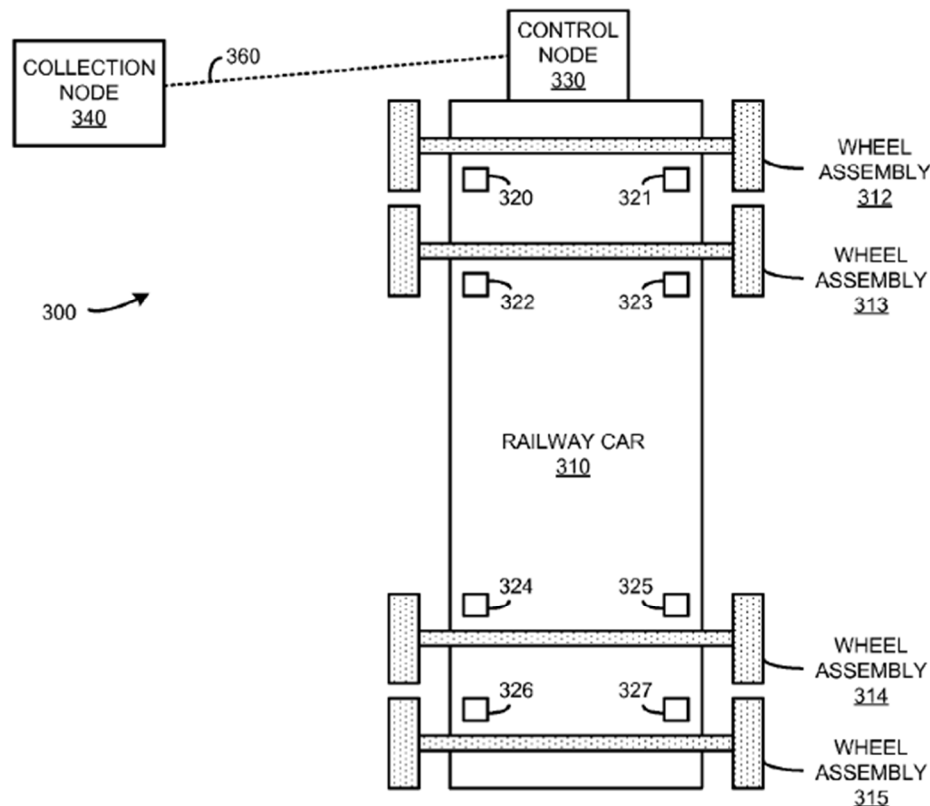


FIGURE 3

Other than the number of sensor nodes and their precise locations, the embodiments depicted in Figures 1 and 3 of Armitage are largely identical.

EX1003, ¶ 194. A PHOSITA would have understood that features described with reference to an element of Figure 1 are also applicable to the corresponding element of Figure 3, and *vice versa*. *Id.* See EX1006, ¶ [0059].

Armitage's system also includes a "control node" on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5. The control node receives "sensor information, or modified sensor information" collected by each of the sensor nodes on the same railcar. EX1006, ¶ [0027]. The sensor nodes and the control node communicate over a wireless network. EX1006, ¶¶ [0014], [0033], [0054]. For example, in the embodiment of Figure 1, control node 130 communicates with each of sensor nodes 121–124 via wireless links 161–164, respectively. EX1003, ¶ 195.

