

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

Case IPR2023-00540
US Patent No. 10,137,915

Before JAMES P. CALVE, KEVIN W. CHERRY, and MICHAEL L. WOODS,
Administrative Patent Judges.

**PETITIONER'S OPPOSITION TO
PATENT OWNER'S MOTION TO AMEND**

TABLE OF CONTENTS

	Page(s)
TABLE OF CONTENTS.....	i
TABLE OF AUTHORITIES	ii
EXHIBIT LIST	iii
I. SUBSTITUTE CLAIMS 38-48 ARE INVALID UNDER 35 U.S.C. § 103.....	1
A. Armitage, LeFebvre, Barone, Winfree, and Leitel are Analogous Art.....	2
B. Claim 38	3
C. Claim 46	20
D. Claim 47	20
E. Dependent Claims 39–45 and 48	21
II. CONCLUSION.....	24

TABLE OF AUTHORITIES

	Page
Cases	
<i>In re Harza</i> , 274 F.2d 669 (C.C.P.A. 1960)	11
<i>In re Fulton</i> , 391 F.3d 1195 (Fed. Cir. 2004)	10
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007)	13
Regulations	
37 C.F.R. §42.121(d)(2)	1
Other Authorities	
MPEP § 2144.04(VI)	11

EXHIBIT LIST

Ex #	Exhibit Description
1001	U.S. Patent No. 10,137,915 (“the ’915 Patent”)
1002	Prosecution History of the ’915 Patent
1003	Expert Declaration of Steven Ricca
1004	<i>Curriculum Vitae</i> for Steven Ricca
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. 7,706,213 to Winfree et al. (“Winfree”)
1009	Bonnie Baker, <u>Filtering? Before or After?</u> , EDN (February 20, 2003), https://www.edn.com/filtering-before-or-after/
1010	Potting and Encapsulation, Master Bond Inc., https://www.masterbond.com/applications/potting-and-encapsulation
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	<i>Intentionally Omitted</i>
1014	<i>Intentionally Omitted</i>
1015	<i>Intentionally Omitted</i>
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
1018	<i>Intentionally Omitted</i>
1019	<i>Intentionally Omitted</i>
1020	Transcript of Conference Call Before James P. Calve, Kevin W. Cherry, and Michael L. Woods (June 8, 2023)

Ex #	Exhibit Description
1021	International Heavy Haul Association Order Confirmation for Electronic Copy of 2007 Conference Proceedings (<i>Not Filed</i>)
1022	International Heavy Haul Association 2007 Conference Proceedings (<i>Not Filed</i>)
1023	June 18, 2011 Wayback Machine Web Capture of “Past Conferences” page on International Heavy Haul Association website (<i>Not Filed</i>)
1024	Declaration of Steven Ricca in support of Exhibits 1009-1010 (<i>Not Filed</i>)
1025	Expert Declaration of Steven Ricca in Support of Petitioner’s Reply
1026	MSP430F1611 Manual (Texas Instruments)
1027	MSP430FG4618 Manual (Texas Instruments)
1028	Expert Declaration of Steven Ricca in Support of Petitioner’s Opposition to Motion to Amend
1029	U.S. Patent Publication No. 2011/0231039 A1 to Leitel et al. (“Leitel”)

Patent Owner's Motion to Amend (Paper No. 16 ("Motion")) should be denied because substitute claims 38-48 are obvious in view of the prior art.

I. SUBSTITUTE CLAIMS 38-48 ARE INVALID UNDER 35 U.S.C. § 103

The Motion should be denied pursuant to 37 C.F.R. §42.121(d)(2) because the newly amended claims are unpatentable over the prior art under 35 U.S.C. § 103. Specifically, a PHOSITA would have understood that substitute claims 38–48 are obvious in view of the prior art under at least the following grounds (EX1028, ¶¶ 12-13):

- Ground 1: Claims 38, 40, 42, 43, and 45–48 are unpatentable under 35 U.S.C. § 103(a) in view of Armitage and Barone;
- Ground 2: Claims 38, 40, 42, 43, 45–48 are unpatentable under 35 U.S.C. § 103(a) in view of Armitage, Barone, and Leitel;
- Ground 3: Claim 39 is unpatentable under 35 U.S.C. § 103(a) in view of Armitage, Barone, LeFebvre, and Leitel;
- Ground 4: Claims 41 and 44 are unpatentable under 35 U.S.C. § 103(a) in view of Armitage, Barone, Leitel, and Winfree;
- Ground 5: Claims 38, 39, 40, 42, 43, 45–48 are unpatentable under 35 U.S.C. § 103(a) in view of LeFebvre, Barone, and Armitage;
- Ground 6: Claims 38, 39, 40, 42, 43, 45–48 are unpatentable under 35 U.S.C. § 103(a) in view of Lefebvre, Barone, Armitage, and Leitel; and

- Ground 7: Claims 41 and 44 are unpatentable under 35 U.S.C. § 103(a) in view of LeFebvre, Barone, Armitage, and Winfree.

