

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. 9,365,223
Issue Date: June 14, 2016
Title: SYSTEM AND METHOD FOR MONITORING
RAILCAR PERFORMANCE

Inter Partes Review No. IPR2023-00538

**DECLARATION OF STEVEN RICCA
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,365,223**

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I. INTRODUCTION

1. I, Steven Ricca, offer this declaration in support of the Petition for *Inter Partes* Review of U.S. Patent No. 9,365,223 (“the ’223 patent”). I am over the age of 18, competent to make this declaration, and have personal knowledge of the facts set forth below. If called to testify, I could and would testify honestly, under oath, to the matters set forth herein.

2. I am not an attorney, and I have not been asked to offer any legal opinions. I have been informed and understand the law to be applied for determining invalidity, which I explain in places below. I have applied the law told to me in developing my technical opinions in this Declaration.

II. BACKGROUND AND QUALIFICATIONS

A. Education and Work Experience

3. I have over 30 years of experience in electrical and systems engineering, including in the railroad industry specifically. I have direct experience within a variety of private companies and industries. I earned my B.S. and M.S. in Electrical Engineering from Ohio University in 1986 and 1988, respectively. My curriculum vitae attached to this declaration as Exhibit 1004 contains a detailed description of my work history and education.

4. At Toledo Scale (1988-1990) I was the lead firmware engineer for a new scale for railcars. Much of the work I did at Toledo Scale led to applications that were industry firsts. For example, I developed electronic systems and software

that measured weight. This included railcar weight, and within that sector some of the first in-motion weighers and automated tank car fillers. Often the wayside communication systems were located near the weighing equipment due to electrical runs, so understanding the wayside communication systems in combination with the weighing equipment was critical.

5. At IRD Mechanalysis (1990-1995) I developed systems that measured all parameters of rotating machinery. This included all types of sensors within systems that monitored and analyzed data in real-time with authority to shut down or signal the system for a shutdown. Very complex systems involving hundreds of accelerometers, temperature sensors and other position detectors were typical. These systems often performed complex algorithms and comparisons on the data for shutdown analysis; as well as storing the compressed data for offloading to larger storage locations using a variety of communications methods. This company pioneered many of the concepts of predictive/preventive maintenance and communicating the system health to outside entities for scheduled service and maximum uptime.

6. At Dynalab, where I was senior electronic engineer from June 1997 to July 2002, I developed several test instruments used by the transportation and appliance industries to test cable and harness assemblies prior to final assembly in to the vehicle or appliance. This work included designing and developing

microprocessor based relay boards, a DC-DC power supply, and understanding the upcoming trends in transportation wiring. The cable analyzer testing equipment was programmable to check for the continuity of connections, splices and the presence of fuses and surge suppression devices. They also could analyze the signal path for high speed communication line.

7. A few jobs and several years later, I worked at Invensys (2004-2006) as a Senior Electrical Engineer. I was responsible for overseeing the automotive climate controls products division. One of my responsibilities was to design a high-volume microcontroller based automotive product family to replace the existing laser trimmed controls which had become difficult to manufacture. Also, our engineering group developed controls for the HVAC industry which would measure and communicate system health to outside entities for preventive maintenance programs. We also developed thermostats and smoke alarms using mesh networking.

8. Since my job at Invensys in 2006, I have continued to work in the electrical and systems engineering industry, leading up to my current job as Lead Electrical Engineer with Vertiv Holdings. My responsibilities include electrical coordination and oversight of multiple product development programs carried out in four design centers worldwide. I also have my own consulting/product development company, Ricca Engineering, LLC, that I have operated since around

2002. Some of my projects have included embedded firmware, analog and digital hardware design, building prototypes, schematic circuit design, simulation and PCB layout, and motorized controls for museum exhibits among others.

9. I have held numerous other positions in my 30-plus years in the engineering field, as shown on my curriculum vitae. Not all have been discussed in detail in my declaration.

10. I have prepared numerous written documents over my career in the engineering field, including operating manuals, technical specifications, and internal research and development documents. With few exceptions, these documents have been kept confidential by the companies that own them, and have not been publicly disclosed or otherwise made available to competitors. For this reason, none of these documents are listed on my curriculum vitae (EX1004).

11. My background demonstrates an expertise and strong understanding of railroad monitoring systems, as well as communications networks used in these systems, such as mesh networks.

B. Engagement

12. I have been retained as an independent expert consultant by Hum Industrial Technology, Inc. (“Petitioner”) in connection with a petition for *inter partes* review of U.S. Patent No. 9,365,223 (EX1001) (the “Petition”).

13. Specifically, I was asked to investigate and opine on the technology claimed in, and the patentability or unpatentability of certain claims of the '223 Patent. Specifically, I was asked to opine on the validity of claims 1–10, 13–18, and 20–32 (the “Challenged Claims”) of the '223 Patent.

14. Although I am being compensated for my services in this matter at my standard consulting rate of \$375 per hour, my compensation is not contingent upon the opinions I render or the outcome of this proceeding. I have no financial interest in any of the parties, and I have no other interest in this proceeding.

15. This report is based on information currently available to me. I reserve the right to amend or supplement my analysis in this report and/or to respond to any additional submissions prepared by or on behalf of the Patent Owner. I also reserve the right to amend or supplement my opinions based on further discovery and information provided in the case.

16. I reserve the right to create any additional summaries, tutorials, demonstrations, charts, drawings, tables, and/or animations that may be appropriate to supplement and demonstrate my opinions as necessary.

17. All of the opinions stated in this report are based on my own personal knowledge and professional judgment.

III. MATERIALS CONSIDERED

18. I have considered the following list of materials in formulating my opinions in this matter:

Ex #	Exhibit Description
1001	U.S. Patent No. 9,365,223 (“the ’223 patent”)
1002	Prosecution History of the ’223 Patent
1005	U.S. Patent Publication No. 2007/0152107 A1 to LeFebvre et al. (“LeFebvre”)
1006	U.S. Patent Publication No. 2011/0282540 A1 to Armitage et al. (“Armitage”)
1007	U.S. Patent Publication No. 2007/0208841 A1 to Barone et al. (“Barone”)
1008	U.S. Patent No. 5,633,628 to Denny et al. (“Denny”)
1009	U.S. Patent No. 4,282,754 to Provasnik (“Provasnik”)
1010	U.S. Patent No. 6,487,478 to Azzaro et al. (“Azzaro”)
1011	Amsted Rail Company, Inc.’s Complaint filed against Hum Industrial Technology, Inc. (ECF No. 1) filed on April 18, 2022
1012	Waiver of the Service of Summons upon Hum Industrial Technology, Inc. (ECF No. 4) dated June 14, 2022
1013	U.S. Provisional Application No. 61/661,661 (“the ’661 Provisional”)
1014	U.S. Patent Application No. 12/861,713 (“the ’713 Application”)
1015	U.S. Patent No. U.S. 7,688,218 to LeFebvre et al. (“LeFebvre ’218”)
1016	Third Generation On-Board Monitoring and Control System Based on Controller Area Network Technology Dr. John Donelson III, et al.
1017	Defendants' Stipulation of Invalidity Contentions

IV. OVERVIEW OF THE PATENT AT ISSUE

19. I have read and considered the ’223 patent, filed March 15, 2013, as well as its prosecution history. (EX1002).

20. It is my understanding that the '223 Patent relates, broadly speaking, to a system for wirelessly monitoring the operating parameters and/or conditions of a railcar. EX1001, (57) Abstract. The system includes one or more sensor units that communicate wirelessly with a “communication management unit,” or “CMU,” mounted on the railcar. *Id.* The system can determine whether an alarm condition is present based upon data collected from the sensor units. *Id.*

21. It is my understanding that the claims of the '223 Patent relate to systems for wirelessly monitoring the operating parameters of a railcar, and to sensing and monitoring devices that may be incorporated into such a system.

22. I understand that U.S. Patent Application 13/842,427 (“the '427 Application”) was filed on March 15, 2013, and issued as the '223 Patent on June 14, 2016. The '223 Patent claims priority to U.S. Provisional Application No. 61/661,661, filed on June 19, 2012. (EX1013). I also understand that the '223 Patent claims to be a continuation-in-part of U.S. Patent Application No. 12/861,713, filed on August 23, 2010. (EX1014).

23. For the purposes of preparing my opinion, I have been informed that the Challenged Claims are entitled to a priority date of no earlier than June 19, 2012. Specifically, I have been informed that each independent claim of the '223 Patent recites at least one limitation that was newly added in the '427 Application, and is neither disclosed in nor supported by the '713 Application.

Independent Claim	Exemplary Limitation(s) Without Support in the '713 Application
1	“a temperature sensor”; “a magnet”
2	“a temperature sensor”
5	“wherein said communication management unit applies heuristics”
23	“a temperature sensor”

24. However, even if the Challenged Claims were entitled to a priority date of August 23, 2010, it is my opinion that the claims would still be unpatentable over the prior art as it existed prior to August 23, 2010. *See* Sections IX.C, IX.D, and IX.E below.

A. Prosecution History of the '223 Patent

25. During prosecution of the '223 Patent, I understand that the first Office Action, issued November 4, 2014, rejected the pending claims as obvious in view of U.S. 8,244,411 (“Baker”) and a web page describing a “Locomotive Monitoring Unit” sold by Lat-Lon (“Lat-Lon”). EX1002, 108-122. In support of a response filed May 1, 2015 (EX1002, 151-166), Amsted submitted a declaration by inventor Andrew Martin (EX1002, 167-171), which alleged that the claimed invention had been reduced to practice prior to January 1, 2013 (antedating the Lat-Lon reference). Amsted then argued that the remaining claims were nonobvious in view of Baker standing alone.

26. A second Office Action was issued on August 24, 2015. EX1002,448-466. The examiner withdrew the previous rejections based upon Baker and Lat-Lon, and instead relied upon new rejections over US 2008/0195265 (“Searle”) in view of Baker. In a response filed January 27, 2016 (EX1002, 507-527), Amsted amended every independent claim (and numerous dependent claims) in an attempt to distinguish Searle. Amsted argued, inter alia, that while Searle “provides a train monitoring system having sensors, located on the bogies of each railcar, wherein the sensors are arranged in a train wide wireless network,” Searle “utilizes a different topology” and fails to disclose a “CMU” on each railcar as required by the claims. See, e.g., EX1002, 518, 523. Additionally, Amsted argued that certain claims (corresponding to issued claims 9, 23, 29, and 31) required a power management technique that is not disclosed by Searle. See, e.g., EX1002, 519. This argument resulted in a Notice of Allowability. EX1002, 538-542.

27. In my opinion, Searle is not the closest prior art reference to the invention claimed by the ’223 Patent. Even so, in my opinion the examiner should not have allowed the claims in view of Searle. The examiner apparently failed to recognize that the wireless network topology described in the ’223 Patent, including the use of a CMU on each railcar, had become standard practice by the late 2000s. For example, LeFebvre and Armitage each disclose the same network

topology as claimed in the '223 Patent, including a CMU on each railcar, as discussed in detail below. *See* Sections V and VIII, *infra*.

B. Listing of Claims

28. The issued claims of the '223 Patent are listed in the table below. To provide consistency with the Petition, I have adopted the same shorthand numbering for the claims, and individual claim limitations, of the '223 Patent. For example, as indicated in the table below, I may use “Limitation 1(b)” as a shorthand reference to the limitation “a temperature sensor” in claim 1.

Claim Designation	Claim Language
Claim 1 Preamble	A sensor device for monitoring temperature on a railcar, comprising:
Limitation 1(a)	a housing mountable on a railcar;
Limitation 1(b)	a temperature sensor;
Limitation 1(c)	electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;
Limitation 1(d)	a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing;
Limitation 1(e)	a probe external to said housing and which probe includes said temperature sensor and a magnet positioned to magnetically attract the part of the railcar against which the probe will be placed; and

Limitation 1(f)	a communication device capable of broadcasting information regarding the temperature sensed, said communication device positioned within said housing;
Limitation 1(g)	wherein the power consumption of said sensor device is managed by placing said sensor device in a standby state and periodically awakening said sensor device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry.
Claim 2 Preamble	A system for monitoring a railcar, comprising:
Limitation 2(a)	a plurality of sensor devices located on the railcar for monitoring parameters or conditions of the railcar, each of said sensor devices being separate from one another and including a sensor for monitoring one of said parameters or conditions of the railcar;
Limitation 2(b)	said plurality of sensor devices including at least one temperature sensor device having:
Limitation 2(c)	a housing;
Limitation 2(d)	a temperature sensor in thermal communication with an item of the railcar for which the temperature is being monitored, which item is external to said housing;
Limitation 2(e)	electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;
Limitation 2(f)	a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing;

Limitation 2(g)	a communication device capable of broadcasting information regarding the temperature sensed via wireless communication, said communication device positioned within said housing; and
Limitation 2(h)	a communication management unit, mounted on the railcar, capable of two way wireless communication with each of said plurality of sensor devices for receiving information therefrom, said communication management unit having a wireless communication device for broadcasting information about the parameter or condition being monitored.
Claim 3	The system of claim 2 wherein said communication management unit can make a determination of an alarm condition based on data collected by two or more of said sensor devices.
Claim 4	The system of claim 2 wherein each of said plurality of sensor devices is capable of exchanging data with other of said plurality of sensor devices and with said communication management unit.
Claim 5 Preamble	A system for monitoring the operation of a railcar comprising:
Limitation 5(a)	a. one or more sensor units mounted on said railcar, each of said sensor units monitoring an operating parameter of said railcar wherein each of said sensor units comprises
Limitation 5(b)	a sensor,
Limitation 5(c)	a power source,
Limitation 5(d)	a processor,
Limitation 5(e)	memory,
Limitation 5(f)	communication circuitry, and

Limitation 5(g)	b. a communication management unit, mounted on said railcar, said communication management unit in wireless communication with said one or more sensor units;
Limitation 5(h)	wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units
Limitation 5(i)	(a) to determine if an actual failure exists and
Limitation 5(j)	(b) to predict potential or imminent failures based on a statistical analysis of said collected data.
Claim 6	The system of claim 5 wherein said determination of an alarm condition can be made by one of said sensor units.
Claim 7	The system of claim 5 wherein said determination of an alarm condition can be made by said communication management unit based on data collected by two or more of said sensor units.
Limitation 8(a)	The system of claim 5 wherein each of said sensor units comprises: a. a sensor; b. a power source; c. a processor; d. memory; e. communications circuitry; and f. software, stored in said memory and executed by said processor,
Limitation 8(b)	said software performing the functions of collecting data from said sensor at periodic intervals.
Limitation 9(a)	The system of claim 8 wherein said software further performs the function of: assessing the collected data to determine if an alarm condition exists;

Limitation 9(b)	and communicating said alarm condition to said communication management unit via said communications circuitry
Limitation 9(c)	and managing the power consumption of said sensor unit by placing said sensor unit in a standby state and periodically awakening said sensor unit to collect data from said sensor and to transmit information regarding said operating parameter to said communication management unit via said communication circuitry.
Claim 10	The system of claim 5 wherein said one or more sensor units and said communication management unit are in wireless communication with each other and form a local area wireless network for said railcar.
Claim 11	The system of claim 10 wherein said local area network is a mesh network running the Time Synchronized Mesh Protocol to facilitate communications therebetween.
Claim 12	The system of claim 10 wherein said communication management unit is in wireless communications with communication management units on other railcars, forming a wide area network.
Limitation 13(a)	The system of claim 5 further comprising a base unit, said base unit being in wireless communication with said communication management unit,
Limitation 13(b)	said based unit performing the functions of: a. collecting data and alarms from said communication management unit;

Limitation 13(c)	b. displaying alarm conditions raised by said communication management unit; and
Limitation 13(d)	c. determining high level alarms based on data and alarms collected from said communication management unit.
Claim 14	The system of claim 13 wherein said base unit is in wireless communication with multiple communication management units.
Claim 15	The system of claim 14 wherein said base unit uses distributed event processing to perform trend analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.
Claim 16	The system of claim 14 wherein said base unit applies heuristics to data collected from said one or more communication management units to determine if a high level alarm should be raised.
Claim 17	The system of claim 16 wherein said base unit and said one or more communication management units communicate with each other via a satellite communications capability or a cellular network capability.
Claim 18	The system of claim 5 wherein said sensor is selected from a group consisting essentially of temperature sensors, pressure sensors, strain sensors, load cell sensors, hand brake position sensors, magnetic sensors, vibration sensors, gyroscopes, acceleration sensors, hall effect sensors, piezoelectric resistive microphones and switches.

Claim 19	The system of claim 5 wherein data and alarms may be relayed from said one or more communication management units to an on-train base unit via an off-train base unit.
Claim 20	The system of claim 5 wherein said alarm is determined using distributed event processing based on a comparison between current data and statistical models of behavior.
Claim 21	The system of claim 5 wherein said alarms are determined based on a comparison of currently collected data versus data collected over a pre-determined preceding time period.
Claim 22	The system of claim 5 wherein an alarm is raised based one or more of the following criteria: a. a pre-determined percentage of current data readings exceeds allowable peak readings; b. a pre-determined percentage of current data readings exceeds a determined value; c. a pre-determined percentage of current data readings exceeds a standard deviation from readings from the same railcar; d. a pre-determined percentage of current data readings exceeds a standard deviation from all railcars in the fleet; or e. the rate of change of current data readings exceeds a pre-determined threshold.
Claim 23 Preamble	A monitoring device for monitoring temperature on a railcar, comprising:
Limitation 23(a)	a housing mountable on a railcar;
Limitation 23(b)	a temperature sensor configured to be in thermal communication with a portion of the railcar to be monitored for temperature, which portion is external to said housing;

Limitation 23(c)	electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing;
Limitation 23(d)	a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing; and
Limitation 23(e)	a communication device capable broadcasting information regarding the temperature sensed, said communication device positioned within said housing;
Limitation 23(f)	wherein the power consumption of said monitoring device is managed by placing said monitoring device in a standby state and periodically awakening said monitoring device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry.
Claim 24	The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.
Claim 25	The monitoring device of claim 23 wherein said circuitry is configured to apply heuristics to analyze data collected from said temperature sensor to determine if a problem exists.
Limitation 26(a)	The system of claim 2 wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor devices
Limitation 26(b)	(a) to determine if an actual failure exists and

Limitation 26(c)	(b) to predict potential or imminent failures based on a statistical analysis of said collected data.
Limitation 27(a)	The system of claim 2 further comprising a second temperature sensor located on said railcar for measuring ambient air temperature,
Limitation 27(b)	wherein said system uses information obtained from said second temperature sensor about the ambient temperature to calibrate the temperature data received from said first sensor regarding the item of the railcar being monitored.
Claim 28	The system of claim 2 wherein said communicating management unit is capable of communicating data and alarms to a remote location located off of the train of which the railcar is a part.
Claim 29	The system of claim 2 wherein the power consumption of each of said sensor devices is managed by placing each said sensor device in a standby state and periodically awakening said sensor device to collect readings from said sensor device and to transmit the information regarding the parameter or condition being sensed via said communication circuitry.
Claim 30	The system of claim 2 wherein said communication management unit and said plurality of sensor devices form a wireless mesh network for said railcar.

Claim 31	The system of claim 5 wherein the power consumption of each of said sensing units is managed by placing each sensing unit in a standby state and periodically awakening said sensing unit to collect readings from said sensor and to transmit information via said communications circuitry.
Claim 32	The system of claim 5 wherein said communication management unit is capable of communicating with a remote location located off of a train of which said railcar is a part.

V. STATE OF THE ART

29. It is my opinion that Amsted did not invent railcar monitoring systems, or the use of wireless sensors in said monitoring systems as claimed in the '223 Patent. In fact, railcar monitoring systems using sensors to detect operational anomalies using heuristics (including statistical analysis) were well-known in the art at the time the '223 Patent was filed. *See generally* EX1005 (LeFebvre), EX1006 (Armitage), EX1007 (Barone), EX1010 (Azzaro). The '223 Patent claims simply recite well-known processes and components (including but not limited to sensors, communication management units, mesh networks, and event processing engines) to yield predictable results that have been employed for decades. *See generally* EX1005 (LeFebvre), EX1006 (Armitage), EX1007 (Barone). There is nothing novel about collecting data through sensors located on a railcar, analyzing the data, and sending messages through a communication architecture (for

example, through a mesh network) to detect operational anomalies and inform the railcar operator of operational conditions of a railcar.

30. As far back as 1999, the Federal Railroad Administration's Office of Research and Development (FRA) sponsored the development of onboard monitoring systems for trains. EX1016, p. 1. In June 1999, the multi-year project commenced, with prototypes being tested as early as November 2000. EX1016, p. 1-2. In 2003, an onboard monitoring system was developed that used the latest wireless communications and bearing monitoring technology. EX1016, p. 2. By the time Donelson was published (2007), a monitoring system called the "On-Board Monitoring and Control System" ("OBMCS") was under development. EX1016, p. 2. The OBMCS contained a modular architecture with a network of microcontrollers linked by a Controller Area Network ("CAN") bus. EX1016, p. 2.