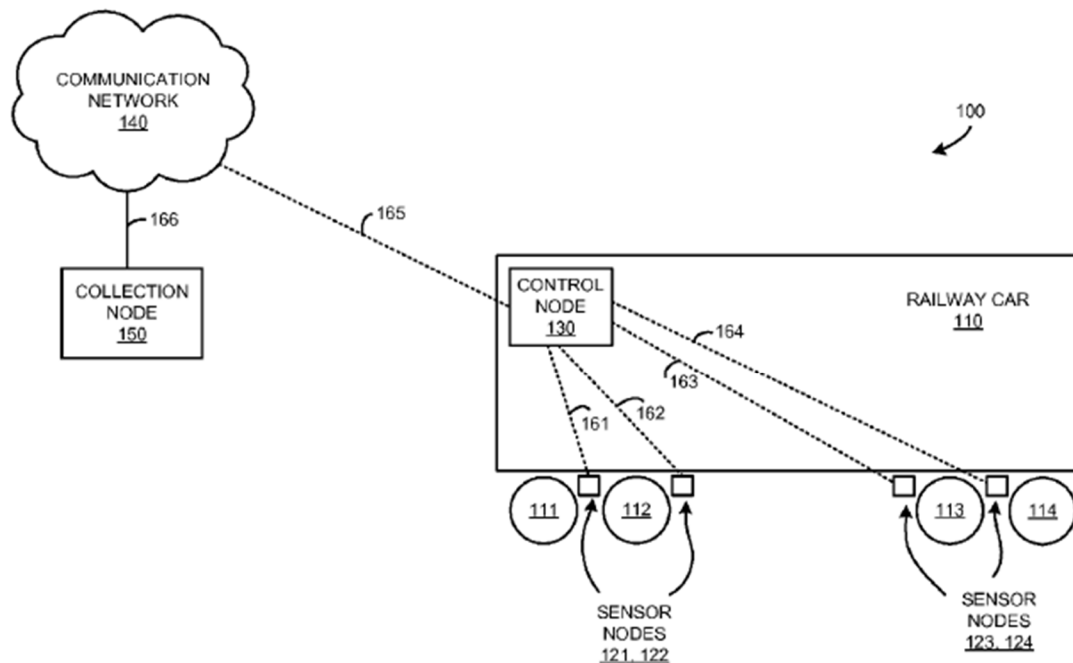


FIGURE 1

The wireless links can utilize, for example, WiFi or Bluetooth, both of which provide two-way communications. EX1006, ¶ [0021]; EX1003, ¶ 196.

A PHOSITA would therefore understand that in Armitage's system, the control node on each railcar receives both data and processed information from one or more sensor nodes located on the same railcar. EX1003, ¶ 197.

c. Limitation 1(b)

After receiving data from the sensor nodes, Armitage's control node analyzes the collected data and uses heuristics to determine whether a fault condition is present. *See* EX1006, ¶ [0027] ("Control node 130 processes (204) the information to determine a fault condition for the undercarriage portion."); This process is illustrated in Figure 2 of Armitage. EX1003, ¶ 198.

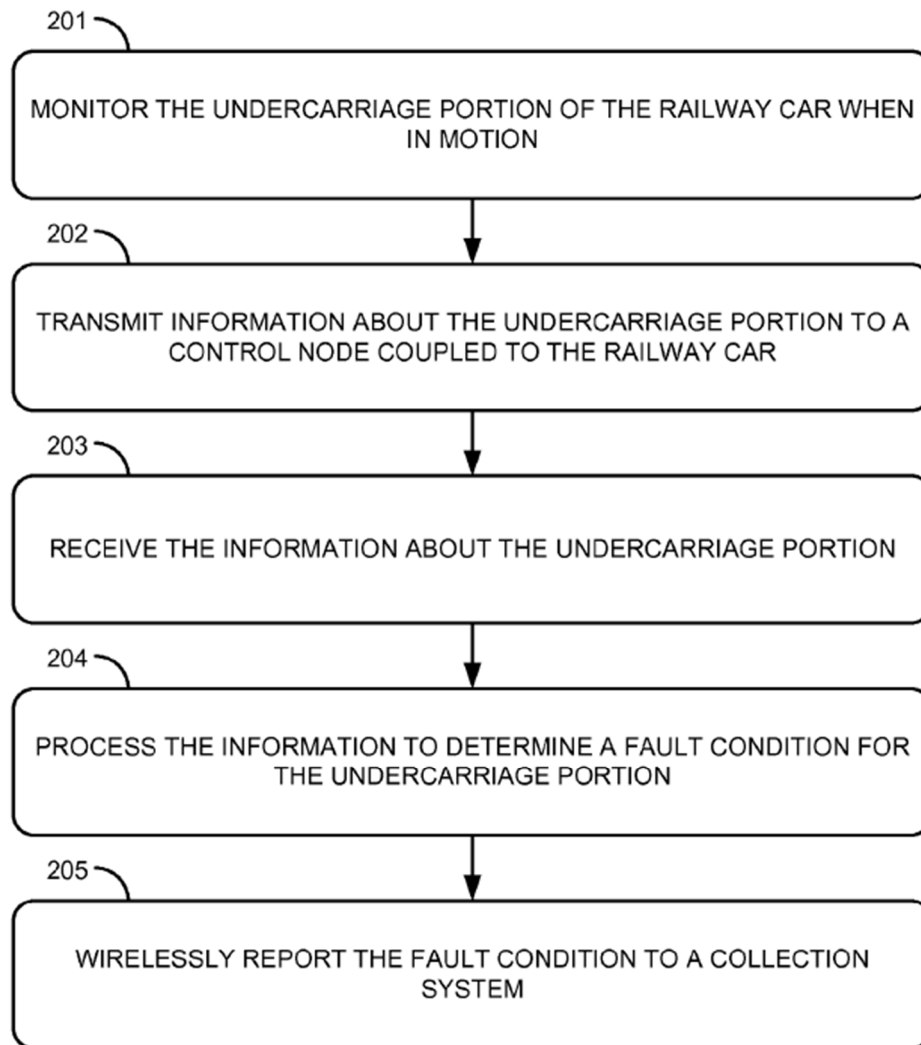


FIGURE 2

Armitage discloses several statistical methods that can be used to process sensor data and identify deviations from nominal operating conditions (i.e., heuristics). EX1003, ¶ 199. For example, Armitage teaches that “a standard deviation metric is employed to determine when data from one or more sensor nodes becomes an outlier from a main cluster of sensor node data, such as when

data from a sensor node deviates by more than three standard deviations[.]”