A. Armitage, LeFebvre, Barone, Winfree, and Leitel are Analogous Art

As explained in the Petition (“Pet.”), Armitage, LeFebvre, and Barone are analogous art and a PHOSITA would have found it obvious to combine their disclosures. *See* Pet., 20-21, 44-45, 49-50; EX1003, ¶¶ 66, 135, 137, 145; EX1028, ¶ 14. Armitage, LeFebvre, and Barone each describe systems for wirelessly monitoring rail vehicles and utilize nearly identical components that function in a similar way. *See* EX1005, (57) Abstract; EX1006, (57) Abstract; EX1007, (57) Abstract. Specifically, each reference discloses a system that utilizes a plurality of wireless sensors to monitor the wheels on a rail vehicle, wherein the sensors communicate with a control unit located on the vehicle to determine anomalous conditions of a railcar in real-time and to wirelessly report the anomalous conditions and determine a failure condition. EX1005, ¶¶ [0058]–[0059]; EX1006, ¶¶ [0013]–[0015], [0025]; EX1007, Abstract, ¶¶ [0002], [0006]; EX1028, ¶ 14.

Like Armitage, LeFebvre, and Barone, Leitel is also directed to a system for wirelessly monitoring rail vehicles using wireless sensor devices. EX1029; EX1028, ¶ 15. Leitel describes wireless sensor devices that can be attached, for example, to the shaft of a vehicle axle of a rail vehicle. EX1029, ¶ [0004]; *id.* The sensor devices

can include a variety of sensors, including temperature sensors capable of detecting bearing temperature (*id.*, ¶ [0018]), and acceleration sensors capable of detecting wheel damage (¶ [0062]), wheel derailments (¶ [0066]), and other conditions. *Id.* Leitel’s sensor devices can wirelessly transmit signals to a telematics unit mounted on the railcar, which in turn is capable of wirelessly transmitting an alarm signal to a remote location. EX1029, ¶¶ [0144]–[0146], Fig. 11; EX1028, ¶ 15.

Winfree, titled “Mechanical filter for sensors,” broadly discloses a filter for mechanical waves entering a sensor. EX1008, (57) Abstract. As explained in detail in the Petition, a PHOSITA would have been motivated to combine the teachings of Armitage, LeFebvre, and the other cited references with Winfree to add another layer of filtering—with a mechanical filter—to filter out undesirable accelerations. *See* Pet. at 45-49, 77-80; EX1003, ¶¶ 138-143, 225-230; EX1028, ¶ 16.

A PHOSITA therefore would have understood that Armitage, LeFebvre, Barone, Leitel, and Winfree are analogous art. EX1028, ¶ 17. A PHOSITA would have been motivated to combine the teachings of these references for the reasons discussed in further detail below.

B. Claim 38

Grounds 1, 2: Most limitations of claim 38, including all limitations present in original claim 1, are disclosed by Armitage and Barone. *See* Pet., 21-33; EX1003, ¶¶ 68-90; EX1028, ¶ 18.

Grounds 5, 6: Most limitations of claim 38, including all limitations present in original claim 1, are disclosed by LeFebvre and Barone. *See* Pet., 51-61; EX1003 at ¶¶ 147-170; EX1028, ¶ 19.

New limitations of claim 38 not previously addressed with respect to original claim 1 are discussed below.

- i. **Limitation 38(b)**: “one or more wireless sensor[[s]] nodes located on said one or more **railcars** and configured to sense an operational parameter of said one or more railcars, said one or more wireless sensor[[s]] nodes being in communication with said one or more communication management units, wherein the one or more wireless sensor[[s]] nodes comprise a tri-axis ~~one or more~~ sensor[[s]] configured to measure accelerations of the railcar along a plurality of axes comprising a first axis extending along a length of the railcar, a second axis extending across a width of the railcar, and a third axis extending along a height of the railcar”

Grounds 1 and 2: As discussed in the Petition, Armitage discloses a railcar monitoring system comprising a plurality of sensor nodes, each of which is attached to a separate undercarriage element of a railcar. EX1003, ¶¶ 70, 74; EX1006, Figs. 1, 3, 5, ¶¶ [0012], [0014], [0020]; *see* Pet., 23-25. The sensor nodes communicate wirelessly with a control node (i.e., a communication management unit) located on the same railcar. EX1003, ¶¶ 70, 74; EX1006, ¶¶ [0004], [0012], [0014], [0027], [0033], [0054], Figs. 1, 3, 5; *see also* Abstract, Fig. 6, [0015]-[0016], [0025]-[0026], [0029]-[0031], [0034]-[0035], [0050], [0053]; EX1028, ¶ 21.