31. The OBMCS architecture considered cost and power consumption in its development. EX1016, p. 2. The OBMCS contained sensors to monitor mechanical operations, which were mounted on railcars and linked together via a wireless network (WLAN) to a computer in the locomotive. EX1016, p. 3. The computer in the locomotive displayed system status information and transmitted messages to actuators on the cars, which controlled and operated mechanical systems. EX1016, p. 3. Figure 1 of Donelson shows the architecture generally.

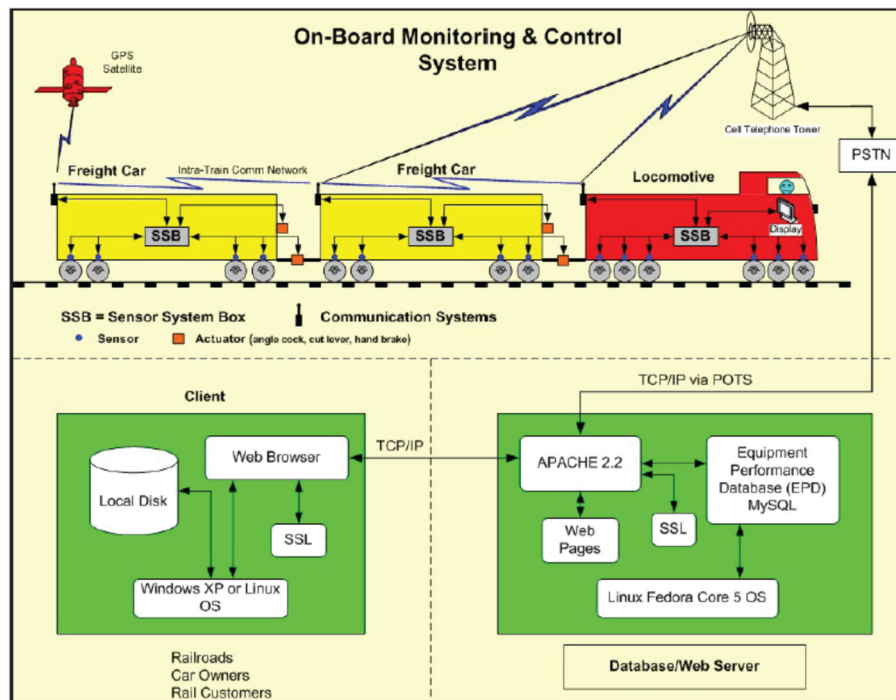


Figure 1: Top-level OBMCS architecture

32. OBMCS can use a number of wireless communications technologies, including Global System for Mobile communications (“GSM”), or a Code Division Multiple Access (“CDMA”) cell phone with 1X Radio Transmission Technology (“1XRTT”) in order to establish a two-way internet connection between the train and database server. EX1016, p. 3. Figure 2 of Donelson shows a diagram of sensors, communications systems, and power subsystem components installed on the railcars. It also includes a list of mechanical systems that can be monitored remotely from the locomotive, including accelerometers. EX1016, p. 3-4. These accelerometers generate data which is then analyzed with a digital signal processing algorithm. EX1016, p. 8.

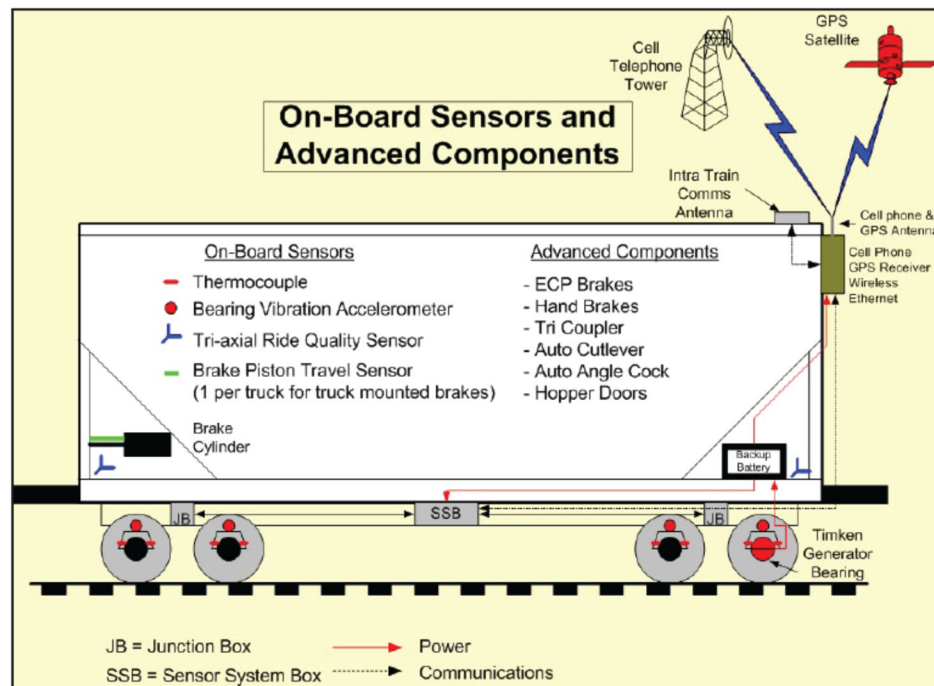


Figure 2: OBMCS sensors, actuators, and communication systems

33. OBMCS includes accelerometers for purposes of continuously monitoring derailment and intermittently monitoring bearing and wheel defects. EX1016, p. 4. It also includes tri-axial accelerometers for monitoring ride quality – including laterally, vertically, and longitudinally oriented sensors for detecting hunting, pitching, bouncing, and shock events. EX1016, p. 4.

34. OBMCS includes bearing temperature sensors embedded inboard and outboard on bearing adapters to continuously measure bearing temperature. EX1016, p. 4. The temperature sensor data is sampled periodically (every 30

seconds), and analyzed to determine whether an alarm message should be sent to the locomotive. EX1016, p. 9.

35. OBMCS also has a Sensor System Box (“SSB”) which includes a single board embedded computer system that manages all communications between OBMCS and external systems (including the locomotive). EX1016, p. 4. The Accessory Interface Box (“AIB”) provides a standard physical connection scheme for interfacing sensors and actuators to the CAN bus. EX1016, p. 5.

36. Donelson discusses various communication systems for the OBMCS, including mesh networks. EX1016, p. 6. The system can also use GPS or cell phone telemetry. EX1016, p. 6. The locomotive computer in OBMCS utilizes software to exchange messages regarding the railcar status information and implement control functions. EX1016, p. 7.

37. OBMCS utilizes a number of algorithms and analog to digital circuitry in microcontrollers to analyze information in the form of sensor signals. EX1016, p. 8-9. These signals are filtered using a low-pass filter and processed by algorithms and compared to other relational data to classify present situation and determine whether an alarm message needs to be sent. EX1016, p. 9.

38. The primary objective of the OBMCS disclosed in Donelson is to improve railroad safety and efficiency through new technologies and continuous monitoring to avoid breakdowns and accidents. EX1016, p. 9-10. In 2007, on-

board power, communication networks, and advanced signal processing was available and well known. EX1016, p. 10. While cost, performance, and reliability were considerations for the OBMCS, none of these considerations rendered OBMCS impossible even as early as 2007 when Donelson was published. For example, the automotive industry had been successfully implementing cost effective packaging of complex electronics and computing/control power in automobiles for many years before this. It is my opinion that Donelson accurately depicts the state of the art in 2007 (or earlier), proving the technology claimed in the '223 Patent was already widely known and accepted in the field at least 5 years before its filing.

39. As a further example, a prior art reference relied on in the Petition, Barone, also provides a detailed background of the invention and state of the art at the time of Barone in 2007—5 years before the provisional application that led to the '223 Patent was filed. EX1007, (22), (65), (60). Barone lists a large number of publicly available articles and publications, dating as far back as the mid-1990's, that disclose onboarding monitoring systems similar to that described and claimed by the '223 Patent. EX1007, ¶¶ [0014]–[0020].

40. Barone notes that, because wayside detection systems turned out to be cheaper and easier to implement in the real world, onboard monitoring systems were not widely utilized in the industry. EX1007, ¶ [0021]. But this changed in the

mid-2000s, when the general progress of technology meant that electronic components—such as sensors, microprocessors, and wireless networking equipment—became cheap and widely available. By the time Barone was published in 2007, it recognized that “[o]nboard monitoring of fleets of railroad cars is more economically feasible due to the drastic decrease in the cost of modern sensors and electronics when mass produced.” EX1007, ¶ [0042].

41. Mesh networks first appeared in the 1980’s and have been well-known in the art since the 1990’s. Barone discloses a mesh network as part of the communication network of the system, showing mesh networks were utilized in onboard railcar monitoring systems at least as early as 2007. *See, e.g.*, EX1007, ¶ [0086]. Other prior art references relied on in the Petition further support the fact that mesh networks were utilized in railcar monitoring systems and were well-known in the art years before the filing date of the ’223 Patent. *See, e.g.*, LeFebvre, EX1005, ¶¶ [0031]–[0032].

VI. LEVEL OF ORDINARY SKILL IN THE ART

A. Legal Principles

42. I have been informed that patents are considered from the perspective of a person having ordinary skill in the art, and that this is a hypothetical person who is presumed to know the relevant prior art.

43. I have been informed that the following five factors inform the analysis for determining the level of ordinary skill in the art: (1) type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field. I have also been informed that in a given case, every factor may not be present, and one or more factors may predominate. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). I apply these factors in the section below in providing my opinion as to the level of one having ordinary skill in the art.

B. Opinion as to the Level of a Person Having Ordinary Skill in the Art of the '223 Patent

44. I have knowledge relevant to what a person having ordinary skill in the art at the time of the invention would understand and do. In 2012, at the priority date of the '223 patent, I had 24 years of experience in this field and was a person having ordinary skill in the art.

45. In my opinion, and applying the factors set forth above in paragraph 43 above, a person of ordinary skill in the art at the time of the filing of the '223 patent would be 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, rotating equipment, or equivalent industrial equipment. It is my opinion that less work experience could be

compensated by a higher level of education, such as a master's degree, and vice versa.

VII. CLAIM CONSTRUCTION

A. Legal Principles

46. I have been informed that in a proceeding for *inter partes* review, claims terms in an unexpired patent are to be given their plain and ordinary meaning, as understood by a person having ordinary skill in the art, in view of the patents' specification. *See* 42 CFR § 42.100(b); 83 FR 51340; *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

B. Opinion of Claim Construction

47. I believe that all claim terms, for the purposes of *inter partes* review can be given their plain and ordinary meaning.

48. The Board need not construe the claims, and may give each and every term its plain and ordinary meaning, because the claims are invalid under the plain and ordinary meaning of each recited term.

VIII. SUMMARY OF THE PRIOR ART

49. I have been informed that each of Armitage, Barone, LeFebvre, Denny, and Provasnik are prior art to the '223 Patent under the law.

A. LeFebvre

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

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.* As I will explain in further detail below, LeFebvre's "control node" is a "communication management unit" in the parlance of the '223 Patent.

51. 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]. If a failure condition is detected, an alarm is wirelessly transmitted to a data processing system in a remote location. EX1005, ¶¶ [0038], [0052]. A PHOSITA would understand that the alarm is displayed to a human operator who can then take appropriate action.

B. Armitage

52. 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.

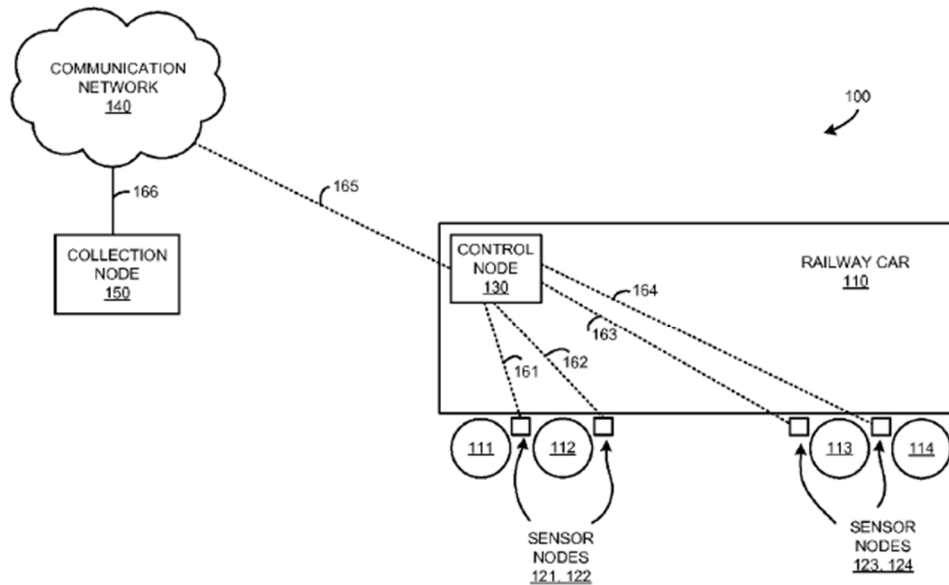


FIGURE 1

53. “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.* The system also includes a “control node” on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5. The control node is a “communication management unit” in the parlance of the ’223 Patent.

54. Data collected by the control unit is analyzed using heuristics to determine, for example, if a component failure is approaching or imminent. EX1006, ¶ [0027]. If a failure condition is detected, an alarm is wirelessly transmitted to a collection node in a remote location. EX1006, ¶ [0028]. A PHOSITA would understand that the alarm is displayed to a human operator who can then take appropriate action.

C. Barone

55. Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract. 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, such as Zigbee. *Id.*

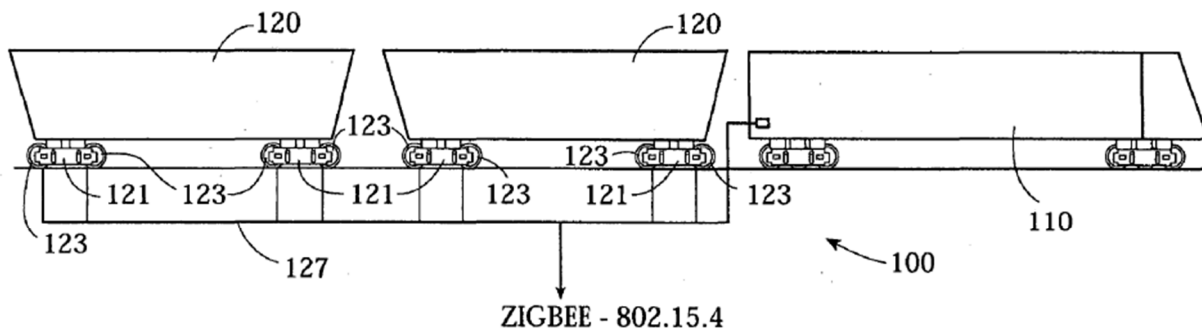


FIG. 1

56. The collected data is analyzed using heuristics to determine, for example, if a wheel bearing failure is approaching or imminent. EX1007, ¶¶ [0201]–[0220]. 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]. Figure 2 of Barone is reproduced below.

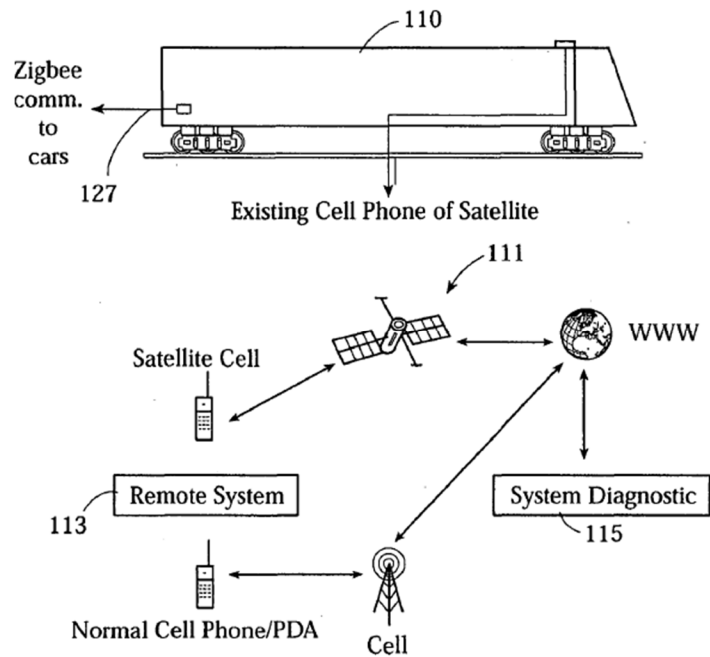


FIG. 2

D. Denny

57. Denny is directed to a temperature sensor for monitoring the temperature of a wheel assembly on a railway car. *See* EX1008; (57) Abstract. Denny uses an external temperature sensor located inside the wheel assembly (to obtain an accurate temperature reading), while its sensor housing is located outside the wheel assembly (to avoid exposing the sensitive electronic circuitry to extreme heat). *Id.* Specifically, Denny's device includes a temperature sensor 16 that is external to the housing 12. EX1008, 2:49-53, Figure 1:

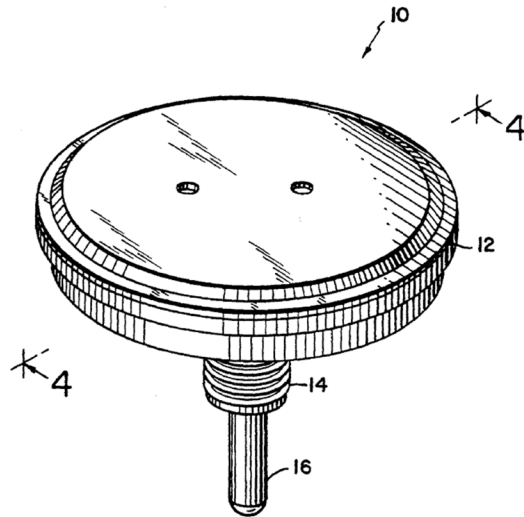


FIG. 1

Denny states the obvious fact that “[i]n order to obtain an accurate high temperature reading of a wheel assembly, the temperature sensor ... should, preferably, extend deep into the wheel assembly.” EX1008, 2:24–27. This concept would have been well-known and obvious to a PHOSITA.

58. Conversely, Denny’s sensor housing 12, which includes electronic circuitry, “is situated away from the outer surface of the wheel assembly so that the electronic circuit will not be subjected to heat from the wheel assembly and may freely dissipate heat produced by its own components.” EX1008, (57) Abstract. Again, this concept would have been well-known and obvious to a PHOSITA.

E. Provasnik

59. Provasnik discloses a temperature sensor that is magnetically attached to an engine block to measure its temperature. EX1009, 2:46–65. Provasnik states

that the advantage of using a magnet is that it permits the sensor to be readily attached to, and removed from, the metallic substrate. EX1009, 1:8–15, 1:38–44, 4:65-68. This is an extremely basic concept, and it would have been well-known and obvious to a PHOSITA. In my experience, magnetic attachments are commonly used in industry to attach sensors, such as temperature sensors or accelerometers, to metallic components in need of monitoring.

IX. OPINION ON GROUNDS OF UNPATENTABILITY

A. Legal Principles of Anticipation

60. I have been informed that, under 35 U.S.C. § 102, novelty is a requirement for patentability. I have further been informed that a patent claim lacks novelty and is anticipated when a single prior art reference discloses all the features of a claim and enables one of ordinary skill in the art to make and use the invention.

B. Legal Principles of Obviousness

61. I have been told that under 35 U.S.C. § 103(a), “[a] patent may not be obtained though the invention is not identically disclosed or described as set forth in Section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.”

62. When considering the issues of obviousness, I have considered each of the following “Graham factors”:

- (a) the scope and content of the prior art;
- (b) the differences between the prior art and the claims at issue;
- (c) the level of ordinary skill in the pertinent art
- (d) evidence of secondary indicia of non-obviousness (if available).

63. I have been told that the relevant time for considering whether a claim would have been obvious to a PHOSITA is the time of alleged invention.

64. I have been told that a reference may be modified or combined with other references or with the PHOSITA’s own knowledge if the person would have found the modification or combination obvious. A PHOSITA is presumed to know all relevant prior art, and the obviousness analysis may consider the inferences and creative steps that a PHOSITA would employ.

65. In determining whether a prior-art reference could have been combined with another prior-art reference or other information known to a person having ordinary skill in the art, I have been told that the following principles may be considered:

- (a) a combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;

- (b) the substitution of one known element for another is likely to be obvious if it yields predictable results;
- (c) the use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;
- (d) the application of a known technique to a prior art reference that is ready for improvement is likely obvious if it yields predictable results;
- (e) any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- (f) a person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and
- (g) the proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a “reasonable expectation of success”—not “absolute predictability” of success—in achieving the claimed invention by combining prior art references.