EX1006, ¶ [0041]. Armitage also discloses that “trend modeling” can be used to “identif[y] specific sensor telemetry that lies outside norms, where ‘normal’ can be defined dynamically by assessing the set of sensors on each railway car.” EX1006, ¶ [0044].

At a more granular level, Armitage provides specific examples of heuristics associated with particular railcar components. EX1003, ¶ 199. For example, Armitage teaches that “[a] single wheel sensor anomaly might ... indicate a ‘wheel out of round’ or ‘flat spot’ condition, where a non-round geometry of a wheel can cause vibrations or shocks at a certain portion of each rotation of a wheel.” EX1006, ¶ [0042]. Conversely, “outliers for sensor nodes on an entire side of railway car 310 could indicate a cornering failure, or an off-track condition.” *Id.*

d. Limitations 1(c) and 1(d)

Armitage recognizes that only “significant” deviations from nominal operating conditions—and not *all* detected deviations—should cause an alarm message (or “event”) to be generated. EX1006, ¶ [0043]; EX1003, ¶ 200.

Armitage’s system includes a “railway car health scorecard” that distinguishes between potential failures (which warrant maintenance) and actual failures (which require immediate service):

“Each event could be ranked by severity and status could be provided periodically, such as twice daily, to provide railcar location and system status. The event ranking could include a ‘yellow’ condition which indicates that a railway car requires service, and a ‘red’ condition which indicates that a sensor has detected a serious deviation from normal operations that requires immediate service.”

EX1006, ¶ [0044]; EX1003, ¶ 201. This analysis is carried out by Armitage’s “Data Correlation Unit (DCU).” EX1006, ¶ [0043]. The DCU can comprise the control node (e.g., control node 130) and/or the collection node (e.g., collection node 150). *Id.* The DCU generates an alarm only “when a sensor exhibits ‘**significant**’ deviation from the normal conditions.” EX1006, ¶ [0043] (emphasis added); EX1003, ¶ 201.

A PHOSITA would therefore understand that Armitage’s system assigns a severity level to detected deviations from nominal operating conditions, and generates alarms (e.g., “yellow” or “red” alarms) based on the assigned severity level. EX1003, ¶ 202.

Armitage therefore discloses or renders obvious every element of independent claim 1. EX1003, ¶ 203.

2. Dependent Claim 2

See Section X.C.1.b; EX1003, ¶ 204.

3. Dependent Claim 4

As described above, in Armitage's system each step (a)–(d) of claim 1 can be carried out by a control node located on the railcar. *See* Sections X.C.1.b, X.C.1.c, and X.C.1.d; EX1003, ¶ 205. Specifically:

- Step (a) is carried out by the control node (e.g., control node 150) attached to the railcar. *See* EX1006, ¶ [0026] (“Each of sensor nodes 121-124 transmits (202) the monitored information about the undercarriage portion to control node 130 coupled to railway car 110.”); EX1003, ¶ 206.
- Step (b) is also carried out by the control node. *See* EX1006, ¶ [0027] (“Control node 130 processes (204) the information to determine a fault condition for the undercarriage portion.”); EX1003, ¶ 207.
- Steps (c) and (d) are carried out by Armitage's “Data Correlation Unit (DCU)”, which is “installed on each railway car” and can comprise the control node (e.g., control node 130). EX1006, ¶¶ [0043], [0044]; EX1003, ¶ 208.

Armitage therefore discloses or renders obvious every element of claim 4. EX1003, ¶ 209.

4. Dependent Claim 6

In Armitage's system, if the control node detects a fault condition, it wirelessly reports the fault (i.e., sends an alarm message) to a collection system.

EX1006, ¶ [0028]; EX1003, ¶ 210. See, for example, step 205 in Figure 2 of Armitage:

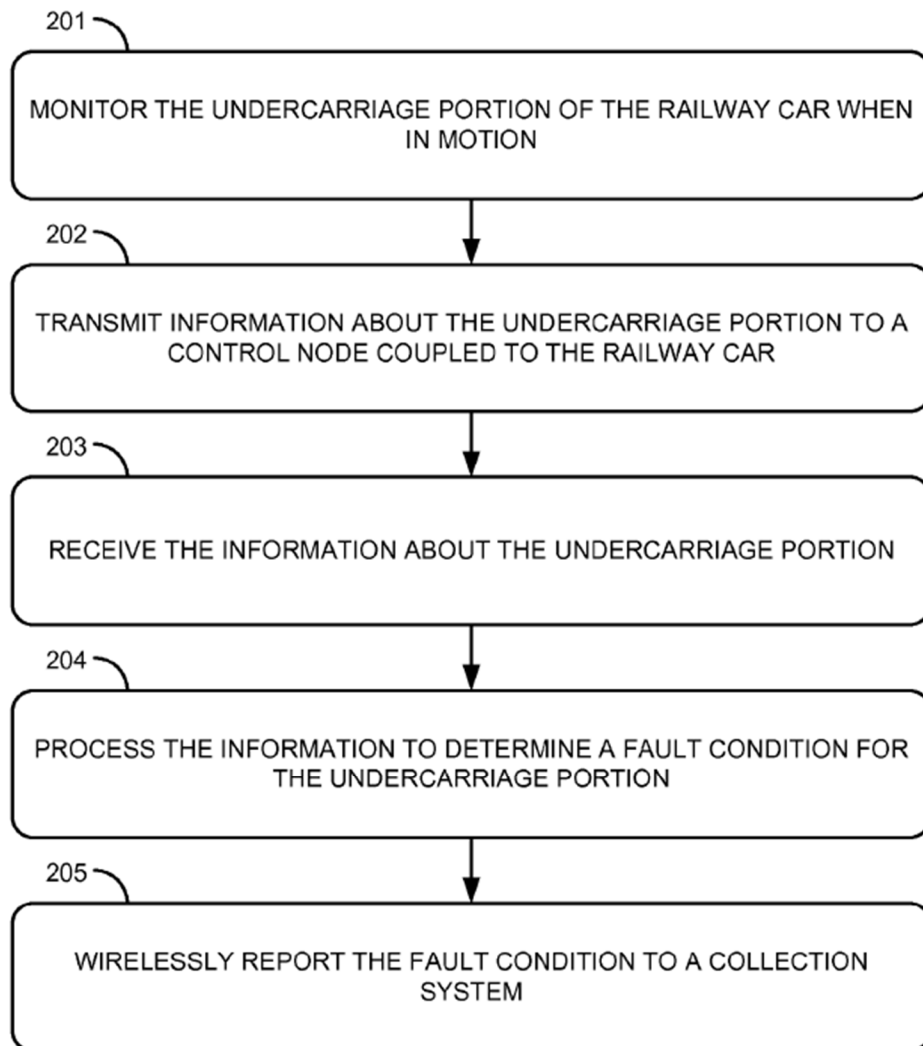


FIGURE 2

Armitage discloses that the collection system comprises a “collection node” located off the train. For example, the collection node can be “a rail-side or handheld device.” EX1006, ¶ [0039]; EX1003, ¶ 211.

Alternatively, the collection node may comprise “application servers,” “web servers,” and other computing equipment. EX1006, ¶¶ [0019], [0039]. A PHOSITA would understand that “rail side” devices, “web servers,” and “application servers” would not be located on the train. EX1003, ¶ 211.

Armitage therefore discloses wirelessly reporting alarm conditions to a “collection system” that is located off the train, as required by dependent claim 6. EX1003, ¶ 212.

5. Dependent Claim 7

Armitage discloses that the control node transmits data—specifically, data collected from the sensors—to the collection node. EX1003, ¶ 213. Specifically, Armitage discloses that “[c]ollection node 150 comprises equipment for receiving *fault conditions, sensor information*, location information, or other information from control node 130.” EX1006, ¶ [0019] (emphasis added).

Armitage also discloses that the collection node is located off the train. *See* Section X.C.4; EX1003, ¶ 214.

Armitage therefore discloses every element of dependent claim 7. EX1003, ¶ 215.

6. Dependent Claim 8

a. Limitation 8(a)

As discussed above, Armitage's system includes one "control node" on each railcar. *See* Section X.C.1.b. Armitage's collection system receives data from multiple control nodes—and, therefore, from multiple railcars:

"Collection node 150 could collect fault conditions and other information from many control nodes. For example, on a train where many railway cars are connected in series, a control node could be coupled to each railway car along with associated sensor nodes. Collection node 150 could receive information from each control node of the train, and thus monitor the entire train."

EX1006, ¶ [0020]; EX1003, ¶ 216.

b. Limitation 8(b)

Armitage discloses that data collected from the sensors is analyzed by the Data Correlation Unit (DCU), which can comprise the collection system (e.g., collection node 150). EX1006, ¶¶ [0043], [0044]; EX1003, ¶ 217.

Armitage teaches that the collection node can apply heuristics to data aggregated from multiple control units and railcars. EX1003, ¶ 218. Specifically, by analyzing the data aggregated by the collection node, "[f]ault conditions could be isolated to a particular railway car, or to a specific location, which may detect track failure or be used to assess root cause of the failure." EX1006, ¶ [0038].