Armitage discloses that the sensor portion of its “sensor nodes” may comprise an accelerometer. EX1006, ¶¶ [0014], [0033], [0045], [0046], [0056]; EX1028, ¶ 21. Armitage specifically discloses that the accelerometer may be “a three-dimensional accelerometer, such as a solid state accelerometer device.” EX1006, ¶ [0045]; EX1028, ¶ 21. A PHOSITA would understand that “a three-dimensional accelerometer” measures accelerations along three perpendicular axes, which may be aligned with the width, length, and height of the railcar, respectively. EX1028, ¶ 22. Armitage (EX1006), for example, discloses a preferred embodiment where the “z-axis [is] aligned with the axle of a particular wheel or wheel assembly,” the “x-axis [is] aligned with the horizontal,” and the “y-axis [is] aligned with the vertical with respect to the railway car or wheel.” *Id.* In this example, the z-, x-, and y-axes extend along the width, length, and height dimensions of the railcar, respectively. *Id.*

Grounds 5 and 6: As addressed in the Petition, LeFebvre discloses a wireless system for continuously monitoring the behavior and condition of trucks, wheels, and bearings of a railcar. Pet., 52-54, 72-73; EX1003, ¶¶ 152, 155, 206; EX1005, ¶ [0006]; EX1028, ¶ 23. LeFebvre’s system includes a multiplicity of instrumented pads (i.e., wireless sensor nodes), which communicate wirelessly with a communications management unit located on the railcar. EX1003, ¶¶ 152, 155, 206; EX1005, ¶¶ [0024]-[0026], Fig. 1; *see also* EX1005, [0021], [0031]-[0032];

EX1028, ¶ 23.

LeFebvre discloses that its sensor nodes may include a variety of sensors, including accelerometers. EX1005, Claims 28, 30; EX1003, ¶ 152; EX1028, ¶¶ 23-24. LeFebvre, however, is silent about the specific features of the accelerometer in its sensor node and does not expressly state that it is a *triaxial* accelerometer as required by Limitation 38(b). EX1028, ¶ 24. A PHOSITA would have understood, however, that there were compelling reasons to select a triaxial accelerometer (as opposed, for example, to a single-axis accelerometer) for incorporation into a railcar sensor device. *Id.*

First, LeFebvre discloses that its communication management unit (which comprises data control unit **23** and communications device **24**) may comprise “a *triaxial accelerometer*...for triggering certain analysis modes or verifying readings made by the pad and providing information on a variety of car body motions.” EX1005, ¶ [0037].¹ A PHOSITA would have understood that, because a triaxial accelerometer collects acceleration data along *three* axes, it is able to provide information on a wider variety of motions than (for example) a single-axis accelerometer. EX1028, ¶ 25.

Second, as discussed in Ground 1, *supra*, Armitage discloses that its sensor

¹ All emphasis is added unless otherwise noted.

nodes may comprise a triaxial accelerometer that measures accelerations along three perpendicular axes, which may be aligned with the width, length, and height of the railcar, respectively. As discussed in further detail with respect to Limitation 38(c) in Section I.B.ii, *infra*, a PHOSITA would have been motivated to select a triaxial accelerometer for use in LeFebvre’s sensor node (rather than, for example, a single-axis accelerometer) because a triaxial accelerometer is capable of monitoring a wider variety of conditions. EX1028, ¶ 26.

Third, a PHOSITA would have understood that a tri-axis accelerometer is—in practical effect—simply a combination of three perpendicular, single-axis accelerometers into a single device. EX1028, ¶ 27. The cost of a triaxial accelerometer is typically only slightly greater than that of a single-axis accelerometer and is typically much less expensive than purchasing three separate single-axis units. *Id.* Additionally, a triaxial accelerometer requires less work to install than three separate, single-axis accelerometers would. *Id.* A PHOSITA would therefore have been motivated to select a triaxial accelerometer for use in LeFebvre’s sensor nodes due to its simplicity, ease of installation, and cost-effectiveness. *Id.*

- ii. **Limitation 38(c):** “one or more sensor sections that are provided with the one or more wireless sensor nodes and that comprise a plurality of filters that are each configured to filter at least a portion of the accelerations by receiving an output signal directly from the tri-axis sensor and selecting ones of the accelerations in the output signal that were measured in a dimension represented

by a respective axis of the plurality of axes, wherein said communication management units perform the functions of

Ground 1: Armitage discloses a filter that takes output signals from a tri-axis sensor (i.e., a triaxial accelerometer) and isolates accelerations corresponding to a single axis. Specifically, Armitage states that:

“The accelerations monitored by the 3-D accelerometer are interpreted as vibrations. In some examples, *axial vibration is monitored along a single axis*, such as a z-axis aligned with the axle of a particular wheel or wheel assembly, *and vibrations in other axes are ignored*, such as radial axes including an x-axis aligned with the horizontal and a y-axis aligned with the vertical with respect to the railway car or wheel.”