66. I have been told that whether a prior art reference renders a patent claim unpatentable as obvious is determined from the perspective of a PHOSITA. Further, I have been told that while there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, a suggestion to combine known elements to achieve the claimed

invention may come from the prior art as a whole or individually, as filtered through the knowledge of one skilled in the art. I have also been told that the inferences and creative steps a PHOSITA would employ are also relevant to the determination of obviousness.

67. I have been told that when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. If a PHOSITA can implement a predictable variation and would see the benefit of doing so, that variation is likely to be obvious. In many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. When there is a design need or market pressure and there are a finite number of predictable solutions, a PHOSITA has good reason to pursue those known options.

68. I have been told that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to combine references. But I also have been told that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. This test poses the question whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that yields the claimed invention and avoids impermissible hindsight analysis.

C. Ground 1: Claims 2–10, 18, 20, 21, 23, and 25–32 are unpatentable under 35 U.S.C. § 103(a) in view of LeFebvre

69. In my opinion, LeFebvre—as it would have been understood by a PHOSITA—discloses each and every limitation of claims 2–10, 18, 20, 21, 23, and 25–32. The claims therefore would have been obvious to a PHOSITA.

70. LeFebvre’s entire disclosure is directed to a railcar monitoring system. To the extent that LeFebvre can be viewed as disclosing different embodiments of a railcar monitoring system, those embodiments are very similar to one another, and share most if not all of the features recited by claims 2–10, 18, 20, 21, 23, and 25–32. In my opinion, a PHOSITA could have, and would have, combined the teachings of LeFebvre as set forth in detail below. It is also my opinion that a PHOSITA could have combined the teachings of LeFebvre as discussed below with a reasonable expectation of success.

71. It is also my opinion that LeFebvre provides an enabling disclosure of every element of these claims. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring systems and sensing/monitoring devices disclosed by LeFebvre) without undue experimentation. A PHOSITA could have followed the teachings of LeFebvre to arrive at the claimed systems and devices with a reasonable expectation of success.

72. More generally, the elements of claims 2–10, 18, 20, 21, 23, and 25–32 are all well-known in the art, and would have been fully understood by a PHOSITA. The art to which these claims are directed—systems and sensors for monitoring operational parameters of railcars—is predictable, involving simple mechanical components and widely available, off-the-shelf electronic components. For at least these reasons, it is my opinion that a PHOSITA could have made any required adjustments or modifications to LeFebvre’s disclosed systems and sensors with a reasonable expectation of success and without undue experimentation.

1. Independent Claim 2

a. Claim 2 Preamble: “A system for monitoring a railcar, comprising”

73. I have been informed by counsel that claim preambles are generally not limiting when the content of the claimed preamble is an “intended use.” I have been informed by counsel that preambles are generally statements of intended use when the body of a claim fully sets forth all the limitations of the claimed invention, and the preamble merely states the purpose or intended use of the invention. Here the preamble merely states “a system for monitoring a railcar.” In my opinion, this preamble is entirely a statement of intended use, and so should not be given patentable weight.

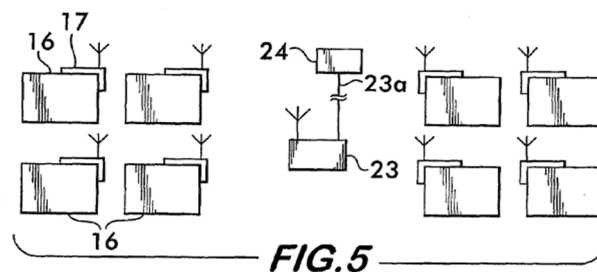
74. Even so, if the preamble was limiting, LeFebvre discloses the entire preamble. Specifically, LeFebvre discloses a railcar monitoring system comprising

a plurality of “instrumented, flexible pads,” each of which “contain sensors for monitoring temperature” and other parameters of the railcar. EX1005, (57) Abstract. Specifically, LeFebvre discloses a system comprising an instrumented pad 16 that contains one or more sensors, such as temperature sensors. EX1005, ¶¶ [0021], [0033], [0058]. LeFebvre teaches that temperature sensors can be used to monitor the temperature of railcar components, such as wheel bearings. EX1005, ¶¶ [0021], [0033], [0058].

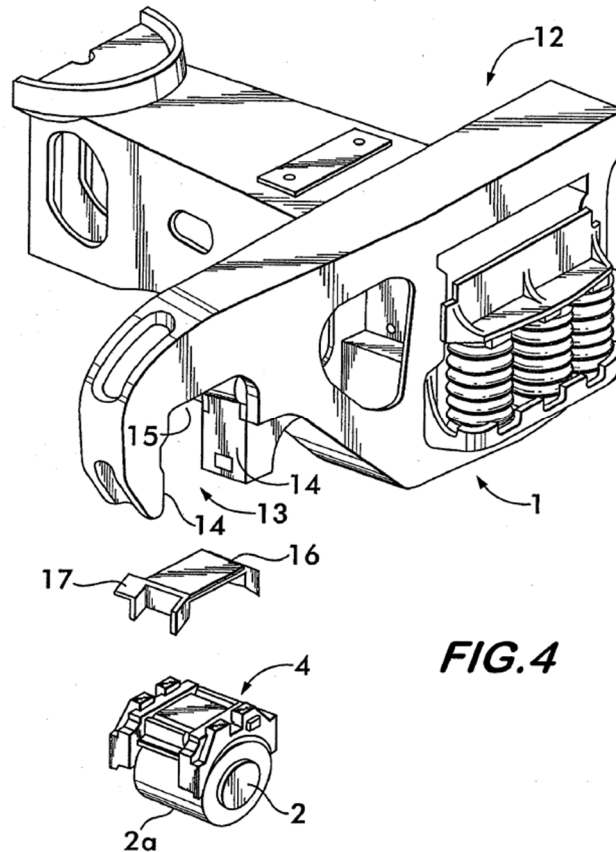
75. LeFebvre therefore discloses “a system for monitoring a railcar” as required by the preamble of claim 2.

b. Limitation 2(a): “a plurality of sensor devices located on the railcar for monitoring parameters or conditions of the railcar, each of said sensor devices being separate from one another and including a sensor for monitoring one of said parameters or conditions of the railcar”

76. LeFebvre discloses a system comprising a plurality of instrumented pads 16, each of which comprises one or more sensors. EX1005, ¶¶ [0019], [0023], [0052]. Figure 5 of LeFebvre depicts an exemplary embodiment with a plurality of instrumented pads 16. EX1005, ¶ [0039]. Figure 5 is reproduced below.



77. 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. [LeFebvre], ¶ [0019].



78. LeFebvre therefore discloses Limitation 2(a).

c. Limitation 2(b): “said plurality of sensor devices including at least one temperature sensor device having”

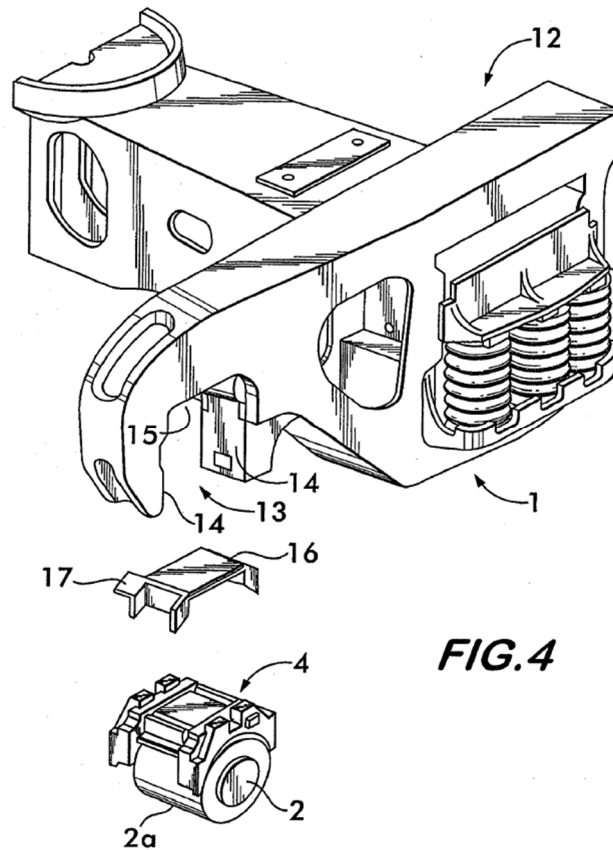
79. LeFebvre discloses that the instrumented pad 16 may comprise one or more temperature sensors. EX1005, (57) Abstract, ¶¶ [0021], [0033], [0058].

80. LeFebvre therefore discloses Limitation 2(b).

d. Limitation 2(c): “a housing”

81. LeFebvre discloses that the instrumented pad 16 “is preferably comprised of a cast or injected molded elastomeric polymer” (EX1005, ¶ [0019]), and “contains a plurality of sensors 5 which are preferably embedded into its upper, side, and lower surfaces or into other locations.” EX1005, ¶ [0021]. A PHOSITA would therefore understand that LeFebvre’s instrumented pad includes a housing—specifically, a housing made of an elastomeric polymer, which encompasses the sensors, processors, and other components of the instrumented pad.

82. LeFebvre also discloses that the housing is mounted on a railcar. Specifically, the instrumented pad **16** is formed to seat on the upper surface of a railcar’s bearing adapter **4**, which in turn seats on the railcar’s wheel bearing **2a**. EX1005, ¶ [0019]. This is shown in Figure 4 of LeFebvre, which I have reproduced below.



83. LeFebvre therefore discloses Limitation 2(c).

84. Additionally, while LeFebvre discloses a housing formed from a cast or injected molded elastomeric polymer, a POSITA would have understood that a wide variety of different housing configurations were possible. For example, a PHOSITA would have understood that the shape, size, or material of the housing could be changed (e.g., to accommodate mounting the sensor device in a different location on the railcar) without affecting the operation of the sensors or electronic circuitry contained within the housing.

85. Indeed, the '223 Patent itself states that “motes may be housed in alternative housings” and expressly acknowledges that “an adapter pad similar to

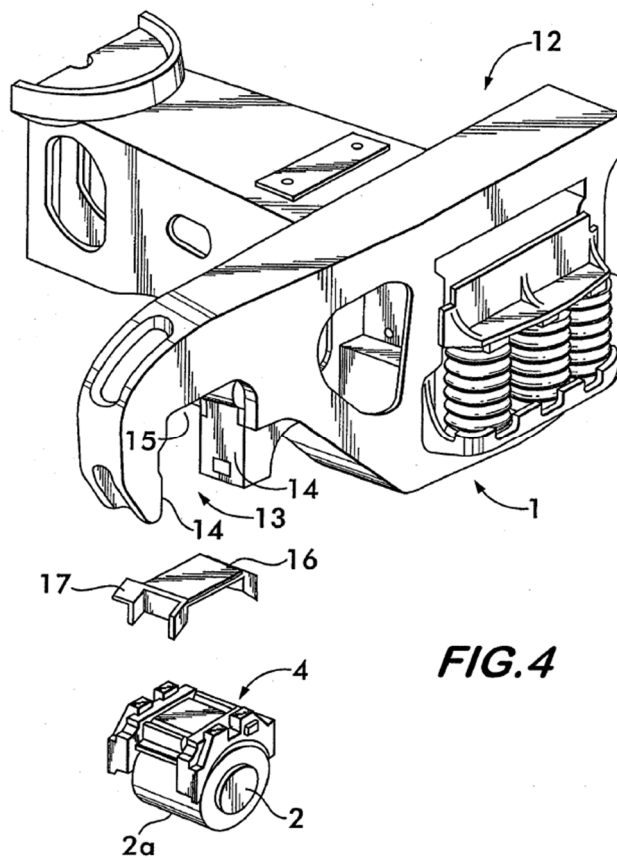
the type shown in U.S. Pat. Nos. 7,698,962 and **7,688,218**¹ ... could be adapted for use with the present invention.” EX1001, 15:18–24. The ’223 Patent itself therefore confirms that LeFebvre’s instrumented pad could be readily adapted to use a different type of housing, if desired.

86. Accordingly, if a PHOSITA wished to use a housing different from the flexible, elastomeric pad disclosed by LeFebvre, the selection of an appropriate housing would have been a straightforward, obvious design choice that could have been carried out without a reasonable expectation of success.

e. Limitation 2(d): “a temperature sensor in thermal communication with an item of the railcar for which the temperature is being monitored, which item is external to said housing”

87. LeFebvre discloses that the instrumented pad 16 may comprise one or more temperature sensors configured to monitor the temperature of a wheel bearing. EX1005, ¶ [0033]. The wheel bearing is external to the housing of instrumented pad 16. Specifically, the instrumented pad 16 is formed to seat on the upper surface of a bearing adapter 4, which in turn seats on the wheel bearing 2a. EX1005, ¶ [0019]. This is shown in Figure 4 of LeFebvre, which I have reproduced below.

¹ As noted above, U.S. 7,688,218 issued from the cited LeFebvre publication.

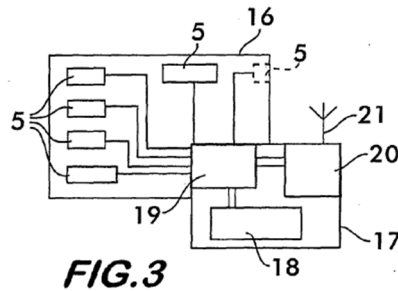


88. LeFebvre therefore discloses Limitation 2(d).

f. Limitation 2(e): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

89. LeFebvre discloses that the instrumented pad 16 comprises electrical circuitry, specifically: “a power source 18, an analog/signal conditioning means and analog to digital conversion means and an associated microprocessor unit 19 and a communications unit 20.” EX1005, ¶ [0021].

90. This electrical circuitry is located within the housing of the sensor device, and preferably within extended attachment portion 17. EX1005, ¶ [0021]. This is shown in Figure 3 of LeFebvre, which I have reproduced below.



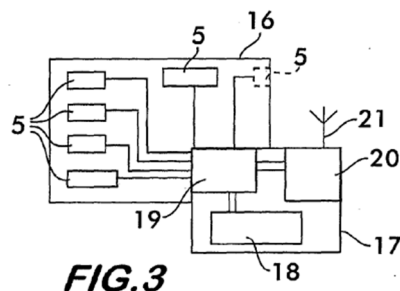
91. A PHOSITA would understand that this electrical circuitry is in communication with the temperature sensor. For example, LeFebvre states that “[t]he sensors are electrically connected to the analog to digital conversion circuit unit and the microprocessor unit which, in turn, is connected to and controls the communications unit.” EX1005, ¶ [0021].

92. LeFebvre therefore discloses Limitation 2(e).

g. Limitation 2(f): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

93. LeFebvre discloses that the instrumented pad 16 comprises a power source 18, which is electrically connected to the electrical circuitry. EX1005, ¶¶ [0021], [0023]. The power source may be, for example, a battery. EX1005, ¶¶ [0021], [0022], [0030]. LeFebvre also discloses that the power source may be

contained within the housing. For example, power source 18 may be contained within extended portion 17, as shown in Figure 3. EX1005, ¶ [0021], Fig. 3.



94. LeFebvre therefore discloses Limitation 2(f).

h. Limitation 2(g): “a communication device capable of broadcasting information regarding the temperature sensed via wireless communication, said communication device positioned within said housing”

95. LeFebvre discloses that the instrumented pad 16 comprises a communications unit 20. EX1005, ¶¶ [0021], [0023]. The communications unit is preferably a radio transmitter/receiver, which is capable of wirelessly broadcasting the information received from one or more sensors. EX1005, ¶¶ [0021], [0023]. Further confirmation is provided by paragraphs [0031]–[0032] and [0043]–[0046] of LeFebvre, which provide details regarding the specific wireless networking protocols that may be employed.

96. LeFebvre also discloses that the communications unit may be contained within the housing. For example, communications unit 20 may be contained within extended portion 17, as shown in Figure 3. EX1005, ¶ [0019], Fig. 3.

provide two-way communications. *See* EX1005, ¶ [0039] (messages are “passed between pads on their way *to and from* the digital communications unit 23”).

100. Although their features are described separately, LeFebvre discloses that “the data control unit and the communications device may be contiguous.” EX1005, ¶ [0024]. LeFebvre later states that “[i]ndeed, the two devices may well be combined or their functions shared so that the distinction could become unnecessary.” EX1005, ¶ [0068]. A PHOSITA would therefore understand that LeFebvre’s system can include *either* a separate “data control unit” and “communications device,” *or* a single component that performs both functions. A PHOSITA would therefore understand that LeFebvre’s data control unit 23 and communication device 24 constitute a “communication management unit having a wireless communication device” in the parlance of the ’223 Patent.

101. Additional evidence, which confirms this understanding of LeFebvre’s disclosure, is provided by the ’713 Application (EX1014). The ’713 Application admits that LeFebvre discloses a CMU having the required architecture:

The CMU includes a wireless communication device 68*a* for communicating with remote receivers 78. In one preferred embodiment, it can also communicate with, control and/or monitor other devices on the railcar 10. An example of such a device and system is described in U.S.

Pat. No. 7,688,218² which is incorporated herein by reference.

EX1014, ¶ [0027]. This passage is incorporated by reference into the '223 Patent. EX1001, 1:6–9. The '223 Patent itself thus states that LeFebvre discloses a CMU. In my opinion, this provides additional confirmation that a PHOSITA would understand the disclosure of LeFebvre as I have described it above.

102. LeFebvre therefore discloses Limitation 2(h).

j. Claim 2 is obvious over LeFebvre

103. LeFebvre therefore discloses or renders obvious every element of independent claim 2, in detail, and in the same arrangement as required by the claim.

104. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 2. LeFebvre's disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre's invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. Specifically, by following the straightforward disclosure of

² I have been informed that U.S. 7,688,218 is the issued patent corresponding to LeFebvre.

LeFebvre, a PHOSITA could have implemented a working system that meets every limitation of claim 2 without inventive effort.³

105. To the extent that different elements of claim 2 are described in different portions of LeFebvre’s specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above.

106. It is therefore my opinion that claim 2 is obvious over LeFebvre.

2. Dependent Claim 3: “The system of claim 2 wherein said communication management unit can make a determination of an alarm condition based on data collected by two or more of said sensor devices.”

107. LeFebvre discloses a communications management unit—specifically, data control unit 23—that (a) collects data from a plurality of sensor devices located on the same railcar, and (b) uses heuristics to determine actual, potential, or imminent failures based on a statistical analysis of the collected data.

108. 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]. And as I have discussed above with respect to

³ Based upon my experience, a company *could* spend a great deal of time and effort to build an *optimized* railcar monitoring system that is ready for sale in a competitive marketplace. But that additional effort (e.g., fine-tuning the sensor units to provide an optimal balance of accuracy, reliability, and ease of maintenance), while helpful for a commercial product, is beyond the scope of what is required by the challenged claims of the ’223 Patent.

Limitation 2(a) and Limitation 2(b), each of the instrumented pads contains one or more sensors that collect data about the railcar. *See* Sections IX.C.1.b and IX.C.1.c, above.

109. The data control unit then uses “inference engine techniques”—or “heuristics,” in the parlance of the ’223 Patent—to analyze the collected data. EX1005, ¶¶ [0036], [0056], [0095]. “As an aggregator of information, it 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]. “When serious trouble is inferred, then messages are sent via the communications link **23a**, **24** to the locomotive, etc.” *See also* EX1005, ¶ [0095]. A PHOSITA would have understood that these messages, which report “serious trouble,” are reporting an “alarm condition” in the parlance of the ’223 Patent.

110. The “inference engine” techniques used by the data control unit include, for example, statistical analysis of the collected data. EX1005, ¶¶ [0058]–[0066]. For example, 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.” Ex. 1005, ¶¶ [0060]–[0061]. Similarly, the data control unit may detect track defects by “[m]onitoring the vertical loads in the instrumented pads and comparing these between wheel sets.” Ex. 1005, ¶ [0066].

111. As discussed above, a PHOSITA would understand that in LeFebvre’s system, the data control unit is ultimately responsible for determining the presence of an alarm condition that relates to the railcar as a whole. Ex. 1005, ¶ [0095]. Additionally, if an alarm condition is present, the data control unit is responsible for sending an alarm message upstream (i.e., to the locomotive and/or a remote data handling location). *Id.*

112. LeFebvre therefore discloses or renders obvious every element of dependent claim 3.

3. Dependent Claim 4: “The system of claim 2 wherein each of said plurality of sensor devices is capable of exchanging data with other of said plurality of sensor devices and with said communication management unit.”

113. 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.

114. 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]. The wireless networking protocol may be a mesh networking protocol conforming to the IEEE802.15.4 standard, such as Zigbee. EX1005, ¶ [0031].