More generally, Armitage describes numerous heuristics that are used to analyze data collected from its sensors. *See* Section X.C.1.c; EX1003, ¶ 219. To the extent Armitage does not *expressly* state that each of these heuristics is applied to data collected from multiple railcars (as opposed to data collected from only a single railcar), a PHOSITA would have been motivated to apply heuristics to data aggregated at the collection node for the same reasons discussed above in Section X.B.1.b, which is incorporated herein by reference. For example, it would have been obvious to apply a heuristic at the collection node to determine whether *multiple* railcars are simultaneously experiencing a braking failure, which would be an extraordinarily dangerous situation that could not be detected by any single control unit. *See* Section X.B.1.b; EX1003, ¶ 219.

c. Limitations 8(c) and 8(d)

As discussed above, Armitage's system assigns a severity level to detected deviations from nominal operating conditions, and generates alarms (e.g., "yellow" or "red" alarms) based on the assigned severity level. *See* Section X.C.1.d; EX1003, ¶ 220.

d. Limitation 8(e)

Armitage teaches that "[a] railway car health 'scorecard' could be provided to a user, presented via email, text message, web page, or discrete software interfaces." EX1006, ¶ [0044]; *see also* Section X.C.1.d. A PHOSITA would have

understood that the scorecard is displayed to operators in the locomotive. EX1003, ¶ 221.

To the extent that Armitage does not *expressly* state that the alarms are displayed to a user on the train, a PHOSITA would have been motivated to modify Armitage’s system to include a device that displays alerts to the operators in a locomotive. EX1003, ¶ 222. For example, an alarm message indicating “a cornering failure, or an off-track condition” affecting one or more railcars (*see* EX1006, ¶ [0042]) would be of great interest to the locomotive operator—who could then take action to stop the train and prevent further (potentially catastrophic) damage. EX1003, ¶ 222.

Armitage therefore discloses or renders obvious every element of claim 8. EX1003, ¶ 223.

7. Dependent Claim 9

a. Limitation 9(a)

Armitage describes a “railway car health scorecard,” which recommends a course of action based on the level of the alarm that is raised. *See* Section X.C.1.d; EX1003, ¶ 225. Specifically, a “yellow” condition “indicates that a railway car requires service,” while a “red” condition indicates “a serious deviation from normal operations that requires *immediate* service.” EX1006, ¶ [0044] (emphasis added).

b. Limitation 9(b)

A PHOSITA would understand that Armitage’s “railway car health scorecard” is displayed to operators in the locomotive. *See* Section X.C.6.d. Alternatively, a PHOSITA would have been motivated to modify Armitage’s system to include a device that displays alerts to the operators in a locomotive for the reasons discussed above with respect to Limitation 8(e). *See* Section X.C.6.d. EX1003, ¶ 225

Armitage therefore discloses or renders obvious every element of claim 9. EX1003, ¶ 226.

8. Independent Claim 10

a. Claim 10 Preamble

See Section X.C.1.a; EX1003, ¶ 227.

b. Limitations 10(a) and 10(b)

Armitage discloses a mobile railway car monitoring system including a plurality of sensor nodes, each of which can comprise one or more temperature sensors. *See* Sections X.C.1.a, X.C.1.b; EX1003, ¶ 228.

The temperature sensors can be used to monitor wheel bearing temperature. EX1006, ¶ [0027]; EX1003, ¶ 229. Armitage does not state that the temperature sensors are attached *directly* to the wheel bearing. To the contrary, Armitage teaches that its sensors are preferably attached to *non-rotating* elements, such as

brackets or bearing mounts. EX1006, ¶ [0034] (“Sensor nodes 320-327 are each attached or coupled to the associated wheel assembly, preferably to a non-rotating portion, such as a bracket, bearing mount, or other nonrotating structure.”); EX1003, ¶ 229.

Consistent with Armitage’s disclosure, a PHOSITA would understand that direct attachment to a wheel bearing is typically impractical because a wheel bearing is a moving component. EX1003, ¶¶ 230–231. Rather, a PHOSITA would understand that, conventionally, the temperature of a rotating mechanical component (e.g., a wheel bearing) is measured indirectly by attaching a temperature sensor to a nearby, stationary component that is in thermal communication with the rotating component. *Id.* This arrangement is commonplace in industry and would be familiar to any PHOSITA. *Id.*, ¶ 231 (citing EX1018).

Accordingly, to the extent not expressly disclosed by Armitage, a PHOSITA would have been motivated to attach the temperature sensor to a stationary component of the railcar adjacent to the wheel bearing (rather than to the wheel bearing itself) because this arrangement is mechanically simple, conventional, and easier to implement than attaching to the bearing directly. EX1003, ¶ 232.

c. Limitation 10(c)

Armitage teaches that the temperature of the wheel bearing should be monitored to determine if it is outside an acceptable range. EX1003, ¶ 233. For

example, “[c]ontrol node 130 could process the sensor information to determine anomalies from an average, such as an anomaly from a running average of the temperature of all wheels on railway car 110.” EX1006, ¶ [0029]. Additionally, as discussed above in Section X.C.1.c, which is incorporated herein by reference, Armitage discloses numerous heuristics that can be used to process sensor data and determine whether a fault condition (e.g., excessively high bearing temperature) is present. EX1003, ¶ 233.

d. Limitation 10(d)

Armitage teaches that an alarm message is generated if a monitored parameter, such as temperature, is outside the expected range and the deviation is significant enough to warrant an alarm. *See* Section X.C.1.d; EX1003, ¶ 234.