EX1006 at ¶ [0045]; EX1028, ¶ 28.

Patent Owner’s expert, Dr. Shamos, admits that Armitage discloses a three-dimensional accelerometer. EX2008 at ¶ 22; EX1028, ¶ 29. Dr. Shamos nevertheless argues that because Armitage monitors vibrations along a single axis and “[v]ibrations along the other two axes...are ignored,” “the sensor is not tri-axial.” EX2008 at ¶ 22. A PHOSITA, however, would understand that a three-dimensional accelerometer—by definition—measures vibrations accelerations along three distinct dimensions. EX1028, ¶ 29. The fact that some of the acceleration measurements may be *ignored* or *discarded* by other components of the system does not change the nature of the acceleration sensor. *Id.* Rather, the manner in which Armitage's preferred embodiment processes the output of the three-dimensional accelerometer—selecting data corresponding to one axis and ignoring or discarding

data corresponding to the other two axes—is *precisely* the type of filtering that is encompassed by Limitation 38(c). *Id.*; see EX1001 (the '915 Patent), 13:11-24 (“[t]hese sensor sections select the data to be analyzed *using a digital data filter*...[d]ata selection can be based on, for example, *direction*...frequency...”); 13:36-14:9 (disclosing three sensor sections of the tri-axis accelerometer that extract certain characteristic data of railcar events corresponding to the x, y, and z axes).

Armitage also explains why, in the context of detecting wheel damage, it is beneficial to consider only accelerations along the z-axis (“axial” accelerations), and to ignore accelerations along the x- and y-axes (“radial” accelerations):

“Ignoring radial acceleration can allow for gravity and wheel balance effects to be minimized in the processing of vibration data for the wheel assemblies or wheels. Axial vibration data could still indicate wheel flat conditions, which are typically high impact, ‘loud’ events, vibrationally.”

EX1006, ¶ [0045]; EX1028, ¶ 30. In other words, filtering the output of a three-dimensional accelerometer to isolate vibrations from a single axis is useful to detect failure conditions, such as wheel damage, that are associated with vibrations along a single axis. *Id.*

Patent Owner has argued that Armitage only isolates vibrations from a single axis, and therefore “teaches away” from the system required in claim 38, which requires “a *plurality* of filters.” Motion, 17–18. But Armitage “does not criticize, discredit, or otherwise discourage” a PHOSITA from filtering a tri-axial

accelerometer's output into three separate outputs (corresponding to each of three axes), and therefore does not "teach away" from the system of claim 38. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). To the contrary, a PHOSITA would have been motivated to monitor accelerations along each axis (i.e., along each of the x-axis, the y-axis, and the z-axis) because each axis was known to be associated with one or more common problem conditions on a railcar. EX1028, ¶ 31.

For example, a PHOSITA would have understood that accelerations along the transverse axis extending along the width of the railcar can be used to monitor conditions including truck hunting, which is a repetitive movement truck back and forth across the line of the rails (*see, e.g.*, EX1005, ¶ [0054]), wheel flat conditions (EX1006, ¶ [0045]), and bearing defects, among others. EX1028, ¶ 32. A PHOSITA would have understood that accelerations along the vertical axis can be used to monitor conditions including track defects, which generate large and sudden forces in the wheels and bearings (*see, e.g.*, EX1005, ¶¶ [0054], [0066]), wheel derailments (*see, e.g.*, EX1005, ¶ [0061]; EX1029 (Leitel), ¶ [0066]), and bearing defects, among others. EX1028, ¶ 32. And a PHOSITA would have understood that accelerations along the longitudinal axis extending along the length of the railcar can be used to monitor conditions including track switching impacts (*see, e.g.*, EX1029 (Leitel), ¶ [0064]), truck hunting movements involving yaw displacements (*see, e.g.*, EX1005, ¶ [0062]), changes in velocity (including collisions), and bearing defects,

among others. EX1028, ¶ 32.