115. LeFebvre therefore discloses or renders obvious every element of dependent claim 4.

4. Independent Claim 5

a. Claim 5 Preamble: “A system for monitoring the operation of a railcar comprising”

116. *See* Claim 2 Preamble, Section IX.C.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 5 Preamble is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 73–75 above also reflect my opinions with respect to the Claim 5 Preamble, and are incorporated here by reference.

b. Limitation 5(a): “a. one or more sensor units mounted on said railcar, each of said sensor units monitoring an operating parameter of said railcar wherein each of said sensor units comprises”

117. *See* Limitation 2(a), Section IX.C.1.b above. For the same reasons I have discussed above with respect to Limitation 2(a), it is my opinion that Limitation 5(a) is also fully disclosed by LeFebvre. Specifically, the opinions I

have expressed in paragraphs 76–78 above also reflect my opinions with respect to Limitation 5(a), and are incorporated here by reference.

c. Limitation 5(b): “a sensor”

118. *See* Limitation 2(b), Section IX.C.1.c above. For the same reasons I have discussed above with respect to Limitation 2(b), it is my opinion that Limitation 5(b) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 79–80 above also reflect my opinions with respect to Limitation 5(b), and are incorporated here by reference.

d. Limitation 5(c): “a power source”

119. *See* Limitation 2(f), Section IX.C.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 5(c) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 93–94 above also reflect my opinions with respect to Limitation 5(c), and are incorporated here by reference.

e. Limitation 5(d): “a processor”

120. LeFebvre discloses that the instrumented pad 16 comprises a microprocessor unit 19. EX1005, ¶ [0021]. Specifically, each instrumented pad may contain its own microprocessor and radio. EX1005, ¶ [0039].

121. LeFebvre therefore discloses Limitation 5(d).

f. Limitation 5(e): “memory”

122. LeFebvre discloses that each instrumented pad contains non-volatile memory, which is used to store certain identifying information. EX1005, ¶ [0070].

123. Additionally, although not expressly disclosed by LeFebvre, a PHOSITA would understand that each instrumented pad must use memory to store data collected from its sensors. Each instrumented pad must also include memory that stores the software code to be executed by the microprocessor 19.

Alternatively, it would have been obvious to include memory for these purposes.

124. LeFebvre therefore discloses Limitation 5(e).

g. Limitation 5(f): “communication circuitry”

125. *See* Limitation 2(g), Section IX.C.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 5(f) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 95–97 above also reflect my opinions with respect to Limitation 5(f), and are incorporated here by reference.

h. Limitation 5(g): “b. a communication management unit, mounted on said railcar, said communication management unit in wireless communication with said one or more sensor units”

126. *See* Limitation 2(h), Section IX.C.1.i above. For the same reasons I have discussed above with respect to Limitation 2(h), it is my opinion that Limitation 5(g) is also fully disclosed by LeFebvre. Specifically, the opinions I

have expressed in paragraphs 98–102 above also reflect my opinions with respect to Limitation 5(g), and are incorporated here by reference.

i. Limitation 5(h): “wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units”

127. *See* Dependent Claim 3, Section IX.C.2 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is my opinion that Limitation 5(h) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 107–112 above also reflect my opinions with respect to the Limitation 5(h), and are incorporated here by reference.

j. Limitation 5(i): “(a) to determine if an actual failure exists”

128. 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]. 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]. A PHOSITA would understand that, for example, a shelled wheel tread is an “actual failure” within the meaning of Limitation 5(i). My discussion of heuristics in Dependent Claim 3, Section IX.C.2 above and Dependent Claim 6, Section IX.C.5 below, is also incorporated here by reference.

129. LeFebvre therefore discloses Limitation 5(i).

k. Limitation 5(j): “(b) to predict potential or imminent failures based on a statistical analysis of said collected data”

130. LeFebvre 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]. 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 “[i]dentifying a failing bearing in its early stages is important in preventative maintenance programs.” *Id.* A PHOSITA would understand that “identifying a failing bearing in its early stages” (the language used by LeFebvre) is the same as “predict[ing] potential or imminent failure” of the wheel bearing (the language used by Limitation 5(j)).

131. LeFebvre therefore discloses Limitation 5(j).

132. Additionally, while LeFebvre discloses several examples of heuristics that can be used to detect wheel bearing failure, a PHOSITA would not have been limited to only those heuristic techniques disclosed by LeFebvre. To the contrary, techniques for predicting wheel bearing failures using statistical analysis of collected data (e.g., accelerometer data) have been publicly known for decades,

and would have been well understood by a PHOSITA prior to the effective filing date of the '223 Patent.

133. For example, Barone discloses a detailed algorithm for detecting wheel bearing defects that comprises applying a discrete Fourier transform to data collected from an accelerometer sensor. EX1007, ¶¶ [0201]–[0220]. While Barone was published in 2007, it notes that the underlying statistical analysis techniques were known as early as the 1940s. EX1007, ¶ [0248].

134. A PHOSITA would therefore have understood that a variety of statistical analysis techniques—including, but not limited to those expressly disclosed by LeFebvre—could be used to analyze collected data for signs of imminent or future bearing failure.

I. Claim 5 is obvious over LeFebvre

135. LeFebvre therefore discloses or renders obvious every element of independent claim 5, in detail, and in the same arrangement as required by the claim.

136. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 5. LeFebvre's disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre's invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 5 are

described in different portions of LeFebvre’s specification, a PHOSITA would have immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above.

137. It is therefore my opinion that claim 5 is obvious over LeFebvre.

5. Dependent Claim 6: “The system of claim 5 wherein said determination of an alarm condition can be made by one of said sensor units.”

138. Claim 6 refers to “said determination of an alarm condition.” I note that claim 5 (from which claim 6 depends) does not refer to an “alarm condition.” For the purposes of this opinion, I have been asked to assume that claim 6 encompasses *any* determination of an alarm condition that may be performed by the sensor unit.

139. LeFebvre discloses that its instrumented pad—a “sensor unit” in the parlance of the ’223 Patent—can use heuristics to determine the presence of an alarm condition. EX1005, ¶¶ [0054]–[0055]. 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., truck hunting, swaying, track defects). EX1005, ¶ [0054]. 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].

140. LeFebvre therefore discloses or renders obvious every element of dependent claim 6.

6. Dependent Claim 7: “The system of claim 5 wherein said determination of an alarm condition can be made by said communication management unit based on data collected by two or more of said sensor units.”

141. *See* Dependent Claim 3, Section IX.C.2 above and Dependent Claim 6, Section IX.C.5 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is also my opinion that each limitation of Dependent Claim 7 is fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 107–112 and 138–140 above also reflect my opinions with respect to Dependent Claim 7, and are incorporated here by reference.

7. Dependent Claim 8

a. Limitation 8(a) “The system of claim 5 wherein each of said sensor units comprises: a. a sensor; b. a power source; c. a processor; d. memory; e. communications circuitry; and f. software, stored in said memory and executed by said processor”

142. In LeFebvre’s system, each instrumented pad—a “sensor unit” in the parlance of the ’223 Patent—comprises:

- one or more sensors (*see* Limitation 2(a), Section IX.C.1.b above),
- a power source (*see* Limitation 2(f), Section IX.C.1.g above),
- a processor (*see* Limitation 5(d), Section IX.C.4.e above),
- memory (*see* Limitation 5(e), Section IX.C.4.h above),

- and communications circuitry (see Limitation 2(g), Section IX.C.1.h above).

143. LeFebvre also discloses that each instrumented pad performs various computational functions, such as collecting data from sensors, analyzing it to determine whether an alarm condition exists, and transmitting messages upstream to the data control unit. *See* Dependent Claim 6, Section IX.C.5 above.

Accordingly a PHOSITA would understand that each instrumented pad comprises software that is executed by the microprocessor to carry out these functions.

EX1005, ¶¶ [0034]–[0035], Claim 22., A PHOSITA would understand that this software would be stored in memory accessible by the microprocessor on the instrumented pad.

144. The instrumented pad therefore contains software that is stored in memory and is executed by the microprocessor as required by Limitation 8(a).

b. Limitation 8(b): “said software performing the functions of collecting data from said sensor at periodic intervals”

145. LeFebvre manages the power consumption of the instrumented pad by periodically placing the device into a low-power, or “standby,” state. EX1005, ¶¶ [0034]–[0035]. “[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 data control unit 23.” EX1005, ¶ [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.” EX1005, ¶ [0035].

146. A PHOSITA would therefore understand that the microprocessor awakens at periodic intervals to process sensor data and, if appropriate, initiate a radio transmission. EX1005, ¶ [0034]. Further confirmation is provided by claim 22 of LeFebvre, which claims “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.”

147. LeFebvre therefore discloses or renders obvious every element of dependent claim 8.

8. Dependent Claim 9

a. Limitation 9(a): “The system of claim 8 wherein said software further performs the function of: assessing the collected data to determine if an alarm condition exists”

148. LeFebvre discloses that each instrumented pad collects data from its associated sensors, uses heuristics to analyze the collected data, and determines whether an alarm condition is present. I have explained this in detail above in Dependent Claim 6, Section IX.C.5 above and Limitation 8(a), Section IX.C.7.a above, which are incorporated here by reference. A PHOSITA would understand

that the functions recited in Limitation 9(a) are carried out by the software that is executed on the microprocessor within each instrumented pad.

b. Limitation 9(b): “and communicating said alarm condition to said communication management unit via said communications circuitry”

149. Each instrumented pad contains communications circuitry. I have explained this in detail above in Limitation 2(g), Section IX.C.1.h above, which is incorporated here by reference. 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].

c. Limitation 9(c): “and managing the power consumption of said sensor unit by placing said sensor unit in a standby state and periodically awakening said sensor unit to collect data from said sensor and to transmit information regarding said operating parameter to said communication management unit via said communication circuitry”

150. *See* Limitation 8(b), Section IX.C.7.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Limitation 9(c) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 145–147 above also reflect my opinions with respect to Limitation 9(c), and are incorporated here by reference.

151. LeFebvre therefore discloses or renders obvious every element of dependent claim 9.

9. Dependent Claim 10: “The system of claim 5 wherein said one or more sensor units and said communication management unit are in wireless

communication with each other and form a local area wireless network for said railcar”

152. *See* Dependent Claim 4, Section IX.C.3 above. For the same reasons I have discussed above with respect to Dependent Claim 4, it is also my opinion that each limitation of Dependent Claim 10 is fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 113–115 above also reflect my opinions with respect to Dependent Claim 10, and are incorporated here by reference.

10. Dependent Claim 18: “The system of claim 5 wherein said sensor is selected from a group consisting essentially of temperature sensors, pressure sensors, strain sensors, load cell sensors, hand brake position sensors, magnetic sensors, vibration sensors, gyroscopes, acceleration sensors, hall effect sensors, piezio resistive microphones and switches.”

153. LeFebvre discloses that the sensor may be a temperature sensor. I have explained this in detail above in Limitation 2(b), Section IX.C.1.c above, which is incorporated here by reference. LeFebvre also disclose handbrake sensors (EX1005, ¶ [0065]) and “acceleration, stress, strain pressure, [and] force” sensors. (Claim 30). It is also my opinion that the other types of sensors listed in claim 18 are obvious, common sensors for use in monitoring rotating elements (on railcars specifically, and in industrial applications generally).

154. LeFebvre therefore discloses or renders obvious every element of dependent claim 18.

11. Dependent Claim 20: “The system of claim 5 wherein said alarm is determined using distributed event processing based on a comparison between current data and statistical models of behavior.”

155. 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.” EX1005, ¶ [0053]. LeFebvre teaches that “part 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.” EX1005, ¶ [0053].

156. LeFebvre teaches that the presence of an alarm condition may be “inferred” from a statistical analysis of the collected data. EX1005, ¶¶ [0054], [0058]–[0066]. For example, with respect to wheel bearing temperature, LeFebvre’s instrumented pad “monitors relative changes in temperature against other bearings and provides an alarm threshold or long term trends to link to bearing condition.” EX1005, ¶ [0058]. More generally, LeFebvre teaches that data collected from sensors can be compared with statistical models to infer the presence of bearing defects (¶ [0059]), wheel defects (¶ [0060]), wheel derailment (¶ [0061]), truck hunting (¶ [0062]), a displaced roller bearing adapter (¶ [0064]), and brake performance and status (¶ [0065]), among others. A PHOSITA would therefore understand that LeFebvre’s system makes a comparison between (a) the

statistical model (i.e., the expected trend) and (b) the actual data, and raises an alarm if the actual data falls outside the expected range predicted by the model.

157. LeFebvre therefore discloses or renders obvious every element of dependent claim 20.

12. Dependent Claim 21: “The system of claim 5 wherein said alarms are determined based on a comparison of currently collected data versus data collected over a pre-determined preceding time period.”

158. 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 generate a “long term trend,” recently collected data must, necessarily, be compared with data collected during one or more earlier, predetermined time periods. This would be fully understood by a PHOSITA.

159. A PHOSITA would therefore understand that LeFebvre discloses that an alarm condition may be determined by comparing currently collected data versus data collected over a predetermined preceding time period. Specifically, a PHOSITA would understand that LeFebvre’s system makes a *comparison* between (a) previously collected data and (b) currently collected data, and raises an alarm if the currently collected data falls outside the expected range predicted by the “long term trend.”

160. LeFebvre therefore discloses or renders obvious every element of dependent claim 21.

13. Independent Claim 23

a. Claim 23 Preamble: “A monitoring device for monitoring temperature on a railcar, comprising”

161. *See* Claim 2 Preamble, Section IX.C.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 23 Preamble is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 73–75 above also reflect my opinions with respect to the Claim 23 Preamble, and are incorporated here by reference.

b. Limitation 23(a): “a housing mountable on a railcar”

162. *See* Limitation 2(c), Section IX.C.1.d above. For the same reasons I have discussed above with respect to Limitation 2(c), it is my opinion that Limitation 23(a) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 81–86 above also reflect my opinions with respect to Limitation 23(a), and are incorporated here by reference.

c. Limitation 23(b): “a temperature sensor configured to be in thermal communication with a portion of the railcar to be monitored for temperature, which portion is external to said housing”

163. *See* Limitation 2(d), Section IX.C.1.e above. For the same reasons I have discussed above with respect to Limitation 2(d), it is my opinion that Limitation 23(b) is also fully disclosed by LeFebvre. Specifically, the opinions I

have expressed in paragraphs 87–88 above also reflect my opinions with respect to Limitation 23(b), and are incorporated here by reference.

d. Limitation 23(c): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

164. *See* Limitation 2(e), Section IX.C.1.f above. For the same reasons I have discussed above with respect to Limitation 2(e), it is my opinion that Limitation 23(c) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 89–92 above also reflect my opinions with respect to Limitation 23(c), and are incorporated here by reference.

e. Limitation 23(d): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

165. *See* Limitation 2(f), Section IX.C.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 23(d) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 93–94 above also reflect my opinions with respect to Limitation 23(d), and are incorporated here by reference.

f. Limitation 23(e): “a communication device capable broadcasting information regarding the temperature sensed, said communication device positioned within said housing”

166. *See* Limitation 2(g), Section IX.C.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 23(e) is also fully disclosed by LeFebvre. Specifically, the opinions I

have expressed in paragraphs 95–97 above also reflect my opinions with respect to Limitation 23(e), and are incorporated here by reference.

g. Limitation 23(f): “wherein the power consumption of said monitoring device is managed by placing said monitoring device in a standby state and periodically awakening said monitoring device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry”

167. *See* Limitation 8(b), Section IX.C.7.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Limitation 23(f) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 145–147 above also reflect my opinions with respect to Limitation 23(f), and are incorporated here by reference.

h. Claim 23 is obvious over LeFebvre

168. LeFebvre therefore discloses or renders obvious every element of independent claim 23, in detail, and in the same arrangement as required by the claim.

169. Additionally, it is my opinion that LeFebvre provides an enabling disclosure of every element of claim 23. LeFebvre’s disclosure is sufficiently detailed that a PHOSITA could have practiced LeFebvre’s invention (i.e., could have implemented the railcar monitoring system disclosed by LeFebvre) without undue experimentation. To the extent that different elements of claim 23 are described in different portions of LeFebvre’s specification, a PHOSITA would have

immediately understood—based upon the disclosure of LeFebvre—that they could be combined in the manner I have described above.

170. It is therefore my opinion that claim 23 is obvious over LeFebvre.

14. Dependent Claim 25: “The monitoring device of claim 23 wherein said circuitry is configured to apply heuristics to analyze data collected from said temperature sensor to determine if a problem exists.”

171. *See* Dependent Claim 6, Section IX.C.5 above. For the same reasons I have discussed above with respect to Dependent Claim 6, it is my opinion that Dependent Claim 25 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 138–140 above also reflect my opinions with respect to Dependent Claim 25, and are incorporated here by reference.

15. Dependent Claim 26

a. Limitation 26(a): “The system of claim 2 wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor devices”

172. *See* Dependent Claim 3, Section IX.C.2 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is my opinion that Limitation 26(a) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 107–112 above also reflect my opinions with respect to Limitation 26(a), and are incorporated here by reference.

b. Limitation 26(b): “(a) to determine if an actual failure exists”

173. *See* Limitation 5(i), Section IX.C.4.j above. For the same reasons I have discussed above with respect to Limitation 5(i), it is my opinion that

Limitation 26(b) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 128–129 above also reflect my opinions with respect to Limitation 26(b), and are incorporated here by reference.

c. Limitation 26(c): “(b) to predict potential or imminent failures based on a statistical analysis of said collected data”

174. *See* Limitation 5(j), Section IX.C.4.k above. For the same reasons I have discussed above with respect to Limitation 5(j), it is my opinion that Limitation 26(c) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 130–134 above also reflect my opinions with respect to Limitation 26(c), and are incorporated here by reference.

175. LeFebvre therefore discloses or renders obvious every element of dependent claim 26.

16. Dependent Claim 27

a. Limitation 27(a): “The system of claim 2 further comprising a second temperature sensor located on said railcar for measuring ambient air temperature”

176. LeFebvre discloses that the railcar may comprise a second temperature sensor for monitoring the ambient air temperature. EX1005, ¶ [0037]. 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].

177. More generally, a PHOSITA would have understood that it was a very common and widespread practice to include an ambient temperature sensor in any application where temperature monitoring is desired. Ambient temperature sensors are commonly used to provide a sanity check (e.g., to detect outliers or faulty temperature sensors), to calibrate temperature sensors, or to determine a temperature *difference* relative to ambient (which is frequently a more meaningful measurement than the absolute temperature of a component).

b. Limitation 27(b): “wherein said system uses information obtained from said second temperature sensor about the ambient temperature to calibrate the temperature data received from said first sensor regarding the item of the railcar being monitored.”

178. LeFebvre does not expressly state that the system uses information from the ambient temperature sensor to calibrate data received from the temperature sensors on the instrumented pads. However, LeFebvre teaches that the ambient temperature measurement may be 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 may be sent from the data control unit to the instrumented pads.

EX1005, ¶ [0093].

179. A PHOSITA would have understood that information about ambient temperature is useful to calibrate readings from temperature sensors, particularly in an outdoor environment. Indeed, the only plausible reason that LeFebvre’s system

would transmit information about ambient temperature to the instrumented pads (see EX1005, ¶ [0093]) is for precisely this purpose. Alternatively, it would have been obvious for a PHOSITA to have incorporated this feature into LeFebvre's system. The ambient (i.e., outdoor) temperature will directly affect the temperature of wheel bearings on a railcar. A PHOSITA would have understood that this effect should be taken into account in order to reliably collect temperature data from wheel bearings that are exposed to a variety of temperatures and weather conditions.

180. It is therefore my opinion that LeFebvre, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 27.

17. Dependent Claim 28: “The system of claim 2 wherein said communicating management unit is capable of communicating data and alarms to a remote location located off of the train of which the railcar is a part.”

181. LeFebvre discloses that the data control unit—a communication management unit, in the parlance of the '223 Patent—transmits data and alarm messages to a remote location.

182. In discussing the purpose of its disclosed system, LeFebvre states that “an alarm message must get through from any railcar to the locomotive or to the remote data handling service as quickly as possible, preferably within a few seconds.” EX1005, ¶ [0052]. LeFebvre's system achieves this goal by wirelessly

transmitting alarm messages, and accompanying data, from the data control unit to a remote location. Specifically, “the 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]. *See* Limitation 2(h), Section IX.C.1.i above, which is incorporated here by reference.

183. LeFebvre’s claims also disclose that the data control unit wirelessly transmits alarm messages and data to a remote location.

- Claim 4 states that “said data collection, evaluation and communications means includes a wireless transmitter for transmission of said signals to said remotely located receiver.”
- Claim 9 states that the system comprises a “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.”
- Claim 21 states that the system comprises a means for “communicating said signals of vibration level indicative of potential failure to said remote location.”
- And claim 22 states that the data control unit comprises “means for receiving said signals of potential failure and transmitting said signals

to a remote location representative of said indications of potential failure.”

184. LeFebvre therefore discloses or renders obvious every element of dependent claim 28.

18. Dependent Claim 29: “The system of claim 2 wherein the power consumption of each of said sensor devices is managed by placing each said sensor device in a standby state and periodically awakening said sensor device to collect readings from said sensor device and to transmit the information regarding the parameter or condition being sensed via said communication circuitry.”