Armitage therefore discloses or renders obvious every element of independent claim 10. EX1003, ¶ 235.

9. Dependent Claim 11

Armitage discloses that each sensor node may include a sensor for monitoring the ambient air temperature. EX1006, ¶ [0025] (“The information monitored could include ... ambient temperature”); *id.*, ¶ [0029] (“the ambient temperature or weather conditions could be evaluated”); EX1003, ¶ 236.

Armitage recognizes that “sensor information can be affected by ambient temperature.” EX1006, ¶ [0029]. This fact would have been well-understood by a PHOSITA. EX1003, ¶ 237.

Armitage further states that “the ambient temperature or weather conditions” should be evaluated to determine whether an anomaly is present in an undercarriage element. EX1006, ¶ [0029]. A PHOSITA would therefore understand that, in Armitage’s system, information collected from temperature sensors should be calibrated—taking ambient temperature and weather into account—before reporting a fault condition or raising an alarm. EX1003, ¶ 238.

Armitage therefore discloses or renders obvious every element of dependent claim 11. EX1003, ¶ 239.

10. Dependent Claim 13

As described above, in Armitage’s system steps (a) and (b) of claim 1 are carried out by the control node. *See* Section X.C.3; EX1003, ¶ 240.

Steps (c) and (d) are carried out by Armitage’s “Data Correlation Unit (DCU).” *See* Section X.C.1.d. The Data Correlation Unit can comprise the collection node (e.g., collection node 150). EX1006, ¶ [0043]; EX1003, ¶ 241.

Accordingly, Armitage discloses, or at least renders obvious, an embodiment wherein steps (a) and (b) are carried out by a control node; and steps (c) and (d) are

carried out by a collection node, thereby meeting the limitations of claim 13.

EX1003, ¶ 242.

D. Ground 4: Claims 3, 5, 12–18, and 20–22 are unpatentable under 35 U.S.C. § 103(a) over Armitage in view of LeFebvre.

A PHOSITA would have found it obvious to combine the disclosures of Armitage and LeFebvre. The references describe very similar systems for monitoring railcars, which contain nearly identical components that function in a similar way. EX1003, ¶ 243. Specifically:

- Like Armitage, LeFebvre is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1005, (57) Abstract; EX1003, ¶ 244.
- Like Armitage, LeFebvre utilizes a plurality of sensors to monitor the wheels and wheel bearings on each railcar, wherein the sensors communicate wirelessly with a control unit located on the railcar. *Id.*; EX1003, ¶ 245.
- Like Armitage, LeFebvre also discloses that the collected data is analyzed to determine, for example, if a wheel bearing failure is approaching or imminent. EX1005, ¶¶ [0058]–[0059]; EX1003, ¶ 246.
- And, like Armitage, LeFebvre discloses that if a failure condition is detected, an alert (including the underlying data) is wirelessly

transmitted to a data processing system in a remote location. EX1005, ¶¶ [0038], [0052]; EX1003, ¶ 247.

A PHOSITA therefore would have understood that Armitage and LeFebvre are analogous art. EX1003, ¶ 248. A PHOSITA would have been motivated to combine the teachings of Armitage and LeFebvre for the reasons discussed in detail below with respect to each challenged claim.

1. Dependent Claim 3

Armitage does not expressly disclose that one or more remote sensing units form a mesh network. A mesh network is a networking configuration where each device communicates with two or more other devices. EX1003, ¶ 250.

LeFebvre discloses that its sensor nodes may be connected to the CMU using a mesh networking protocol. *See* Section X.A.3; EX1003, ¶ 251. A PHOSITA would have understood that mesh networking provides certain advantages relative to point-to-point protocols such as Bluetooth or WiFi. EX1003, ¶ 251. Most significantly, a mesh network allows sensor nodes to be placed in locations where they could not communicate with the CMU directly (e.g., due to interference). *Id.* For at least this reason, a PHOSITA would have been motivated to modify Armitage to use a wireless mesh network to connect the sensor devices and the control node, as disclosed by LeFebvre. *Id.*

Armitage, in view of LeFebvre, therefore renders obvious every element of claim 3. EX1003, ¶ 252.

2. Dependent Claim 5

See Section X.D.1; EX1003, ¶ 253.

3. Dependent Claim 12

It would have been obvious to modify Armitage’s system such that each step (a)–(d) of claim 10 is carried out by a single sensor node. EX1003, ¶ 254.

Limitations 10(a) and 10(b) are carried out by Armitage’s sensor node, as explained above. *See* Section X.C.8.b; EX1003, ¶ 255.