The claimed limitations are therefore obvious in view of Armitage. Armitage discloses a three-dimensional accelerometer, it discloses that the output can be filtered to isolate accelerations corresponding to a single axis, and it expressly provides an example of filtering accelerations along the axis extending along the width of the railcar. EX1006, ¶ [0045]; EX1028, ¶ 33. To the extent that claim 38 requires the use of *multiple* filters, each corresponding to a different axis, a PHOSITA would have been motivated to use multiple filters in order to monitor multiple axes and thereby detect a wider range of potential problem conditions. EX1028, ¶ 33.

Under controlling precedent, merely duplicating parts or features that are known in the prior art is not patentable. *In re Harza*, 274 F.2d 669, 671 (C.C.P.A. 1960) (“It is well settled that the mere duplication of parts has no patentable significance unless a new and unexpected result is produced.”); *see also* MPEP § 2144.04(VI) (citing *Harza*). Here, using three copies of a single-axis filter—i.e., the filter disclosed by Armitage, duplicated for each of the x-, y-, and z-axes—does not provide any new or unexpected results. EX1028, ¶ 34. Instead, three copies of the single-axis filter will provide *exactly* the result a PHOSITA expects: three output signals corresponding to (1) accelerations along the x-axis, (2) accelerations along the y-axis, and (3) accelerations along the z-axis. *Id.*

As discussed in the Petition, it would also have been obvious to a PHOSITA to filter the output signals from the triaxial accelerometer in Armitage using the techniques taught in Barone. Pet., 25-29. Barone explicitly teaches output of an “accelerometer 171” being transmitted to “signal conditioning 178”, where the analog signals are amplified and/or filtered as appropriate (electronic filter), and then routed to analog to digital (A/D) converters for wide bandwidth calculations and data manipulations. EX1003, ¶ 80; EX1007, ¶¶ [0114]-[0116], Fig. 8; EX1028, ¶ 35. Barone further teaches the use of a high-pass, low-pass, and/or band-pass filters to remove unwanted data and/or amplify particularly relevant accelerations data (e.g., using software running on micro-controller 177). EX1003, ¶ 81; EX1007, ¶¶ [0116], [0172]-[0185], Fig. 8; EX1028, ¶ 36. Barone explicitly discloses filtered data (both digital and electronic), which shows filtering accelerations was well-known in the art and a PHOSITA would be motivated to include the filtering taught by Barone to remove unwanted data and/or amplify particularly relevant accelerations data. EX1003, ¶ 81; EX1028, ¶ 36.

A PHOSITA therefore would have been motivated to apply the filtering techniques taught by Barone to the accelerometer data collected by Armitage for the same reasons discussed in the Petition: the advantage of filtering is to remove unwanted data and/or amplify particularly relevant data, and the purpose of both the Armitage and Barone systems is to analyze data in a train monitoring system to

accurately predict anomalous conditions and avoid false or inaccurate data processing. EX1003, ¶ 82; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007); EX1028, ¶ 37. Combining the selection/ignoring of data (i.e., filtering) in Armitage and the filtering taught in Barone would have predictably resulted in the filtering of accelerations data. EX1003, ¶¶ 76, 79, 82; EX1028, ¶ 37.

Ground 2: As discussed in Ground 1, *supra*, Armitage discloses a wireless sensor node comprising a tri-axis accelerometer, and further discloses filtering the output of the tri-axis accelerometer to isolate accelerations corresponding to a single axis. EX1028, ¶ 39. The discussion of Armitage and Barone with respect to Ground 1 above applies equally to Ground 2 and is incorporated herein by reference.

As discussed above, a PHOSITA would have found it obvious in view of Armitage to process the output of a tri-axis accelerometer using multiple filters—specifically, one filter for each of the x-, y-, and z-axes. EX1028, ¶ 39. Leitel expressly discloses monitoring acceleration data corresponding to each of the x-, y-, and z-axes, and a PHOSITA would have been motivated to combine the teachings of Armitage and Leitel as discussed in detail below. EX1028, ¶ 39.

Like Armitage, Leitel discloses a wireless system for monitoring railcars, including one or more wireless sensor nodes in communication with a telematics unit (i.e., a communication management unit) located on the railcar. *See, e.g.*, EX1029 at ¶¶ [0004], [0010], [0013], [0035], [0044], [0071], [0077], [0134];

EX1028, ¶ 40. The wireless sensor nodes can include acceleration sensors capable of detecting wheel damage (¶ [0062]), wheel derailments (¶ [0066]), and other conditions. *Id.*; EX1028, ¶ 40.