185. *See* Limitation 8(b), Section IX.C.7.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Dependent Claim 29 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 145–147 above also reflect my opinions with respect to Dependent Claim 29, and are incorporated here by reference.

19. Dependent Claim 30: “The system of claim 2 wherein said communication management unit and said plurality of sensor devices form a wireless mesh network for said railcar.”

186. *See* Dependent Claim 4, Section IX.C.3 above. For the same reasons I have discussed above with respect to Dependent Claim 4, it is my opinion that Dependent Claim 30 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 113–115 above also reflect my opinions with respect to Dependent Claim 30, and are incorporated here by reference.

20. Dependent Claim 31: “The system of claim 5 wherein the power consumption of each of said sensing units is managed by placing each sensing unit in a standby state and periodically awakening said sensing unit to collect readings from said sensor and to transmit information via said communications circuitry.”

187. *See* Limitation 8(b), Section IX.C.7.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Dependent Claim 31 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 145–147 above also reflect my opinions with respect to Dependent Claim 31, and are incorporated here by reference.

21. Dependent Claim 32: “The system of claim 5 wherein said communication management unit is capable of communicating with a remote location located off of a train of which said railcar is a part.”

188. *See* Dependent Claim 28, Section IX.C.17 above. For the same reasons I have discussed above with respect to Dependent Claim 28, it is my opinion that Dependent Claim 32 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 181–184 above also reflect my opinions with respect to Dependent Claim 32, and are incorporated here by reference.

D. Ground 2: Claims 13–17, 22, and 24 are unpatentable under 35 U.S.C. § 103(a) as obvious over LeFebvre in view of Barone.

1. Motivation to Combine LeFebvre and Barone

189. 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. Specifically:

- Like LeFebvre, Barone is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1007, (57) Abstract.
- 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. EX1007, (57) Abstract. In both references, the wireless mesh network preferably conforms to the IEEE 802.15.4 “Zigbee” standard. EX1007, ¶ [0086].
- 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].
- 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].

190. A PHOSITA therefore would have understood that LeFebvre and Barone are analogous art. LeFebvre and Barone solve the same problem using the same components in the same way. They are extremely similar references that

describe extremely similar systems for monitoring the condition of wheels and wheel bearings on railcars. Because they are both directed to the same subject matter, a PHOSITA would have been motivated to consider the teachings of both references. A PHOSITA also would have understood that because the systems, methods, and devices described in the references are so similar, their teachings could be combined with a reasonable expectation of success.

191. My opinions with respect to particular claims are set forth in more detail below.

2. Dependent Claim 13

a. Limitation 13(a): “The system of claim 5 further comprising a base unit, said base unit being in wireless communication with said communication management unit”

192. For the purposes of my analysis of claim 13, I have been instructed to consider a “base unit” to be a device or component that is located either in the locomotive or in a remote location, and which wirelessly communicates with a CMU.

193. LeFebvre discloses that its data control units (i.e., a CMU) may communicate with a base unit located (i) in the locomotive, and/or (ii) at a central data handling facility in a remote location. EX1005, ¶ [0038]. The data control unit may communicate with the base unit via, for example, “a cellular or satellite radio system.” EX1005, ¶ [0025]. LeFebvre explains that because wheel or bearing

failures “could lead very quickly to a catastrophic failure of the train,” a PHOSITA would have been motivated “to monitor and report exceptions to the locomotive or to a central data handling facility [i.e., a base unit] as quickly as possible.”

EX1005, ¶ [0003]. I have explained this in detail above with respect to Dependent Claim 28, Section IX.C.17 above, which is incorporated here by reference.

b. Limitation 13(b): “said based unit performing the functions of: a. collecting data and alarms from said communication management unit”

194. LeFebvre discloses that its data control unit (i.e., the CMU) transmits alarms and collected data to the base unit. Specifically, LeFebvre notes that because individual wheel or bearing failures “could lead very quickly to a catastrophic failure of the train, it is desirable to monitor and report exceptions to the locomotive or to a central data handling facility as quickly as possible.”

EX1005, ¶ [0003]. “An alarm message must get through from any railcar to the locomotive or to the remote data handling service as quickly as possible, preferably within a few seconds.” EX1005, ¶ [0052]. To achieve this goal, LeFebvre’s data control unit (i.e., the CMU) determines whether “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 [i.e., a base unit] is needed. If so, then the report can be sent.” EX1005, ¶ [0095]. A PHOSITA would therefore understand that the base unit—such as LeFebvre’s “remote data handling service”—collects data and alarms from the CMU (LeFebvre’s data control unit).

c. Limitation 13(c): “b. displaying alarm conditions raised by said communication management unit”

195. LeFebvre discloses that its base unit displays alarm conditions raised by the CMU. 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. In other words: LeFebvre discloses a base unit that is located in the locomotive and displays alarm messages to the locomotive operators.

196. More generally, a PHOSITA would understand that to be useful, the alarm message must be displayed to an operator who can take appropriate action in response. For example, an alarm message indicating that a wheel bearing has failed, or that a wheel derailment has occurred, would be of great interest to the locomotive operator—who could then take action to stop the train and prevent further (potentially catastrophic) damage. LeFebvre states the obvious, which is that “[i]dentifying when a wheel set has derailed prevents a possible full derailment and possible catastrophic consequences.” EX1005, ¶ [0061]. In my experience, alarms are often communicated to locomotive operators by lighting an LED in a panel with a graphic overlay that looks like a train; the location of the illuminated LED corresponds to the location of the component for which the alarm was generated. More recently, it has become common to include one or more

computer monitors (or similar graphical displays) inside a locomotive to display this type of alarm message.

197. Similarly, displaying alarms at a remote location would be useful, for example, to alert maintenance technicians of wheel bearings or other parts in need of upcoming repair or replacement LeFebvre again states the obvious, which is that “[i]dentifying a failing bearing in its early stages is important in preventative maintenance programs.” EX1005, ¶ [0059]

198. Barone provides further confirmation that this limitation would have been obvious to a PHOSITA. Barone expressly states that its monitoring system “displays reports to users in the locomotive itself, and also to users having access to the distributed system via the Internet or other communications systems,” such as a railroad maintenance worker carrying a mobile device. EX1007, ¶¶ [0087]–[0089].

d. Limitation 13(d): “c. determining high level alarms based on data and alarms collected from said communication management unit”

199. For the purposes of my analysis of claim 13, I have been instructed to consider a “high level alarm” to be an alarm that indicates a severe fault condition and is based on data and/or alarms collected from a CMU.⁴

⁴ For example, a temperature measurement of +40°F over ambient might be sufficient to raise a general warning or low level alarm, while a temperature measurement of +75°F over ambient might be sufficient to raise a higher level alarm signaling imminent failure. Raising more urgent alarms in response to more

200. LeFebvre does not expressly disclose a base unit that determines high level alarms. Barone, however, discloses least two distinct base units—one located in the locomotive, and one located in a remote location—that process sensor data collected from multiple railcars and determine whether a high level alarm should be raised.

201. Barone’s system includes a base unit in the locomotive. EX1007, ¶¶ [0087]–[0089]. The locomotive base unit “is constantly receiving communications from [sensor] nodes” located throughout the train. EX1007, ¶ [0087]. It has access to “an abundance of electrical power,” (*id.*, ¶ [0088]), and “interfaces with the existing locomotive computer processor and communication system.” *Id.*, ¶ [0087]. The locomotive base unit processes data from the sensor nodes, “displays reports of the data to users in the locomotive itself,” and raises “an audible alarm” to alert the locomotive operators of “especially urgent conditions” (i.e., a high level alarm). *Id.*, ¶¶ [0088], [0089].

202. Barone’s system relays the collected data and alerts to a “central monitoring station” (i.e., another base unit). EX1007, ¶¶ [0036], [0045], [0087]–[0089]. Barone’s central monitoring station then applies heuristics to detect potential or actual failure conditions, assess their severity, and raise a high level

serious conditions (and less urgent alarms in response to less serious conditions) is an extremely common practice across every industry I have worked in, and would have been obvious to a PHOSITA.

alarm if warranted. For example, with respect to wheel bearing health, Barone teaches that “[i]f 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.” EX1007, ¶ [0036]. A PHOSITA would understand that an alarm indicating the train must be “diverted or stopped” before a catastrophic bearing failure occurs is a “high level alarm.”

203. In my opinion, it would have been obvious for a PHOSITA to apply heuristic to the sensor data collected at LeFebvre’s base unit (i.e., the remote data handling location). It also would have been obvious to raise a high level alarm if any severe failure conditions were detected.

204. For example, because a CMU (i.e., LeFebvre’s data control unit) has access to data from only a single railcar, but LeFebvre’s base unit collects data from *multiple* railcars (*see* Dependent Claim 14, Section IX.D.3 below), the base unit has the ability to detect dangerous conditions that could not be observed by any single CMU. 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. This condition could not be observed by any single CMU, which only has information regarding the status of a single railcar; but it could easily be observed by applying heuristics at a base unit with access to data

collected from multiple railcars. Another example is recognizing a track defect, such as a broken rail weld combining two sections. One rail car might detect two high acceleration signals on the left side of the tracks that occurred exactly 250 milliseconds apart, but without additional data, this reading would be inconclusive. However, if that data is combined with other cars on the same rail that show similarly spaced, high acceleration signals (and taking the overall speed of the train into account), the existence of a critical issue with the track can be confirmed. It therefore would have been obvious for a PHOSITA to apply heuristics at LeFebvre's base unit to detect potentially serious issues involving multiple railcars, and to raise a high level alarm if any such issues are detected.

205. Additionally, by at least the mid-2000s, the benefits of analyzing data collected at a central data handling location had become well-known in the industry. For example, Azzaro recognized 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. Azzaro further notes that data analysis techniques, which may include “case-based or artificial intelligence strategies,” can “operate on the data to identify the source of potential or actual faults,” allowing lessons learned from a single locomotive to be applied to an entire fleet. EX1010, 2:35–58. Azzaro therefore provides corroborative evidence to confirm my opinion that collecting data from multiple

CMUs at a base unit, and performing analysis on that collected data, would have been a straightforward and obvious design choice for a PHOSITA.

206. A PHOSITA would therefore have been motivated to apply heuristics to data that is aggregated at LeFebvre's central data handling location, which would have the computational resources necessary to process large amounts of data in a timely manner. LeFebvre's sensor nodes and data control unit, in contrast, are subject to size and power constraints, and have limited computational resources as a result.

207. In my opinion, a PHOSITA could have arrived at the solution of claim 13 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 13.

3. Dependent Claim 14: “The system of claim 13 wherein said base unit is in wireless communication with multiple communication management units”

208. LeFebvre discloses a system comprising a multiplicity of data control units—one per railcar. I have explained this in detail above in Limitation 2(h), Section IX.C.1.i above, which is incorporated here by reference.

209. Likewise, each data control unit (i.e., each CMU) communicates wirelessly with a base unit, which may be either on the locomotive or in a remote location. I have explained this in detail above in Limitation 13(a), Section IX.D.2.a above, which is incorporated here by reference.

210. A PHOSITA would therefore have understood that LeFebvre discloses a base unit—either on the locomotive, or at a remote location—that communicates wirelessly with multiple CMUs.

211. In my opinion, a PHOSITA could have arrived at the solution of claim 14 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 14.

4. Dependent Claim 15: “The system of claim 14 wherein said base unit uses distributed event processing to perform trend analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.”

212. For the purposes of my analysis of claim 15, I have been instructed to consider “distributed event processing” to be any process that comprises trend

analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.

213. LeFebvre does not expressly disclose that the base unit processes alarms and data collected from the CMUs using “trend analysis.” However, the use of trend analysis was widely known in the art prior to the effective filing date of the ’223 Patent. Barone states that “true trending analysis ... has been widely acclaimed in the literature ... as leading to vastly improved failure prediction capability.” EX1007, ¶ [0042]. Barone itself uses trend analysis at the central monitoring station (i.e., a base unit): the system “reports critical situations back to the central monitoring station, thus allowing continuous monitoring and true trending data analysis.” EX1007, ¶ [0045].

214. More generally, a PHOSITA would understand that “trend analysis,” or “trending,” is a basic analytical tool that has been commonly used for decades. Since at least the mid-20th century, data was collected manually and logged and then manually graphed and kept at companies. In the 1980s, as computer technology began to become commonplace, this process started to become automated. By the 1990s, it was completely automatic, and trend analysis was available on networked PCs that an operator (such as a supervisor or maintenance lead) could access at any time and view real-time alerts.

215. A PHOSITA would have been motivated to modify LeFebvre to utilize trend analysis due to the “vastly improved failure prediction capability” that it provides. The use of trend analysis was well known in the industry, and a PHOSITA could have followed the disclosure of Barone to implement trend analysis with a reasonable expectation of success.

216. In my opinion, a PHOSITA could have arrived at the solution of claim 15 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 15.

5. Dependent Claim 16: “The system of claim 14 wherein said base unit applies heuristics to data collected from said one or more communication management units to determine if a high level alarm should be raised.”

217. *See* Limitation 13(d), Section IX.D.2.d above, and Dependent Claim 14, Section IX.D.3 above. For the same reasons I have discussed above with respect to Limitation 13(d) and Dependent Claim 14, it is my opinion that Dependent Claim 16 is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 199–207 and 208–211 above also reflect my

opinions with respect to Dependent Claim 16, and are incorporated here by reference.

6. Dependent Claim 17: “The system of claim 16 wherein said base unit and said one or more communication management units communicate with each other via a satellite communications capability or a cellular network capability.”

218. LeFebvre’s data control unit may communicate with a remote (off-train) base unit via, for example, “a cellular or satellite radio system.” EX1005, ¶ [0025]. *See also* Limitation 2(h), Section IX.C.1.i above, which is incorporated herein by reference.

219. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 17.

7. Dependent Claim 22: “The system of claim 5 wherein an alarm is raised based one or more of the following criteria: a. a pre-determined percentage of current data readings exceeds allowable peak readings; b. a pre-determined percentage of current data readings exceeds a determined value; c. a pre-determined percentage of current data readings exceeds a standard deviation from readings from the same railcar; d. a pre-determined percentage of current data readings exceeds a standard deviation from all railcars in the fleet; or e. the rate of change of current data readings exceeds a pre-determined threshold.”

220. A system meets the limitations of claim 22 if an alarm is raised based on *any one* of criteria (a) through (e). Criteria (a) through (e) recited in claim 22 are well-known, conventional heuristic techniques that would have been obvious to

a PHOSITA and could have been implemented with a reasonable expectation of success.

221. For example, LeFebvre teaches that “[t]rack defects can generate *large and sudden* forces in the wheels, bearings and truck.” EX1005, ¶ [0054]. A PHOSITA would have understood that a measured force may be considered “large” if its standard deviation exceeds a predetermined threshold (i.e., if it rises significantly above the “normal” forces experienced by a moving railcar). Likewise, a PHOSITA would have understood that the appearance of a force may be considered “sudden” if the rate of change in the measured value exceeds a predetermined threshold. *Id.* LeFebvre therefore expressly discloses raising an alarm based upon criteria (d) and (e).

222. More generally, a PHOSITA could have used the known, conventional heuristic techniques recited in criteria (a) through (e) to implement the performance monitoring features as described in the reference. EX1005, ¶¶ [0054], [0058]–[0066]. For example, Barone discloses that “[w]hen a railroad wheel bearing is very near catastrophic failure the temperature rapidly increases,” and that an alert should therefore be raised when “the temperature rate of change exceeds a pre-selected threshold trigger value.” EX1007, ¶ [0253]. Barone therefore provides corroborative evidence to confirm my opinion that, at a minimum, the heuristic technique recited in criteria (e) was known, obvious, and

could have been implemented by a PHOSITA with a reasonable expectation of success. A PHOSITA would have been motivated to modify LeFebvre's system (if extent necessary) to apply this heuristic, because Barone teaches that it is effective to detect wheel bearings that are "very near catastrophic failure."

223. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 22.

8. Dependent Claim 24: "The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored."

224. LeFebvre does not expressly disclose that its temperature sensor is "disposed outside of and spaced from" the housing of the instrumented pad as required by claim 24.

225. This feature is taught by Barone. Specifically, in Barone's sensor device, "[t]he sensor portion 259 is pressed into engagement with the actual end cap 281 of the wheel assembly 140 as shown in FIG. 28." EX1007, ¶ [0103].

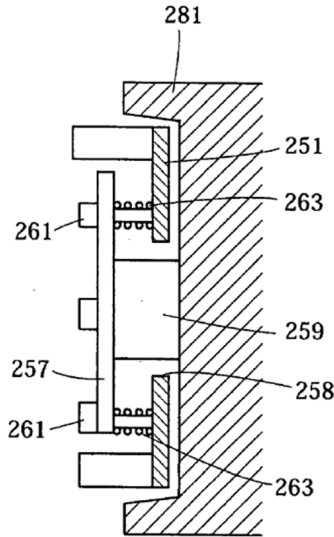


FIG. 28

226. This design ensures that “the engagement is firm and the temperature, acceleration, and acoustic data is as reliable as possible.” *Id.* A PHOSITA would have modified LeFebvre’s sensor devices to include an external temperature sensor, as taught by Barone, to obtain the most accurate and reliable temperature readings.

227. It is therefore my opinion that LeFebvre, in view of Barone and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 24.

E. Ground 3: Claims 1 and 24 are unpatentable under 35 U.S.C. § 103(a) as obvious over LeFebvre in view of Provasnik and Denny.

1. Motivation to Combine LeFebvre, Provasnik, and Denny

228. LeFebvre does not expressly disclose the “external temperature sensor” limitations of claims 1 and 24. These limitations, however, would have

been obvious to a PHOSITA based on the general knowledge in the art. Denny and Provasnik, discussed in detail below, are exemplary prior art references that illustrate the general knowledge possessed by a PHOSITA.

229. LeFebvre, Denny, and Provasnik are analogous art. All three references are directed to devices for monitoring the temperature of metallic mechanical components—specifically, wheel bearings (LeFebvre and Denny) and engines (Provasnik). Denny (EX1008) provides evidence that external temperature sensors are standard components, commonly used in industrial applications, and provide advantages that would have been clearly understood by a PHOSITA. Similarly, Provasnik (EX1009) provides evidence that magnetic sensor attachments are standard components, commonly used in industrial applications, and provide advantages that would have been clearly understood by a PHOSITA.

230. As I will explain in detail below, a PHOSITA would therefore have been motivated to modify LeFebvre’s instrumented pad to include an external temperature sensor with a magnetic attachment.

2. Independent Claim 1

a. Claim 1 Preamble: “A sensor device for monitoring temperature on a railcar, comprising”

231. *See* Claim 2 Preamble, Section IX.C.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 1 Preamble is also fully disclosed by LeFebvre. Specifically, the

opinions I have expressed in paragraphs 73–75 above also reflect my opinions with respect to the Claim 1 Preamble, and are incorporated here by reference.

b. Limitation 1(a): “a housing mountable on a railcar”

232. *See* Limitation 2(c), Section IX.C.1.d above. For the same reasons I have discussed above with respect to Limitation 2(c), it is my opinion that Limitation 1(a) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 81–86 above also reflect my opinions with respect to Limitation 1(a), and are incorporated here by reference.

c. Limitation 1(b): “a temperature sensor”

233. *See* Limitation 2(b), Section IX.C.1.c above. For the same reasons I have discussed above with respect to Limitation 2(b), it is my opinion that Limitation 1(b) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 79–80 above also reflect my opinions with respect to Limitation 1(b), and are incorporated here by reference.

d. Limitation 1(c): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

234. *See* Limitation 2(e), Section IX.C.1.f above. For the same reasons I have discussed above with respect to Limitation 2(e), it is my opinion that Limitation 1(c) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 89–92 above also reflect my opinions with respect to Limitation 1(c), and are incorporated here by reference.

e. Limitation 1(d): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

235. *See* Limitation 2(f), Section IX.C.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 1(d) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 93–94 above also reflect my opinions with respect to Limitation 1(d), and are incorporated here by reference.

f. Limitation 1(e): “a probe external to said housing and which probe includes said temperature sensor and a magnet positioned to magnetically attract the part of the railcar against which the probe will be placed”

236. LeFebvre does not expressly disclose a temperature sensor that is external to the housing of the instrumented pad. However, selecting an optimal location for a temperature sensor would have been a straightforward design choice for a PHOSITA. In general, including a probe that is external to the housing of a sensor unit was (and is) a commonplace practice, and is often used in connection with both temperature sensors and vibration sensors (such as accelerometers).

237. In particular, a PHOSITA would have understood that it is advantageous to locate a temperature sensor close to the part of the railcar whose temperature is to be measured. Additionally, a PHOSITA would have understood that sensitive electronic components, such as microprocessors or electronic

circuitry, should not be directly exposed to the high temperatures occurring in wheel assemblies.