Armitage does not expressly state that its sensor devices “determine[e] if said temperature of the desired part is outside an acceptable range,” as required by Limitation 10(c), or transmit an alarm as required by Limitation 10(d). LeFebvre, however, describes these limitations in detail. *See* Section X.A.10; EX1003, ¶ 256.

LeFebvre teaches that the burden of transmitting *all* data collected from the sensors is “extremely large.” EX1005, ¶ [0053]. To “reduce the radio traffic to manageable proportions,” it is desirable to have the sensor devices “[look] for signs of trouble and then send only essential indicative information” upstream to the control node. EX1005, ¶ [0053]. In other words: LeFebvre’s sensor devices monitor the sensor readings (i.e., temperature) for values outside the expected

range, and transmit an alarm upstream (i.e., to the control node) **only** if a deviation is detected. EX1003, ¶ 257.

A PHOSITA would have been motivated to modify Armitage's sensor devices to monitor sensor data, determine alarm conditions, and wirelessly transmit any alarms to the data control unit, as disclosed by LeFebvre. This modification would have had an obvious and predictable benefit—specifically, it would reduce the amount of data, and radio traffic, that must be transmitted from the sensor devices to the control unit on each railcar. EX1003, ¶ 258.

Armitage, in view of LeFebvre, therefore renders obvious every element of claim 12. EX1003, ¶ 259.

4. Dependent Claim 13

As discussed above with respect to Dependent Claim 12, Section X.D.3, a PHOSITA would have been motivated to modify Armitage's sensor devices to monitor sensor data, determine alarm conditions, and wirelessly transmit any alarms to the data control unit, as disclosed by LeFebvre. Accordingly, the combination of Armitage and LeFebvre discloses, or at least renders obvious, an embodiment wherein each of steps (a)–(d) are carried out by a plurality of sensor devices; steps (a) and (b) are carried out by a control node; and steps (c) and (d) are carried out by a collection node, thereby meeting the limitations of claim 13. EX1003, ¶ 260.

5. Independent Claim 14

a. Claim 14 Preamble

See Section X.C.1.a; EX1003, ¶ 261. A PHOSITA would understand that Armitage’s control node is a “communication management unit” that performs each step required by claim 14, as explained in detail below. EX1003, ¶ 261.

b. Limitation 14(a)

Armitage’s control node communicates wirelessly with one or more sensor units located on the same railcar. *See* Section X.C.1.b; EX1003, ¶ 262.

Armitage does not expressly disclose that its sensor nodes *periodically* collect sensor readings from the sensor units. This feature would necessarily be present if Armitage’s sensor nodes were equipped with one or more digital sensors, which inherently transmit data on a periodic basis. EX1003, ¶ 263. Digital sensors are commonplace, and it would have been obvious for a PHOSITA to have equipped Armitage’s sensor nodes with, for example, digital temperature sensors. *Id.*

This feature is also disclosed, in detail, by LeFebvre. *See* Section X.A.12.b; EX1003, ¶ 264. More generally, the power-saving scheme described by LeFebvre (where an electronic device enters a sleep mode to save power, and awakens periodically to collect data, perform computations, and transmit data over a network) was a well-known, standard practice prior to the priority date of the ’673

Patent. *Id.* A PHOSITA would have incorporated this well-known feature into Armitage's sensor nodes because—as LeFebvre explains—it predictably saves power. EX1005, ¶¶ [0034]–[0035]; EX1003, ¶ 264.

c. Limitation 14(b)

Armitage discloses statistical methods that can be used to process sensor data and detect a deviation from nominal operating conditions. *See* Section X.C.1.c; EX1003, ¶ 265.

Armitage also indicates that its system can distinguish between potential failures (which indicate a need for upcoming maintenance) and actual failures (which require immediate service). *See* Sections X.C.1.d, X.C.6.d, and X.C.7.a; EX1003, ¶ 266.

d. Limitation 14(c)

See Section X.C.4; EX1003, ¶ 267.

Armitage, in view of LeFebvre, therefore renders obvious every element of independent claim 14. EX1003, ¶ 268.

6. Dependent Claim 15

a. Limitation 15(a)

As explained above, it would have been obvious to modify Armitage's sensor devices to monitor sensor data, determine alarm conditions, and wirelessly

transmit any alarms to the control node, as disclosed by LeFebvre. *See* Section X.D.3; EX1003, ¶ 269.

b. Limitation 15(b)

Armitage discloses wirelessly reporting alarm conditions to a “collection system” that is located off the train. *See* Section X.C.4; EX1003, ¶ 270.

7. Dependent Claim 16

a. Limitation 16(a)

Armitage’s control node aggregates data from multiple sensor nodes located on the same train, and uses heuristics to analyze the aggregated data and determine if an alarm should be raised. *See* Sections X.C.1.a and X.C.1.b; EX1003, ¶ 272.

b. Limitation 16(b)

Armitage’s control node wirelessly reports alarm conditions to a “collection system” that is located off the train *See* Section X.C.4; EX1003, ¶ 273.