Leitel specifically discloses that the acceleration sensor may be a tri-axial sensor, which outputs signals corresponding to measured accelerations in three axial directions. EX1029, ¶¶ [0056] (“Acceleration sensors typically have one, two or *three axial directions* orthogonal to each other (also referred to as axes or dimensions), in which they can determine the *accelerations*. To each of these axial directions (axes, dimensions), *an output signal can be provided by the acceleration sensor.*”); ¶ [0060] (“Thus, the *acceleration sensor can be designed as a...3-dimensional sensor...*”); ¶ [0073] (“a device...can be composed of a one to three-axis...acceleration sensor...”); *see also* ¶¶ [0122], [0125], [0128], [01251]–[0164]; EX1028, ¶ 41.

Leitel teaches that the output of the tri-axial accelerometer is split into three separate signals, SX, SY, and SZ, associated with each of the three axes measured by the accelerometer. EX1029 at ¶ [0122]; *see also id.* at ¶¶ [0125], [0128], [0151]–[0164]; EX1028, ¶ 42. Leitel demonstrates that these signals are useful to detect a variety of conditions associated with a railcar. For example:

- ¶ [0154] – accelerations along the x-axis and z-axis can be used to determine headway;

- ¶ [0156] – accelerations along the x-axis and z-axis can be used to determine the location of wheel damage;
- ¶¶ [0156]-[0158] accelerations along the x-axis and z-axis can be used to determine vertical and horizontal impacts; and
- ¶ [0161] accelerations measured in the z-axis can be used to determine the speed of the vehicle axle.

See EX1029; EX1028, ¶ 43.

At paragraphs [0125] and [0128], Leitel notes that each of the output signals may be filtered in the sensor node before being transmitted to the telematics unit (i.e., the CMU, referenced in Leitel as “device 3”). Leitel notes several advantages of performing this filtering and processing on the sensor node, including reduction of the amount of data for storage or transmission, as well as the direct transmission of error codes and failure conditions to the CMU.

“The evaluation in the unit **23** can extend beyond intermediate storage and/or transmission of the sensor data SX, SY and/or SZ. It can be provided to perform certain evaluation steps already within the device **3** *to reduce the amount of data for storage/transmission* or to make subsequent evaluation dispensable. Thus, for example, the number of the revolutions of the wheels or the traveled distance could be immediately provided based on the sensor signals SX, SY and SZ. In addition, certain error signals (blockage of the wheels) could be calculated and/or transmitted with time designations such as point of time and/or duration of the error.”

EX1029, ¶ [0125]; *see also id.*, ¶ [0128] (“It has become apparent that *it is advantageous to preprocess numerous sensor data* such as for example the sensor data SX, SY, SZ in the device 3, as above described, and to output or *to transmit already the calculated quantities* (mileage or km reading, blockage of the wheels, error codes etc.).”).

Further, Leitel discloses that it is generally desirable to filter out vibrations or disturbances that are unrelated to the conditions being monitored. EX1029, ¶ [0028] (“It can be determined in that a movement sensor is attached, which determines a movement value, which is filtered and evaluated in order to block out simple vibrations or disturbances.”); EX1028, ¶¶ 44-45. Leitel discloses—and a PHOSITA would understand—that such “simple vibrations or disturbances” can be detected by monitoring accelerations collected by the tri-axis accelerometer. EX1029, ¶¶ [0091]-[0093] (explaining acceleration sensors can be used to determine vibrations); EX1028, ¶¶ 44-45.

In summary, a PHOSITA would have been motivated to filter the output of Armitage’s tri-axial accelerometer into three distinct outputs—one corresponding to each axis—as disclosed by Leitel. EX1028, ¶ 46. In particular, a PHOSITA would have understood that accelerations corresponding to each axis are useful to detect a variety of problems and other conditions of a railcar, either alone or as a combination of data from multiple selected axes. *Id.* Additionally, Leitel teaches that such

accelerations can be filtered and processed on the sensor nodes, prior to transmission to the CMU, which is consistent with the manner in which Armitage collects and processes data. *Id.*

Ground 5: As discussed above with respect to Limitation 38(c), LeFebvre discloses that its sensor node may comprise an accelerometer, but does not specify that the accelerometer is a *tri-axial* accelerometer. A PHOSITA would have been motivated, in view of Armitage, to select a tri-axial accelerometer for use in LeFebvre's sensor node. *See* Limitation 38(b), Grounds 5-6, *supra*; EX1028, ¶ 47.

For the same reasons discussed above with respect to Armitage, a PHOSITA would also have been motivated to filter the output of the tri-axial accelerometer into three distinct sets of acceleration data, corresponding to accelerations along the length, width, and height axes of the railcar. *See* Limitation 38(c), Ground 1, *supra*; EX1028, ¶ 48.² A PHOSITA would have been motivated to use multiple filters, corresponding to multiple axes, in order to monitor and detect a wider range of potential problem conditions than would be possible by monitoring only a single axis. EX1028, ¶ 48.