238. Denny is an example of a prior art reference that illustrates this general knowledge. Denny is directed to a thermal warning device, which attaches to a wheel assembly of a railway car to detect whether the wheel assembly has reached high temperatures and may lead to a potential bearing failure. EX1008, (57) Abstract. For example, Denny states the obvious fact that “[i]n order to obtain an accurate high temperature reading of a wheel assembly, the temperature sensor ... should, preferably, extend deep into the wheel assembly.” EX1008, 2:24–27. This concept is obvious, and would have been fully understood by a PHOSITA even without reference to Denny. Likewise, Denny states that “the electronic circuit is situated away from the outer surface of the wheel assembly so that the electronic circuit will not be subjected to heat from the wheel assembly and may freely dissipate heat produced by its own components.” EX1008, (57) Abstract. Again, this concept is obvious, and would have been fully understood by a PHOSITA even without reference to Denny.

239. It therefore would have been obvious to a PHOSITA to locate a temperature sensor external to the housing (i.e., in close proximity or contact with the wheel assembly) to provide the best possible measurement of wheel bearing temperature. At the same time, it would have been obvious to locate sensitive

electronic components (e.g., microprocessors) within the protective housing and away from the high temperatures produced in the wheel assembly.

240. LeFebvre does not describe the manner in which the temperature sensor is attached to the railcar. However, numerous means for attaching sensors (e.g., temperature sensors) to substrates were known in the art at the filing date of the '223 Patent. Selecting an appropriate attachment method would have been a straightforward design choice for a PHOSITA. In particular, a PHOSITA would have understood that a magnet could be used to attach a temperature sensor to a metallic substrate (e.g., a wheel bearing or other metallic portion of a railcar).

241. To provide a concrete example, Provasnik discloses a temperature sensor that is magnetically attached to an engine block to measure the temperature of the engine oil. EX1009, 2:46–65. The advantage of using a magnet is that it permits the sensor to be readily attached to, and removed from, the metallic substrate. EX1009, 1:8–15, 1:38–44, 4:65-68. All of this would have been entirely obvious to a PHOSITA. While Provasnik describes an exemplary embodiment of a magnetically attached temperature sensor, the underlying concept was common knowledge in the art and would have been readily understood by a PHOSITA—namely, that a temperature sensor can be attached to a metallic substrate using a magnet. Since the beginning of my career 30+ years ago, magnet mounts have

been commonly used to mount sensors that measure vibration, temperature, and the presence of light or sound, among many other applications.

242. It therefore would have been obvious for a PHOSITA to have used a magnet to attach a temperature sensor to a metallic portion of a railcar—such as a wheel, a wheel bearing, a portion of the railcar body, or any other metallic component—where temperature monitoring is desired.

g. Limitation 1(f): “a communication device capable of broadcasting information regarding the temperature sensed, said communication device positioned within said housing”

243. *See* Limitation 2(g), Section IX.C.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 1(f) is also fully disclosed by LeFebvre. Specifically, the opinions I have expressed in paragraphs 95–97 above also reflect my opinions with respect to Limitation 1(f), and are incorporated here by reference.

h. Limitation 1(g): “wherein the power consumption of said sensor device is managed by placing said sensor device in a standby state and periodically awakening said sensor device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry”

244. *See* Limitation 8(b), Section IX.C.7.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Limitation 1(g) is also fully disclosed by LeFebvre. Specifically, the opinions I

have expressed in paragraphs 145–147 above also reflect my opinions with respect to Limitation 1(g), and are incorporated here by reference.

i. Claim 1 is obvious in view of LeFebvre.

245. It is therefore my opinion that LeFebvre, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of independent claim 1. As I have explained in detail above, a PHOSITA could have arrived at the solution of independent claim 1 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of LeFebvre, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success.

3. Dependent Claim 24: “The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.”

246. *See* Limitation 1(e), Section IX.E.2.f above. For the same reasons I have discussed above with respect to Limitation 1(e), it is my opinion that Dependent Claim 24 is also obvious over LeFebvre in view of the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 236–242 above also reflect my opinions with respect to Dependent Claim 24, and are incorporated here by reference.

F. Ground 4: Claims 2, 3, 5, 7, 13–18, 20–22, 26–28, and 32 are unpatentable under 35 U.S.C. § 103(a) as obvious in view of Armitage

247. In my opinion, Armitage—as it would have been understood by a PHOSITA—discloses each and every limitation of claims 2, 3, 5, 7, 13–18, 20–22, 26–28, and 32. The claims therefore would have been obvious to a PHOSITA.

248. Armitage’s entire disclosure is directed to a railcar monitoring system. To the extent that Armitage can be viewed as disclosing different embodiments of a railcar monitoring system, those embodiments are very similar to one another, and share most if not all of the features recited by claims 2, 3, 5, 7, 13–18, 20–22, 26–28, and 32. In my opinion, a PHOSITA could have, and would have, combined the teachings of Armitage as set forth in detail below. It is also my opinion that a PHOSITA could have combined the teachings of Armitage as discussed below with a reasonable expectation of success.

249. It is also my opinion that Armitage provides an enabling disclosure of every element of these claims. Armitage’s disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage’s invention (i.e., could have implemented the railcar monitoring systems and sensing/monitoring devices disclosed by Armitage) without undue experimentation. A PHOSITA could have followed the teachings of Armitage to arrive at the claimed systems and devices with a reasonable expectation of success.

250. More generally, the elements of claims 2, 3, 5, 7, 13–18, 20–22, 26–28, and 32 are all well-known in the art, and would have been fully understood by a PHOSITA. The art to which these claims are directed—systems and sensors for monitoring operational parameters of railcars—is predictable, involving simple mechanical components and widely available, off-the-shelf electronic components. For at least these reasons, it is my opinion that a PHOSITA could have made numerous adjustments and modifications to Armitage’s disclosed systems and sensors with a reasonable expectation of success and without undue experimentation.

1. Independent Claim 2

a. Claim 2 Preamble: “A system for monitoring a railcar, comprising:”

251. In my opinion, this preamble is entirely a statement of intended use, and should not be given patentable weight. To the extent that the preamble is limiting, Armitage discloses “a mobile railway car monitoring system.” EX1006, (57) Abstract.

b. Limitation 2(a): “a plurality of sensor devices located on the railcar for monitoring parameters or conditions of the railcar, each of said sensor devices being separate from one another and including a sensor for monitoring one of said parameters or conditions of the railcar”

252. 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. For ease of reference, I have reproduced Figure 1 below.

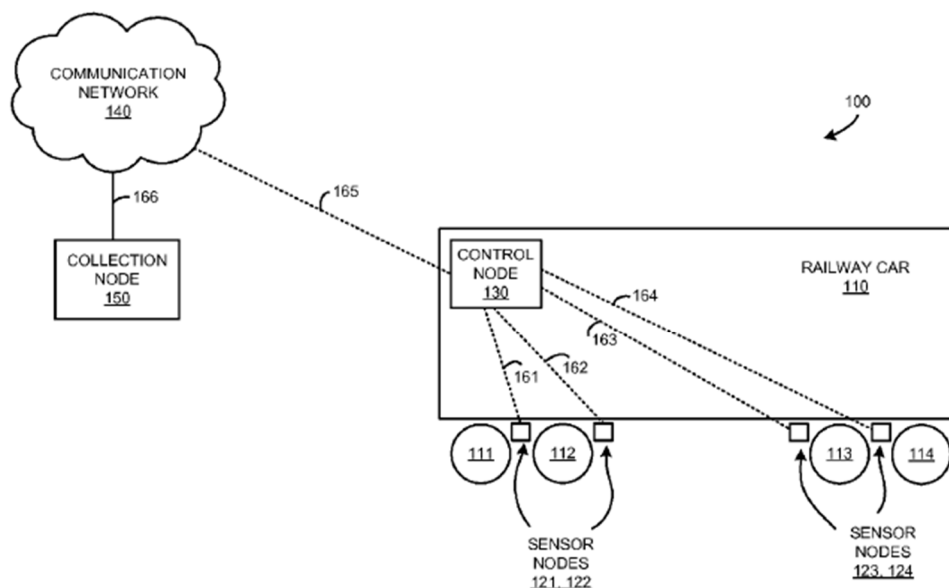


FIGURE 1

253. “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.*

254. 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 attached to each wheel assembly. EX1006, ¶¶ [0033]–[0034], Fig. 3. A PHOSITA would generally understand that the number of sensor nodes is not critical, and that a system could employ many (or as few) nodes as needed for a particular application. Sensor nodes 320–327 have the same features described

above for nodes 121–124. EX1006, ¶ [0033]. For ease of reference, I have reproduced Figure 3 below.

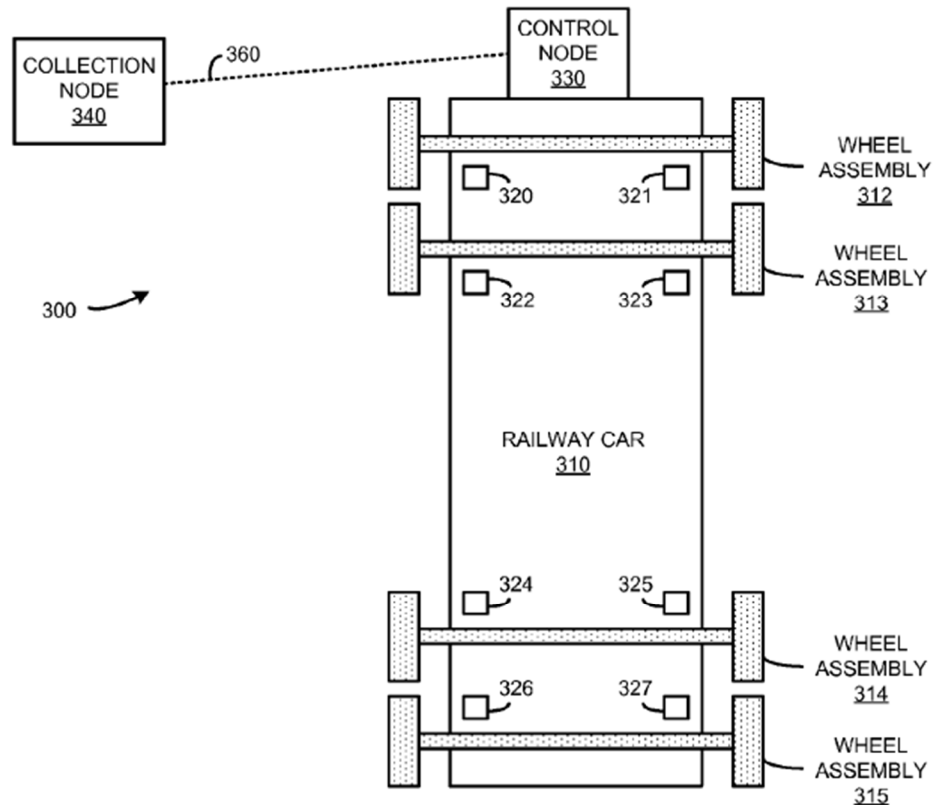


FIGURE 3

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

256. Armitage therefore discloses Limitation 2(a).

c. Limitation 2(b): “said plurality of sensor devices including at least one temperature sensor device having”

257. Armitage discloses that the sensor node may comprise a temperature sensor (such as a thermometer, thermocouple, infrared sensor, etc.). EX1006, ¶¶ [0014], [0033], [0056].

258. Armitage therefore discloses Limitation 2(b).

d. Limitation 2(c): “a housing”

259. Armitage discloses that the sensor nodes “could each be encased in a potted, weatherproof, or sealed enclosure, or may have openings for air circulation.” EX1006, ¶¶ [0034]. *See also* EX1006, ¶ [0015]. The sensor nodes may be mounted on the railcar using mechanical fasteners, adhesive methods, or magnets. EX1006, ¶¶ [0015], [0034].

260. Armitage therefore discloses Limitation 2(c).

e. Limitation 2(d): “a temperature sensor in thermal communication with an item of the railcar for which the temperature is being monitored, which item is external to said housing”

261. Armitage discloses that each sensor node is “coupled to an undercarriage portion of a railway car,” EX1006, ¶ [0004], “such as a wheel, axle, gearbox, bearing, bearing box, journal box, trucks, brakes, or other equipment.” EX1006, ¶ [0013]. “The information monitored could include undercarriage element temperature,” among other parameters. EX1006, ¶ [0025]. Armitage thus

discloses a temperature sensor in thermal communication with an undercarriage element that is outside the sensor housing.

262. Armitage therefore discloses Limitation 2(d).

f. Limitation 2(e): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

263. Armitage’s sensor node comprises electrical circuitry that processes data received from the sensors. Specifically, each sensor node “include[s] a processing portion for receiving the sensor information, amplifying, scaling, modifying, adjusting, digitizing, or converting the sensor information, as well as controlling the transceiver portion and sensor portions.” EX1006, ¶ [0014].

264. An exemplary embodiment is provided in Figure 6, which “is a block diagram illustrating sensor node 600, as an example of sensor nodes 121-124 found in FIG. 1 or sensor nodes 320-327 found in FIG. 3.” EX1006, ¶ [0053]. Figure 6 depicts “processing system 620” within the sensor node 600. *Id.* Processing system 620 “comprises specialized circuitry,” i.e., electrical circuitry, which operates to “process the sensor information.” EX1006, ¶ [0055] A PHOSITA would understand—and Figure 6 confirms—that in Armitage’s system, this electrical circuitry may be positioned within the sensor node’s housing.

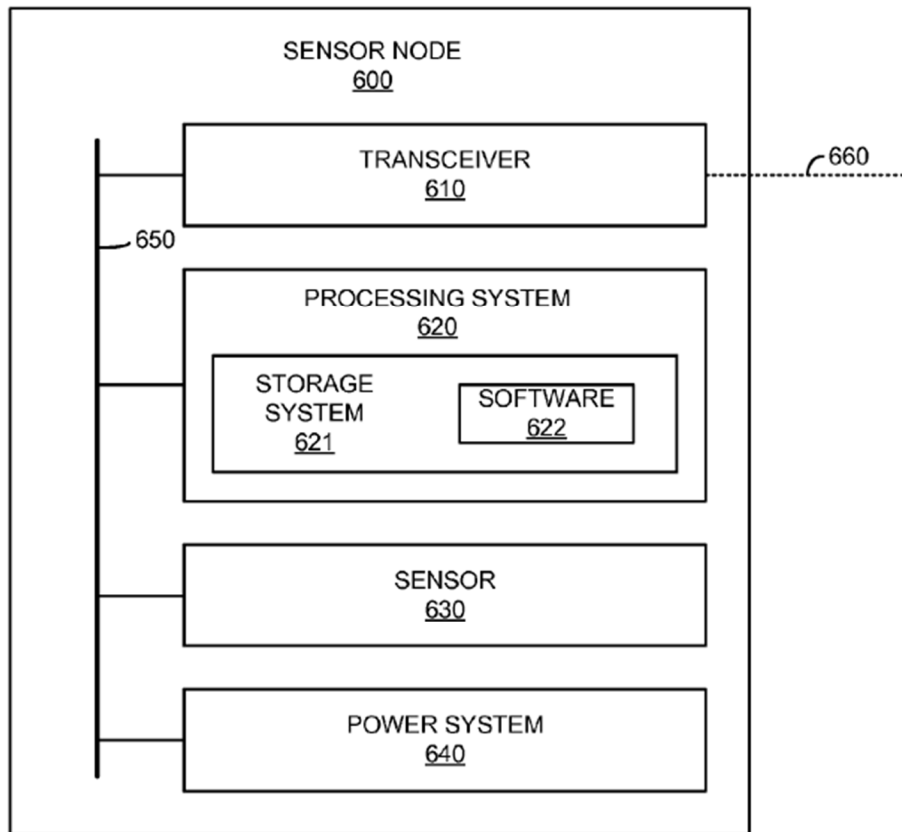


FIGURE 6

265. Armitage therefore discloses Limitation 2(e).

g. Limitation 2(f): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

266. Armitage states that “[e]ach of sensor nodes 121-124 could also comprise a power system, such as a battery or solar cell.” EX1006, ¶ [0014]. *See also* EX1006, ¶ [0033]. A specific example is provided by the embodiment of Figure 6, where “[p]ower system 640 includes circuitry and a power source to provide power to the elements of sensor node 600.” EX1006, ¶ [0057].

267. Armitage therefore discloses Limitation 2(f).

h. Limitation 2(g): “a communication device capable of broadcasting information regarding the temperature sensed via wireless communication, said communication device positioned within said housing”

268. Armitage discloses that each sensor node comprises a wireless transceiver for communicating with the control node. EX1006, ¶ [0014] (“the transceiver portion includes a wireless transceiver and antenna for wirelessly communicating with control node 130”). *See also* EX1006, ¶¶ [0033], [0054]. Specifically, each sensor node may be configured to “transfer the processed sensor information to control node 130.” EX1006, ¶ [0026]. As discussed above with respect to Limitation 2(b), the sensor may be a temperature sensor.

269. Additionally, a PHOSITA would understand—and Figure 6 confirms—that in Armitage’s system, the wireless transceiver may be positioned within the sensor node’s housing. *See* EX1006, Fig. 6 (depicting transceiver 610 located within sensor node 600).

270. Armitage’s sensor node thus includes a communication device located within the housing and capable of wirelessly broadcasting information regarding the temperature sensed. Armitage therefore discloses Limitation 2(g).

i. Limitation 2(h): “a communication management unit, mounted on the railcar, capable of two way wireless communication with each of said plurality of sensor devices for receiving information therefrom, said communication

management unit having a wireless communication device for broadcasting information about the parameter or condition being monitored”

271. Armitage’s system includes a “control node” on each railcar. EX1006, ¶¶ [0004], [0012], Figs. 1, 3, 5. The control node is a “communication management unit” in the parlance of the ’223 Patent.

272. The control node communicates wirelessly with each sensor node on the same railcar. 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. The wireless links can utilize, for example, WiFi or Bluetooth, either of which would provide two-way communications between the control node and the sensor nodes. EX1006, ¶ [0021].

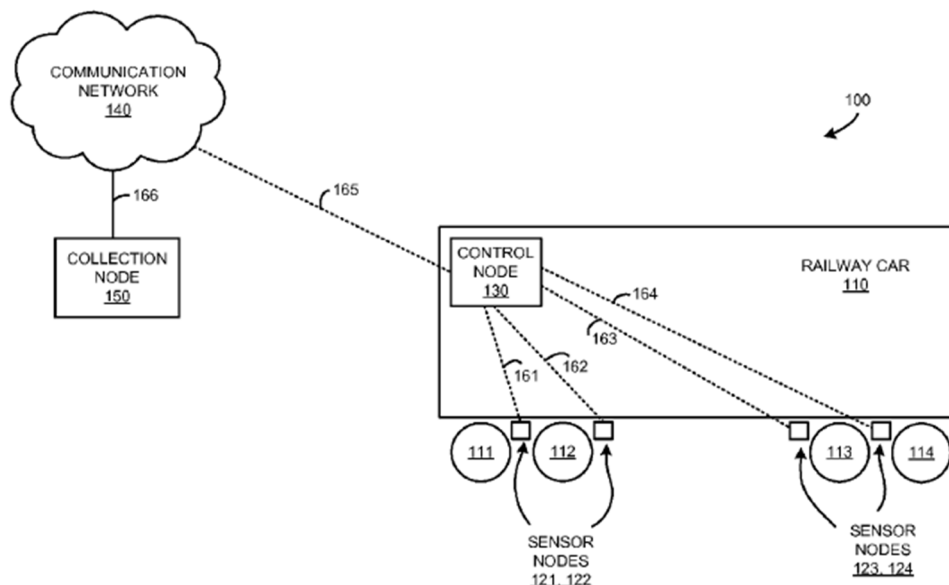


FIGURE 1

273. Control node 130 is also capable of broadcasting information upstream to communication network 140 over wireless link 165. EX1006,

¶ [0022]. Armitage identifies WiFi, cellular networks (e.g., LTE, GSM, or CDMA), and satellite networks (e.g., Iridium) as examples of the wireless communications technologies that may be employed in wireless link 165. EX1006, ¶ [0022]. All of these technologies can provide two-way communications between the control node and the upstream communication network.

274. Armitage therefore discloses Limitation 2(h).

j. Claim 2 is obvious over Armitage

275. Armitage therefore discloses or renders obvious every element of independent claim 2, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that Armitage provides an enabling disclosure of every element of claim 2. Armitage's disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage's invention (i.e., could have implemented the railcar monitoring system disclosed by Armitage) without undue experimentation. To the extent that different elements of claim 2 are described in different portions of Armitage's specification, a PHOSITA would have immediately understood—based upon the disclosure of Armitage—that they could be combined in the manner I have described above. It is therefore my opinion that claim 2 is obvious over Armitage.

2. Dependent Claim 3: “The system of claim 2 wherein said communication management unit can make a determination of an alarm condition based on data collected by two or more of said sensor devices.”