8. Dependent Claim 17

See Section X.D.5.b; EX1003, ¶ 274.

9. Dependent Claim 18

See Section X.D.1; EX1003, ¶ 275.

10. Dependent Claim 20

a. Limitation 20(a)

Armitage discloses that each control node contains “memory devices” and “computer readable storage mediums.” EX1006, ¶¶ [0016], [0035]. *See also*

EX1006, ¶ [0049] (describing storage system 521 as a component of control node 500); EX1003, ¶ 276. Additionally, a PHOSITA would understand that data received from the sensor units is stored in some form of memory (e.g., in RAM or on a hard drive) on the control node until it is processed. EX1003, ¶ 276.

For example, as discussed in detail below in Limitation 20(b), Armitage discloses heuristics that involve comparing currently collected data against *data collected during a previous time period*, which would necessarily be stored in memory on the data control unit. EX1003, ¶ 277.

b. Limitation 20(b)

Armitage discloses heuristics that involve comparing currently collected data against stored data collected during a previous time period. EX1003, ¶ 278.

For example, Armitage teaches that a “standard deviation metric” can be used to determine when data from one or more sensor nodes becomes an outlier. EX1006, ¶ [0041]. Calculating the standard deviation involves comparing the current data point (received from the sensor unit) against the mean value of previously collected data points (which are stored in memory on the control unit). EX1003, ¶ 279. Likewise, to apply the “trend modeling” heuristic disclosed by Armitage (EX1006, ¶ [0044]), current data is compared with data collected during an earlier time period in order to generate a trendline. EX1003, ¶ 280.

Armitage, in view of LeFebvre, therefore discloses or renders obvious every element of claim 20. EX1003, ¶ 281.

11. Independent Claim 21

a. Claim 21 Preamble

See Section X.C.1.a; EX1003, ¶ 282.

b. Limitation 21(a)

See Section X.D.5.b; EX1003, ¶ 283.

c. Limitation 21(b)

See Section X.D.5.b; EX1003, ¶ 284. Armitage’s control node is a “communication management unit” in the parlance of the ’673 Patent. *Id.*

d. Limitation 21(c)

See Section X.D.5.c; EX1003, ¶ 285.

12. Dependent Claim 22

a. Limitation 22(a)

See Section X.D.7.a; EX1003, ¶ 287.

b. Limitation 22(b)

See Section X.D.7.b; EX1003, ¶ 288.

XI. CONCLUSION

Petitioner has demonstrated in this Petition that claims 1–18 and 20–22 of the ’673 Patent are unpatentable. Petitioner, therefore, respectfully requests

Patent No. 9,981,673
Petition for *Inter Partes* Review

institution of an *inter partes* review of the '673 Patent and that claims 1–18 and 20–22 be canceled.

Respectfully submitted,

Dated: January 31, 2023

By: /Eric J. Rakestraw/
Eric J. Rakestraw, Reg. No. 68,740
Daisy Manning, Reg. No. 66,369
HUSCH BLACKWELL LLP
190 Carondelet Plaza, Suite 600
St. Louis, MO 63105
(314) 480-1500 Telephone
(314) 480-1505 Facsimile
PTAB-ERakestraw@huschblackwell.com
PTAB-DManning@huschblackwell.com

Andrea L. Shoffstall, Reg. No. 75,426
HUSCH BLACKWELL LLP
1801 Wewatta Street, Suite 1000
Denver, CO 80202
303.749.7200 Telephone
303.749.7272 Facsimile
PTAB-AShoffstall@huschblackwell.com

Attorneys for Petitioner

Patent No. 9,981,673
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CERTIFICATION

The Petition excluding the caption, Table of Contents, Table of Exhibits, Mandatory Notices under 37 C.F.R. § 42.8, and this Certification contains 12,851 words.

Respectfully submitted,

Dated: January 31, 2023

By: /Eric J. Rakestraw/
Eric J. Rakestraw, Reg. No. 68,740
Lead Counsel for Petitioner

Patent No. 9,981,673
Petition for *Inter Partes* Review

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.105, Petitioner certifies that this Petition for Inter Partes Review and supporting evidence was served by Federal Express®, on January 31, 2023, to the Patent Owner of U.S. Patent No. 9,981,673 at their correspondence address of record according to USPTO records:

Gary A. Hecht
Fox Rothschild LLP
997 Lenox Drive
Lawrenceville, NJ 08684

With courtesy copy to:
Jeff E. Schwartz
Fox Rothschild LLP
2020 K Street NW
Suite 500
Washington, DC 20006

By: /Eric J. Rakestraw/
Eric J. Rakestraw, Reg. No. 68,740
Lead Counsel for Petitioner