² For the same reasons discussed *supra* in Ground 1, and also in the Petition, a PHOSITA would have been motivated to combine the filtering of Barone with LeFebvre's system. Pet., 55-57; EX1003, ¶¶ 160-162; EX1028, ¶ 48.

This motivation is consistent with, and reinforced by, the disclosure of LeFebvre, which teaches that a triaxial accelerometer can be used to determine “a variety of car body motions.” EX1005 at ¶ [0037]; EX1028, ¶ 49. A PHOSITA would have understood that accelerations pertaining to particular axial orientations can determine certain events and/or failure conditions of the railcar. EX1028, ¶ 49. LeFebvre explicitly describes the use of certain directional measurements which “correspond[] to a particular inference that may be drawn if the data justifies it.” EX1005 at ¶ [0086]; EX1028, ¶ 49.

As one example, LeFebvre discusses the detection of truck hunting, which requires the detection of longitudinal, lateral and yawing forces. EX1005 at ¶ [0062]; EX1028, ¶ 50. As another example, LeFebvre discloses the detection of brake performance by monitoring the longitudinal forces (i.e., x-axis)— requiring the filtering of data in the other two directions in order to provide meaningful information. EX1005, ¶ [0065]; EX1028, ¶ 50. A PHOSITA would have understood that detection of these exemplary events in LeFebvre can only be accomplished by analyzing accelerations along the x, y, and z axes as measured by a triaxial accelerometer. EX1028, ¶ 50.

Further, as discussed in detail in the Petition, LeFebvre discloses the filtering of data, generally, at both the sensor and CMU level to identify “essential indicative information” from a large data set. Pet., 54-55; EX1003, ¶¶ 156-159. Because

LeFebvre generally teaches the collection and identification of acceleration data, it would have been obvious to a PHOSITA that the output of an accelerometer—for example, a triaxial accelerometer as disclosed by Armitage—could be filtered and analyzed to determine certain car body motions or failure conditions. EX1005, ¶¶ [0034]-[0037]; EX1028, ¶ 51. As discussed in the Petition, and with respect to Ground 1 above, it would also have been obvious to a PHOSITA to filter the output signals from the triaxial accelerometer using the techniques taught in Barone. Pet., 54-57; EX1003, ¶¶ 156-162; Limitation 38(c), Ground 1 *supra*; EX1028, ¶ 51

Ground 6: Having incorporated the elements addressed in the previous grounds, a PHOSITA would have been motivated to select a triaxial accelerometer for use in LeFebvre's sensor node, and to filter the acceleration outputs as taught in Armitage, Leitel, and Barone. EX1028, ¶ 52.

As explained in detail in Limitation 38(c), Ground 2, *supra*, Leitel teaches that the output of its tri-axial accelerometer is split into three separate signals, SX, SY, and SZ, associated with each of the three axes measured by the accelerometer. EX1029 at ¶ [0122]; *see also id.* at ¶¶ [0125], [0128], [0151]–[0164]; EX1028, ¶ 53. Leitel demonstrates that these signals are useful to detect a variety of conditions associated with a railcar. *Id.* A PHOSITA would have been motivated to use a tri-axial accelerometer, and to filter the resulting accelerations as taught by Armitage, Leitel, and Barone, in order to identify a wider range of potential problem conditions

than would be possible by monitoring only a single axis. *See* Limitation 38(c), Ground 1, *supra*; EX1028, ¶ 53.

C. Claim 46

Grounds 1, 2: Most limitations of claim 46, including all limitations present in original claim 30, are disclosed by Armitage and Barone. *See* Pet., 38-39; EX1003, ¶¶ 112-118; EX1028, ¶ 54.

Grounds 5, 6: Most limitations of claim 46, including all limitations present in original claim 30, are disclosed by LeFebvre and Barone. *See* Pet., 66-67; EX1003, ¶¶ 183-189; EX1028, ¶ 55.

Patent Owner acknowledges that “claim 46 is limited similar to independent substitute claim 38.” Mot., 20. Petitioner’s discussion of claim 38 in Sections I.B.i-ii, *supra* applies equally to claim 46. Accordingly, the new limitations of claim 46 that were not previously addressed in this proceeding with respect to claim 30 are addressed in Sections I.B.i-ii, *supra*; EX1028, ¶ 56.

D. Claim 47

Grounds 1, 2: Most limitations of claim 47, including all limitations present in original claim 36, are disclosed by Armitage and Barone. *See* Pet. at 39-40; EX1003, ¶¶ 119-125; EX1028, ¶ 57.