276. Armitage discloses a communications management unit—specifically, a “control node” on each railcar—that (a) collects data from a plurality of sensor devices located on the same railcar, and (b) uses heuristics to determine actual, potential, or imminent failures based on a statistical analysis of the collected data.

277. As discussed above, each sensor node contains one or more sensors that collect data about the railcar (*see* Limitation 2(a), Section IX.F.1.b above), and wirelessly transmit that data to the control node. *See* Limitation 2(b), Section IX.F.1.c above. The control node collects this data and analyzes it to determine whether a fault condition is present. Specifically:

“The information received could include sensor information, or modified sensor information, from each of sensors 121-124 received over wireline or wireless links. Control node 130 processes (204) the information to determine a fault condition for the undercarriage portion.”

EX1006, ¶ [0027]. If a fault condition is detected, the control node wirelessly reports it (i.e., sends an alarm message) to a collection system. EX1006, ¶ [0028].

278. Armitage describes the use of heuristics to determine both the presence and nature of a fault condition. For example, Armitage discloses 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.* A PHOSITA would understand that these are examples of heuristics.

279. The control node can also perform statistical analysis on the collected data to detect failure conditions. For example, the control node can “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 a railway car.” EX1006, ¶ [0029]. Armitage also discloses the use of a “moving average and trend analysis” to detect “statistically significant deviations” that are indicative of failure. EX1006, ¶ [0030]. *See also* EX1006, ¶ [0045] (describing “time series analysis” and statistical sampling of accelerometer data).

280. Armitage also indicates that its system can distinguish between potential failures (which warrant maintenance) and actual failures (which require immediate service). For example, Armitage states that an operator can be presented with a “health scorecard” that distinguishes “yellow condition[s]” (which a PHOSITA would understand to indicate potential or imminent failures) from “red

condition[s]” (which a PHOSITA would understand to indicate actual failures).

EX1006, ¶ [0044].

281. Armitage therefore discloses or renders obvious every element of dependent claim 3.

3. Independent Claim 5

a. Claim 5 Preamble: “A system for monitoring the operation of a railcar comprising”

282. *See* Claim 2 Preamble, Section IX.F.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 5 Preamble is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraph 251 above also reflect my opinions with respect to the Claim 5 Preamble, and are incorporated here by reference.

b. Limitation 5(a): “a. one or more sensor units mounted on said railcar, each of said sensor units monitoring an operating parameter of said railcar wherein each of said sensor units comprises”

283. *See* Limitation 2(a), Section IX.F.1.b above. For the same reasons I have discussed above with respect to Limitation 2(a), it is my opinion that Limitation 5(a) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 252–256 above also reflect my opinions with respect to Limitation 5(a), and are incorporated here by reference.

c. Limitation 5(b): “a sensor”

284. *See* Limitation 2(b), Section IX.F.1.c above. For the same reasons I have discussed above with respect to Limitation 2(b), it is my opinion that Limitation 5(b) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 257–258 above also reflect my opinions with respect to Limitation 5(b), and are incorporated here by reference.

d. Limitation 5(c): “a power source”

285. *See* Limitation 2(f), Section IX.F.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 5(c) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 266–267 above also reflect my opinions with respect to Limitation 5(c), and are incorporated here by reference.

e. Limitation 5(d): “a processor”

286. *See* Limitation 2(e), Section IX.F.1.f above. For the same reasons I have discussed above with respect to Limitation 2(e), it is my opinion that Limitation 5(d) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 263–265 above also reflect my opinions with respect to Limitation 5(d), and are incorporated here by reference.

f. Limitation 5(e): “memory”

287. Armitage discloses that each sensor node may comprise a processing system for receiving, processing, and transmitting information received from the

sensors. I have explained this in detail with respect to Limitation 2(e), Section IX.F.1.f above, which is incorporated here by reference.

288. The processing system includes a storage system comprising at least one “memory device.” EX1006, ¶ [0055]. Additionally, a PHOSITA would understand that the processing system must include working memory, or RAM, that stores state information for the software being executed. Alternatively, it would have been obvious to include RAM as part of the processing system because RAM is a standard and essential component of a modern computing device that software developers would expect to be present.

289. Armitage therefore discloses Limitation 5(e).

g. Limitation 5(f): “communication circuitry”

290. *See* Limitation 2(g), Section IX.F.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 5(f) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 268–270 above also reflect my opinions with respect to Limitation 5(f), and are incorporated here by reference.

h. Limitation 5(g): “b. a communication management unit, mounted on said railcar, said communication management unit in wireless communication with said one or more sensor units”

291. *See* Limitation 2(h), Section IX.F.1.i above. For the same reasons I have discussed above with respect to Limitation 2(h), it is my opinion that

Limitation 5(g) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 271–274 above also reflect my opinions with respect to Limitation 5(g), and are incorporated here by reference.

i. Limitations 5(h), 5(i), and 5(j): “wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor units (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.”

292. *See* Dependent Claim 3, Section IX.F.2 above. For the same reasons I have discussed above with respect to Dependent Claim 3, it is my opinion that Limitations 5(h), 5(i), and 5(j) are also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 276–281 above also reflect my opinions with respect to Limitations 5(h), 5(i), and 5(j), and are incorporated here by reference.

j. Claim 5 is obvious over Armitage

293. Armitage therefore discloses or renders obvious every element of independent claim 5, in detail, and in the same arrangement as required by the claim. Additionally, it is my opinion that Armitage provides an enabling disclosure of every element of claim 5. Armitage’s disclosure is sufficiently detailed that a PHOSITA could have practiced Armitage’s invention (i.e., could have implemented the railcar monitoring system disclosed by Armitage) without undue experimentation. To the extent that different elements of claim 5 are described in

different portions of Armitage’s specification, a PHOSITA would have immediately understood—based upon the disclosure of Armitage—that they could be combined in the manner I have described above. It is therefore my opinion that claim 5 is obvious over Armitage.

4. Dependent Claim 7: “The system of claim 5 wherein said determination of an alarm condition can be made by said communication management unit based on data collected by two or more of said sensor units.”

294. See Dependent Claim 3, Section IX.F.2 above. For the same reasons I have discussed above with respect to Claim 3, it is my opinion that Claim 7 is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 276–281 above also reflect my opinions with respect to Claim 7, and are incorporated here by reference.

5. Dependent Claim 13

a. Limitation 13(a): “The system of claim 5 further comprising a base unit, said base unit being in wireless communication with said communication management unit”

295. Armitage discloses that its control node (i.e., a CMU) communicates with a “collection system” or “collection node.” EX1006, ¶¶ [0004], [0019]–[0020], [0038], Fig. 1. A PHOSITA would understand that Armitage’s “collection system” or “collection node” is equivalent to a “base unit” in the parlance of the ’223 Patent.

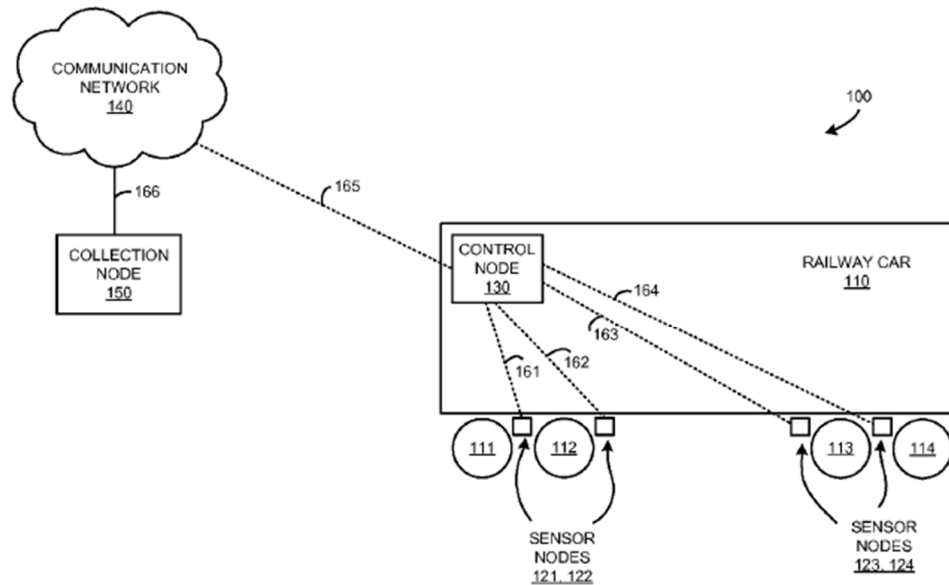


FIGURE 1

296. “In the example shown in FIG. 1, collection node 150 communicates with control node 130 through communication network 140.” EX1006, ¶ [0020]. Information from control node 130 is broadcast to communication network 140 over wireless link 165. EX1006, ¶ [0022]. Armitage identifies WiFi, cellular networks (e.g., LTE, GSM, or CDMA), and satellite networks (e.g., Iridium) as examples of the wireless communications technologies that may be employed in wireless link 165. All of these are technologies that enable two-way communication.

297. The embodiment depicted in Figure 3 is substantially identical to that of Figure 1, and similarly includes a control node 330 (i.e., a CMU) that communicates with a collection node 340 (i.e., a base unit) over a wireless link 360. EX1006, ¶¶ [0037]–[0038], Fig. 3.

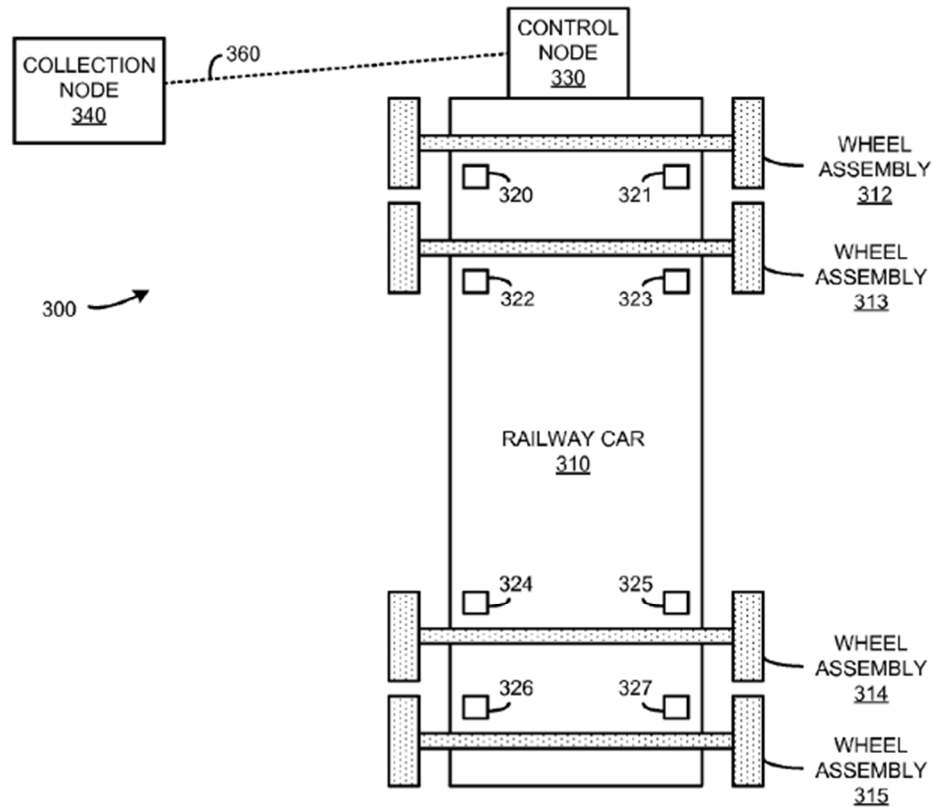


FIGURE 3

298. Communications network 140, which can itself comprise one or more “wireless communication systems,” then routes the information to collection node 150 (the “base unit” in the parlance of the ’223 Patent). EX1006, ¶ [0018].

299. “Collection node 150 could collect fault conditions and other information from many control nodes.” EX1006, ¶ [0020]. For example, “[c]ollection node 150 could receive information from each control node [130] of the train, and thus monitor the entire train.” EX1006, ¶ [0020].

b. Limitation 13(b): “said based unit performing the functions of: a. collecting data and alarms from said communication management unit”

300. Armitage discloses that the control unit (i.e., the CMU) transmits alarms and collected data to the base station. 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). *See also* EX1006, ¶ [0037].

c. Limitation 13(c): “b. displaying alarm conditions raised by said communication management unit”

301. Armitage discloses that the collection node (i.e., the base unit) can include a user interface for displaying the status of the control node, or information received from the sensor nodes, to a user. Specifically, “[c]ollection node 340 could include a user interface for displaying a status of control node 330 or sensor nodes 320-327 to a user.” EX1006, ¶ [0039]. A PHOSITA would understand that “displaying a status” means displaying an alarm condition, if one is present.

302. More generally, a PHOSITA would understand that to be useful, the alarm message must be displayed. I have explained this in detail above in Section IX.D.2.c above, which is incorporated here by reference. Because Armitage’s collection node is capable of aggregating data received from multiple control units (as I have explained above with respect to Limitation 13(b)), it would have been

natural and obvious to include a user interface at the collection node, and for that user interface to display any detected alarm conditions.

d. Limitation 13(d): “c. determining high level alarms based on data and alarms collected from said communication management unit”

303. Armitage discloses that the collection node (i.e., the base unit) can analyze the information collected from one or more control units (i.e., CMUs) for the purpose of detecting high-level fault conditions. The collection node can then raise alarms corresponding to any detected faults, as I have discussed above with respect to Limitations 13(b) and 13(c).

304. For example, Armitage teaches that with data collected from multiple control units, “[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 discloses that analysis of the collected sensor data may occur at the control node (i.e., the CMU), at the collection node (i.e., the base unit), or a combination thereof.

305. For example, in reference to Figure 4, Armitage refers to a “Data Correlation Unit” (“DCU”) that analyzes collected data. EX1006, ¶ [0043]. The DCU may include the control node (i.e., the CMU) *or* the collection node (i.e., the base unit). EX1006, ¶ [0043]. The DCU can generate an alert (i.e., an alarm) if it detects a significant deviation from normal conditions. EX1006, ¶ [0043]. A PHOSITA would have understood that it was particularly important to raise “high

level” alarms, such as alarms for issues affecting multiple railcars or corresponding to a “red condition” on Armitage’s health scorecard. EX1006, ¶ [0044]. Armitage therefore discloses, or at least renders obvious, a system wherein the collection node analyzes collected data and raises an alarm if failure conditions are detected.

306. It is therefore my opinion that Armitage, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 13.

6. Dependent Claim 14: “The system of claim 13 wherein said base unit is in wireless communication with multiple communication management units.”

307. *See* Limitation 13(a), Section IX.F.5.a above. For the same reasons I have discussed above with respect to Limitation 13(a), it is my opinion that Claim 14 is also obvious over Armitage in view of the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 295–299 above also reflect my opinions with respect to Claim 14, and are incorporated here by reference.

7. Dependent Claim 15: “The system of claim 14 wherein said base unit uses distributed event processing to perform trend analysis based on alarms and data collected from one or more communication management units to determine if a high level alarm should be raised.”

308. Armitage discloses that the collection node “may be distributed among multiple processing devices.” EX1006, ¶¶ [0019], [0037]. A PHOSITA

would therefore understand that the collection node is capable of “distributed event processing.”

309. Armitage also discloses that its system may perform “trend modeling” to “identif[y] specific sensor telemetry that lies outside norms.” EX1006, ¶ [0044]. In Armitage’s system, this analysis is performed by the DCU, which can be a part of the collection node (i.e., the base unit). I have explained this in detail with respect to Limitation 13(d), Section IX.F.5.d above, which is incorporated here by reference.

310. More generally, the use of trend analysis was widely known in the art prior to the effective filing date of the ’223 Patent. I have explained this in detail in Section IX.D.4 above, which is incorporated here by reference. A PHOSITA would have been motivated to use trend analysis (for example, as described in paragraphs [0030] and [0044] of Armitage) due to the “vastly improved failure prediction capability” that trend analysis provides relative to other techniques. EX1007, ¶ [0042].

311. It is therefore my opinion that Armitage, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 15.

8. Dependent Claim 16: “The system of claim 14 wherein said base unit applies heuristics to data collected from said one or more communication management units to determine if a high level alarm should be raised.”

312. Armitage discloses that the collection node (i.e., the base unit) can apply heuristics to data collected from multiple CMUs to determine if a high level alarm should be raised.

313. In general, a PHOSITA would have been aware of obvious, predictable benefits to performing heuristics on data collected by multiple control nodes and aggregated at the collection node. I have explained this in detail in Section IX.D.5 above, which is incorporated here by reference. Armitage discloses examples of heuristics that are conducted at the collection node and provide these expected benefits.

314. For example, the “trend modeling” analysis that can be performed at the collection node, which I have discussed above with respect to Claim 15, is a type of “heuristic” that also meets the limitations of Claim 16. As discussed with respect to Limitation 13(a), Section IX.F.5.a above, Armitage teaches that data collected from multiple control units can be used to isolate fault conditions to a particular railway car, to detect track failures, or to assess the root cause of a failure detected at the sensor level. EX1006, ¶ [0038]. And as I have discussed above with respect to Claim 3, Armitage also discloses the use of a “moving average and trend analysis” to detect “statistically significant deviations” that are

indicative of failure. All of these are examples of heuristics that can be performed at Armitage's collection node.

315. It is therefore my opinion that Armitage, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 16.

9. Dependent Claim 17: “The system of claim 16 wherein said base unit and said one or more communication management units communicate with each other via a satellite communications capability or a cellular network capability.”

316. *See* Limitation 13(a), Section IX.F.5.a above. For the same reasons I have discussed above with respect to Limitation 13(a), it is my opinion that Claim 17 is also obvious over Armitage in view of the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 295–299 above also reflect my opinions with respect to Claim 17, and are incorporated here by reference.

10. Dependent Claim 18: “The system of claim 5 wherein said sensor is selected from a group consisting essentially of temperature sensors, pressure sensors, strain sensors, load cell sensors, hand brake position sensors, magnetic sensors, vibration sensors, gyroscopes, acceleration sensors, hall effect sensors, piezoelectric resistive microphones and switches.”

317. Armitage discloses that the sensor may be a temperature sensor. I have explained this in detail in Limitation 2(b), Section IX.F.1.c above, which is incorporated here by reference.

318. Armitage therefore discloses or renders obvious every element of dependent claim 18.

11. Dependent Claim 20: “The system of claim 5 wherein said alarm is determined using distributed event processing based on a comparison between current data and statistical models of behavior.”

319. Armitage discloses the use of “trend modeling” 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]. “Realtime, continuous monitoring of all critical railway car components can be monitored and predictive analytics performed for wheels, bearings and trucks which is dynamically adjusted to operating conditions.” *Id.*

320. A PHOSITA would understand that “trend modeling” is a type of analysis that (a) uses a model to predict *expected* sensor readings, based on the current operating conditions, and (b) identifies *actual* sensor readings that lie outside the predicted range. Specifically, a PHOSITA would understand that trend modeling involves a *comparison* between (a) the statistical model (i.e., the expected trend) and (b) the actual data, which may lie outside the expected range predicted by the model, and that Armitage’s system raises an alarm if the actual data falls outside the expected range. In Armitage’s system, this analysis can be performed by the control node (i.e., the CMU), by the collection node (i.e., the base unit), or both. EX1006, ¶ [0043]. I have provided a more detailed discussion

of this point below in Limitation 13(b), Limitation 13(d), and Dependent Claim 15, Sections IX.F.5.b, IX.F.5.d, and IX.F.7 above, all of which are incorporated here by reference.

321. Armitage therefore discloses or renders obvious every element of dependent claim 20.

12. Dependent Claim 21: “The system of claim 5 wherein said alarms are determined based on a comparison of currently collected data versus data collected over a pre-determined preceding time period.”

322. Armitage discloses numerous analytical techniques that involve a comparison between (a) currently collected data, and (b) data collected over a pre-determined period of time

323. For example, as I explained above with respect to Claim 20, the “trend modeling” performed in Armitage’s system involves a comparison between (a) currently collected data, and (b) data collected over a pre-determined period of time.

324. As an additional example, Armitage teaches that its system “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.” EX1006, ¶ [0029]. In other words, Armitage teaches that temperature anomalies can be detected by comparing current temperature data (i.e., the current sensor

reading) with temperature data collected over a pre-determined period of time (i.e., the running average. *See also* EX1006, ¶ [0043] (describing a similar procedure).

325. Armitage therefore discloses or renders obvious every element of dependent claim 21.

13. Dependent Claim 22: “The system of claim 5 wherein an alarm is raised based one or more of the following criteria: a. a pre-determined percentage of current data readings exceeds allowable peak readings; b. a pre-determined percentage of current data readings exceeds a determined value; c. a pre-determined percentage of current data readings exceeds a standard deviation from readings from the same railcar; d. a pre-determined percentage of current data readings exceeds a standard deviation from all railcars in the fleet; or e. the rate of change of current data readings exceeds a pre-determined threshold.”

326. A system meets the limitations of claim 22 if an alarm is raised based on *any one* of criteria (a) through (e). Criteria (a) through (e) recited in claim 22 are well-known, conventional heuristic techniques that would have been obvious to a PHOSITA, and could have been routinely implemented to detect failure conditions with a reasonable expectation of success. I have explained this in detail in Section IX.D.7 above, which is incorporated here by reference.

327. Armitage discloses a variety of heuristic techniques that fall within the scope of claim 22. For example, Armitage teaches that:

In some examples, 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, among other examples.

EX1006, ¶ [0041]. This corresponds to criteria (c).

328. It is therefore my opinion that Armitage, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 22.

14. Dependent Claim 26: “The system of claim 2 wherein said communication management unit applies heuristics to analyze data collected from said one or more sensor devices (a) to determine if an actual failure exists and (b) to predict potential or imminent failures based on a statistical analysis of said collected data.”

329. *See* Dependent Claim 3, Section IX.F.2 above. For the same reasons I have discussed above with respect to Claim 3, it is my opinion that Claim 26 is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 276–281 above also reflect my opinions with respect to Claim 26, and are incorporated here by reference

15. Dependent Claim 27

a. Limitation 27(a): “The system of claim 2 further comprising a second temperature sensor located on said railcar for measuring ambient air temperature”

330. 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”); ¶ [0029] (“the ambient temperature or weather conditions could be evaluated”).

b. Limitation 27(b): “wherein said system uses information obtained from said second temperature sensor about the ambient temperature to calibrate the temperature data received from said first sensor regarding the item of the railcar being monitored.”

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

332. 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 thus 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.

333. More generally, a PHOSITA would have understood that information about ambient temperature is useful to calibrate readings from temperature sensors, particularly in an outdoor environment. I have explained this in detail in Section IX.C.16.b above, which is incorporated here by reference.

334. It is therefore my opinion that Armitage, together with the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 27.

16. Dependent Claim 28: “The system of claim 2 wherein said communicating management unit is capable of communicating data and alarms to a remote location located off of the train of which the railcar is a part.”

335. Armitage discloses that the control node on each railcar (i.e., a CMU) wirelessly transmits information, such as sensor data and alarm messages, to a collection node (i.e., a base unit). EX1006, ¶¶ [0004], [0019]–[0020], [0038], Fig. 1. I have provided a more detailed discussion of this point below in Limitation 13(a) and Limitation 13(b), Sections IX.F.5.a and IX.F.5.b above, which are incorporated here by reference.

336. Armitage further discloses that the collection node can be in a remote location located off of the train. As one example, the collection node can be “a rail-side or handheld device.” EX1006, ¶ [0039]. Alternatively, a PHOSITA would understand that the collection node could be a server, or a collection of servers, located in a data center. EX1006, ¶¶ [0019], [0039]. When Armitage refers to “application servers,” “web servers,” and the like, a PHOSITA would understand that these components are located in a stationary location such as a remote data center, and not on a moving train.

337. Armitage therefore discloses or renders obvious every element of dependent claim 28.

17. Dependent Claim 32

338. *See* Dependent Claim 28, Section IX.F.15 above. For the same reasons I have discussed above with respect to Claim 28, it is my opinion that Claim 32 is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 335–337 above also reflect my opinions with respect to Claim 32, and are incorporated here by reference.

G. Ground 5: Claims 4, 6, 8, 9, 10, 23, 25, and 29–31 are unpatentable under 35 U.S.C. § 103(a) as obvious over Armitage in view of LeFebvre

1. Motivation to Combine Armitage and LeFebvre

339. 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.

- Like Armitage, LeFebvre is directed to a system for wirelessly monitoring the condition of railcar wheels and wheel bearings. *See* EX1005, (57) Abstract.
- 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. EX1005, (57) Abstract.

- 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].
- 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].

340. A PHOSITA therefore would have understood that Armitage and LeFebvre are analogous art—indeed, they are extremely similar references that describe extremely similar systems for monitoring the condition of wheels and wheel bearings on railcars. Because the references are so similar, a PHOSITA would have considered both of them when designing and implementing a railcar monitoring system. And in my opinion, a PHOSITA could have combined the teachings found in the disclosures of Armitage and LeFebvre with a reasonable expectation of success.

2. Dependent Claim 4: “The system of claim 2 wherein each of said plurality of sensor devices is capable of exchanging data with other of said plurality of sensor devices and with said communication management unit.”

341. Armitage does not expressly disclose that each sensor device is capable of exchanging data with other sensor devices. However, the use of wireless mesh networking was widely known in the art prior to the effective filing date of

the '223 Patent, and could have been implemented by a PHOSITA with a reasonable expectation of success.

342. LeFebvre, for example, teaches that sensor nodes may be connected to the CMU using a mesh networking protocol conforming to the IEEE802.15.4 standard, such as ZigBee. *See* Section IX.C.3 above, which is incorporated here by reference. A PHOSITA would have understood that mesh networking protocols provide certain advantages relative to point-to-point protocols such as Bluetooth or WiFi—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). All of this was known, and a PHOSITA would have been motivated to implement a mesh network on Armitage’s railcar for at least this reason.

343. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 4.

3. Dependent Claim 6: “The system of claim 5 wherein said determination of an alarm condition can be made by one of said sensor units.”

344. Armitage does not expressly state that its sensor devices can determine an alarm condition. LeFebvre, however, describes this limitation in detail. *See* Section IX.C.5 above, which is incorporated here by reference. A PHOSITA would have understood that the burden of transmitting all data collected from the sensors is “extremely large,” and that to “reduce the radio traffic to

manageable proportions,” it is desirable to “[look] for signs of trouble and then send only essential indicative information” upstream to the control node. EX1005, ¶ [0053]. Determining the presence of an alarm device at the sensor node, rather than upstream, allows radio traffic to be reduced. Accordingly, a PHOSITA would have been motivated to combine the disclosures of Armitage and LeFebvre, and could have done so with a reasonable expectation of success.

345. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 6.

4. Dependent Claim 8

a. Limitation 8(a): “The system of claim 5 wherein each of said sensor units comprises: a. a sensor; b. a power source; c. a processor; d. memory; e. communications circuitry; and f. software, stored in said memory and executed by said processor”

346. In Armitage’s system, each sensor node comprises:

- one or more sensors (*see* Limitation 2(a), Section IX.F.1.b above),
- a power source (*see* Limitation 2(f), Section IX.F.1.g above),
- a processor (*see* Limitation 2(e), Section IX.F.1.f above),
- memory (*see* Limitation 5(e), Section IX.F.3.f above),
- and communications circuitry (*see* Limitation 2(g), Section IX.F.1.h above).

347. Armitage also discloses that each sensor node comprises software. EX1006, ¶ [0055] (“Processing system 620 retrieves and executes software 622 from storage system 621.”).

b. Limitation 8(b): “said software performing the functions of collecting data from said sensor at periodic intervals”

348. Armitage does not disclose that its sensor nodes periodically enter a standby state and periodically awaken to collect sensor readings.

349. This feature is disclosed, in detail, by LeFebvre. *See* Section IX.C.7.b above, which is incorporated here by reference. A PHOSITA would have been motivated to incorporate this feature into Armitage’s sensor nodes because—as LeFebvre explains—it saves power, as it allows the microprocessor in the sensor node to be in a low powered state most of the time. EX1005, ¶¶ [0034]–[0035].

350. More generally, this software architecture—where a microprocessor enters a sleep mode to save power, and wakes up periodically to collect input data, analyze it, and transmit the results—was a well-known, standard practice prior to the priority date of the ’223 Patent. In addition to being commonly used in railcar monitoring sensors (e.g., LeFebvre), numerous electronic devices in the consumer and industrial markets implement this type of power saving feature. Smoke alarms, for example, have used precisely this technique for decades—periodically awakening to check sensor readings, but otherwise entering a low-power state to save battery power. This feature is also ubiquitous in computing equipment

generally; by the mid-2000s, most microprocessors had *multiple* levels of “sleep” available, and came with clear technical instructions on how to activate these sleep levels using software running on the microprocessor. Accordingly, it is my opinion that this feature could have been implemented in the software running on Armitage’s sensor nodes, by a PHOSITA, without undue effort and with a reasonable expectation of success.

351. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of claim 8.

5. Dependent Claim 9

a. Limitations 9(a) and 9(b): “The system of claim 8 wherein said software further performs the function of: assessing the collected data to determine if an alarm condition exists; and communicating said alarm condition to said communication management unit via said communications circuitry”

352. Armitage does not expressly state that its sensor devices can determine an alarm condition. However, as I have explained above with respect to claim 6, it would have been obvious in view of LeFebvre to modify Armitage’s sensor nodes to include this functionality. *See* Dependent Claim 6, Section IX.G.3 above, which is incorporated here by reference.

b. Limitation 9(c): “and managing the power consumption of said sensor unit by placing said sensor unit in a standby state and periodically awakening said sensor unit to collect data from said sensor and to transmit information

regarding said operating parameter to said communication management unit via said communication circuitry.”

353. Armitage does not disclose that its sensor nodes periodically enter a standby state and periodically awaken to collect sensor readings. However, as I have explained above with respect to Limitation 8(b), it would have been obvious in view of LeFebvre to modify Armitage’s sensor nodes to include this functionality. *See* Section IX.G.4.b above, which is incorporated here by reference.

6. Dependent Claim 10: “The system of claim 5 wherein said one or more sensor units and said communication management unit are in wireless communication with each other and form a local area wireless network for said railcar.”

354. *See* Dependent Claim 4, Section IX.G.2 above. For the same reasons I have discussed above with respect to Claim 4, it is my opinion that Dependent Claim 10 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 341–343 above also reflect my opinions with respect to Claim 10, and are incorporated here by reference.

7. Independent Claim 23

a. Claim 23 Preamble: “A monitoring device for monitoring temperature on a railcar, comprising”

355. *See* Claim 2 Preamble, Section IX.F.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 23 Preamble is also fully disclosed by Armitage. Specifically, the

opinions I have expressed in paragraph 251 above also reflect my opinions with respect to the Claim 23 Preamble, and are incorporated here by reference.

b. Limitation 23(a): “a housing mountable on a railcar”

356. *See* Limitation 2(c), Section IX.F.1.d above. For the same reasons I have discussed above with respect to Limitation 2(c), it is my opinion that Limitation 23(a) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 259–260 above also reflect my opinions with respect to Limitation 23(a), and are incorporated here by reference.

c. Limitation 23(b): “a temperature sensor configured to be in thermal communication with a portion of the railcar to be monitored for temperature, which portion is external to said housing”

357. *See* Limitation 2(d), Section IX.F.1.e above. For the same reasons I have discussed above with respect to Limitation 2(d), it is my opinion that Limitation 23(b) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 261–262 above also reflect my opinions with respect to Limitation 23(b), and are incorporated here by reference.

d. Limitation 23(c): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

358. *See* Limitation 2(e), Section IX.F.1.f above. For the same reasons I have discussed above with respect to Limitation 2(e), it is my opinion that Limitation 23(c) is also fully disclosed by Armitage. Specifically, the opinions I

have expressed in paragraphs 263–265 above also reflect my opinions with respect to Limitation 23(c), and are incorporated here by reference.

e. Limitation 23(d): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

359. *See* Limitation 2(f), Section IX.F.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 23(d) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 266–267 above also reflect my opinions with respect to Limitation 23(d), and are incorporated here by reference.

f. Limitation 23(e): “a communication device capable broadcasting information regarding the temperature sensed, said communication device positioned within said housing”

360. *See* Limitation 2(g), Section IX.F.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 23(e) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 268–270 above also reflect my opinions with respect to Limitation 23(e), and are incorporated here by reference.

g. Limitation 23(f): “wherein the power consumption of said monitoring device is managed by placing said monitoring device in a standby state and periodically awakening said monitoring device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry”

361. *See* Limitation 8(b), Section IX.G.4.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that

Limitation 23(f) is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 348–351 above also reflect my opinions with respect to Limitation 23(f), and are incorporated here by reference.

h. Claim 23 is Obvious in view of Armitage and LeFebvre

362. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of independent claim 23. As I have explained in detail above, a PHOSITA could have arrived at the solution of independent claim 23 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. It is therefore my opinion that claim 23 is obvious over Armitage in view of LeFebvre.

8. Dependent Claim 25: “The monitoring device of claim 23 wherein said circuitry is configured to apply heuristics to analyze data collected from said temperature sensor to determine if a problem exists.”

363. *See* Dependent Claim 6, Section IX.G.3 above. For the same reasons I have discussed above with respect to Claim 6, it is my opinion that Claim 25 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 344–345 above also

reflect my opinions with respect to Claim 25, and are incorporated here by reference.

9. Dependent Claim 29: “The system of claim 2 wherein the power consumption of each of said sensor devices is managed by placing each said sensor device in a standby state and periodically awakening said sensor device to collect readings from said sensor device and to transmit the information regarding the parameter or condition being sensed via said communication circuitry.”

364. *See* Limitation 8(b), Section IX.G.4.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Claim 29 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 348–351 above also reflect my opinions with respect to Claim 29, and are incorporated here by reference.

10. Dependent Claim 30: “The system of claim 2 wherein said communication management unit and said plurality of sensor devices form a wireless mesh network for said railcar.”

365. *See* Dependent Claim 4, Section IX.G.2 above. For the same reasons I have discussed above with respect to Claim 4, it is my opinion that Claim 30 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 341–343 above also reflect my opinions with respect to Claim 30, and are incorporated here by reference.

11. Dependent Claim 31: “The system of claim 5 wherein the power consumption of each of said sensing units is managed by placing each sensing unit in a standby state and periodically awakening said sensing unit to collect readings from said sensor and to transmit information via said communications circuitry.”

366. *See* Limitation 8(b), Section IX.G.4.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Claim 31 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 348–351 above also reflect my opinions with respect to Claim 31, and are incorporated here by reference.

H. Ground 6: Claims 1 and 24 are unpatentable under 35 U.S.C. § 103(a) as obvious over Armitage in view of LeFebvre, Provasnik, and Denny

1. Motivation to Combine Armitage, LeFebvre, Provasnik, and Denny

367. Armitage and LeFebvre do not expressly disclose the “external temperature sensor” limitations of claims 1 and 24. As discussed with respect to Ground 3, Section IX.E.1 above, these limitations would have been obvious to a PHOSITA based on the general knowledge in the art, which is illustrated by Denny and Provasnik.

368. Armitage, LeFebvre, Denny, and Provasnik are analogous art. *See* Section IX.E.1 and Section IX.G.1 above. All four references are directed to devices for monitoring the temperature of metallic mechanical components—specifically, wheel bearings (Armitage and Denny) and engines (Provasnik). A

PHOSITA would have been motivated to modify Armitage's sensor device to include an external temperature sensor with a magnetic attachment for the reasons discussed in further detail below.

2. Independent Claim 1

a. Claim 1 Preamble: "A sensor device for monitoring temperature on a railcar, comprising"

369. *See* Claim 2 Preamble, Section IX.F.1.a above. For the same reasons I have discussed above with respect to the Claim 2 Preamble, it is my opinion that the Claim 1 Preamble is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraph 251 above also reflect my opinions with respect to the Claim 1 Preamble, and are incorporated here by reference.

b. Limitation 1(a): "a housing mountable on a railcar"

370. *See* Limitation 2(c), Section IX.F.1.d above. For the same reasons I have discussed above with respect to Limitation 2(c), it is my opinion that Limitation 1(a) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 259–260 above also reflect my opinions with respect to Limitation 1(a), and are incorporated here by reference.

c. Limitation 1(b): "a temperature sensor"

371. *See* Limitation 2(b), Section IX.F.1.c above. For the same reasons I have discussed above with respect to Limitation 2(b), it is my opinion that Limitation 1(b) is also fully disclosed by Armitage. Specifically, the opinions I

have expressed in paragraphs 257–258 above also reflect my opinions with respect to Limitation 1(b), and are incorporated here by reference.

d. Limitation 1(c): “electrical circuitry in communication with said temperature sensor for obtaining information regarding the temperature being sensed, said electrical circuitry positioned within said housing”

372. *See* Limitation 2(e), Section IX.F.1.f above. For the same reasons I have discussed above with respect to Limitation 2(e), it is my opinion that Limitation 1(c) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 263–265 above also reflect my opinions with respect to Limitation 1(c), and are incorporated here by reference.

e. Limitation 1(d): “a power source electrically connected to said electrical circuitry for providing power thereto, said power source positioned within said housing”

373. *See* Limitation 2(f), Section IX.F.1.g above. For the same reasons I have discussed above with respect to Limitation 2(f), it is my opinion that Limitation 1(d) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 266–267 above also reflect my opinions with respect to Limitation 1(d), and are incorporated here by reference.

f. Limitation 1(e): “a probe external to said housing and which probe includes said temperature sensor and a magnet positioned to magnetically attract the part of the railcar against which the probe will be placed”

374. Armitage does not expressly disclose a temperature sensor that is external to the housing. However, as I have explained in detail in Section IX.E.2.f above (which is incorporated here by reference), selecting an optimal location for a

temperature sensor would have been a straightforward design choice for a PHOSITA. External temperature sensors were standard, commonly used components with well-understood advantages (e.g., monitoring high-temperature components). A PHOSITA would have been motivated to use an external sensor probe because, as I have explained above, it is obvious that placing a temperature probe closer to the element to be monitored (e.g., a wheel bearing) will provide a more accurate temperature reading. Evidence is provided by Denny (EX1008), which discloses an external temperature probe as I have discussed in detail above.

375. Similarly, magnetic attachments were standard, commonly used components with well-understood advantages (e.g., for removably attaching a probe to a metallic substrate). A PHOSITA would have been motivated to use a magnetic attachment for the temperature because, as I have explained above, it is obvious that a magnet would quickly and easily attract the temperature probe to the metallic component to be monitored. Evidence is provided by Provasnik (EX1009), which discloses the use of a temperature probe having a magnetic attachment as I have discussed in detail above. Armitage likewise states that each sensor node may be “coupled to the associated undercarriage element with a magnet.” EX1006, ¶ [0015]. Accordingly, and for the additional reasons I have explained in Section IX.E.2.f above, it would have been obvious to attach Armitage’s temperature sensor to an undercarriage element using a magnet.

376. In summary, to the extent that Armitage fails to expressly disclose a magnetically attached temperature sensor that is external to the housing, a PHOSITA could have arrived at the claimed solution by combining prior art elements according to known methods to yield predictable results.

g. Limitation 1(f): “a communication device capable of broadcasting information regarding the temperature sensed, said communication device positioned within said housing”

377. *See* Limitation 2(g), Section IX.F.1.h above. For the same reasons I have discussed above with respect to Limitation 2(g), it is my opinion that Limitation 1(f) is also fully disclosed by Armitage. Specifically, the opinions I have expressed in paragraphs 268–270 above also reflect my opinions with respect to Limitation 1(f), and are incorporated here by reference.

h. Limitation 1(g): “wherein the power consumption of said sensor device is managed by placing said sensor device in a standby state and periodically awakening said sensor device to collect readings from said temperature sensor and to transmit the information regarding the temperature sensed via said communication circuitry”

378. *See* Limitation 8(b), Section IX.G.4.b above. For the same reasons I have discussed above with respect to Limitation 8(b), it is my opinion that Limitation 1(g) is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 348–351 above also reflect my opinions with respect to Limitation 1(g), and are incorporated here by reference.

i. Claim 1 is Obvious in view of Armitage and LeFebvre

379. It is therefore my opinion that Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, discloses or renders obvious every element of independent claim 1. As I have explained in detail above, a PHOSITA could have arrived at the solution of independent claim 1 by combining prior art elements according to known methods to yield predictable results. To the limited extent that a PHOSITA would need to modify the disclosure of Armitage, the required modifications are obvious, predictable, and could have been carried out by the PHOSITA with a reasonable expectation of success. Armitage, in view of LeFebvre and the general knowledge possessed by a PHOSITA, therefore renders obvious every element of independent claim 1.

3. Dependent Claim 24: “The monitoring device of claim 23 wherein at least a section of said temperature sensor is disposed outside of and spaced from said housing to be capable of contacting the surface of the railcar for which the temperature is to be monitored.”

380. *See* Limitation 1(e), Section IX.H.2.f above. For the same reasons I have discussed above with respect to Limitation 1(e), it is my opinion that Claim 24 is also obvious over Armitage in view of LeFebvre and the general knowledge in the art. Specifically, the opinions I have expressed in paragraphs 374–376 above also reflect my opinions with respect to Claim 24, and are incorporated here by reference.

X. CONCLUSION

381. For these reasons, it is my opinion that claims 1–10, 13–18, and 20–32 of the '223 patent are unpatentable.

I understand that this declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also understand that I may be subject to cross-examination concerning this declaration, and I will appear for cross-examination, if required of me, during the time allotted for cross-examination.

I hereby declare that all of the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

January 30, 2023



STEVEN RICCA