Grounds 5, 6: Most limitations of claim 47, including all limitations present in original claim 36, are disclosed by LeFebvre and Barone. *See* Pet. at 67; EX1003,

¶¶ 190-196; EX1028, ¶ 58.

Patent Owner acknowledges that “claim 47 is limited similar to independent substitute claim 38.” Mot. at 20. Petitioner’s discussion of claim 38 in Sections I.B.i-ii, *supra* applies equally to claim 47. Accordingly, the new limitations of claim 47 that were not previously addressed in this proceeding with respect to claim 30 are addressed in Sections I.B.i-ii, *supra*; EX1028, ¶ 59.

E. Dependent Claims 39–45 and 48

Dependent claims 39–45 and 48 depend from substitute independent claims 38, 46, and 47, each of which is unpatentable as obvious for the reasons discussed above. Patent Owner has not identified any features of dependent claims 39–45 or 48 that patentably distinguish the prior art, beyond the features of the independent claims from which they depend. Petitioner respectfully submits that these claims are obvious for the reasons set forth below.

i. Dependent Claim 39

Ground 3: The limitations in dependent claim 39, corresponding to original claim 21, are disclosed by Armitage in view of Barone and LeFebvre. *See* Pet. at 44-45; EX1003 at ¶¶ 136-137; EX1028, ¶ 60.

Ground 6: The limitations in dependent claims 39 and 45 corresponding to original claims 21 and 29 are disclosed by LeFebvre and Barone. *See* Pet. at 61, 66; EX1003 at ¶¶ 171, 182; EX1028, ¶ 61.

ii. Dependent Claim 40

Grounds 1 and 2: The limitations in dependent claim 40, corresponding to original claim 22, are disclosed by Armitage and Barone. *See* Pet. at 34; EX1003 at ¶ 91; EX1028, ¶ 62.

Grounds 5 and 6: The limitations in dependent claim 40, corresponding to original claim 22, are disclosed by LeFebvre and Barone. *See* Pet. at 61-62; EX1003 at ¶ 172; EX1028, ¶ 63.

iii. Dependent Claim 41

Ground 4: The limitations in dependent claim 41, corresponding to original claim 23, are disclosed by Armitage, Barone, and Winfree. *See* Pet. at 46-49; EX1003 at ¶¶ 139-143; EX1028, ¶ 64.

Ground 7: The limitations in dependent claim 41, corresponding to original claim 23, are disclosed by LeFebvre, Barone, Armitage, and Winfree. *See* Pet. at 77-80; EX1003 at ¶¶ 226-230; EX1028, ¶ 65.

To the extent claim 41 has been amended to require “one or more wireless sensor nodes” and a “tri-axis sensor,” these limitations are discussed above with respect to independent claim 38, from which claim 41 depends.

iv. Dependent Claim 42

Grounds 1 and 2: The limitations in dependent claim 42, corresponding to original claim 24, are disclosed by Armitage and Barone. *See* Pet. at 34-35; EX1003

at ¶¶ 93-100; EX1028, ¶ 67.

Grounds 5 and 6: The limitations in dependent claim 42, corresponding to original claim 24, are disclosed by LeFebvre, Barone, and Armitage. *See* Pet. at 72-74; EX1003 at ¶¶ 205-214; EX1028, ¶ 68.

To the extent claim 42 has been amended to require a “tri-axis sensor,” this limitation is discussed above with respect to independent claim 38, from which claim 41 depends.

v. Dependent Claim 43

Grounds 1 and 2: The limitations in dependent claim 43, corresponding to original claim 25, are disclosed by Armitage and Barone. *See* Pet. at 36-38; EX1003 at ¶¶ 101-108; EX1028, ¶ 70.

Grounds 5 and 6: The limitations in dependent claim 43, corresponding to original claim 25, are disclosed by LeFebvre and Barone. *See* Pet. at 62-66; EX1003 at ¶¶ 173-179; EX1028, ¶ 71.

vi. Dependent Claim 44

Ground 4: The limitations in dependent claim 44, corresponding to original claim 23, are disclosed by Armitage, Barone, and Winfree. *See* Pet. at 46-49; EX1003 at ¶¶ 139-143; EX1028, ¶ 72.

Ground 7: The limitations in dependent claim 44, corresponding to original claim 23, are disclosed by LeFebvre, Barone, Armitage, and Winfree. *See* Pet. at 77-

80; EX1003 at ¶¶ 226-230; EX1028, ¶ 73.

vii. Dependent Claim 45

Grounds 1 and 2: The limitations in dependent claim 45, corresponding to original claim 29, are disclosed by Armitage and Barone. *See* Pet. at 38; EX1003 at ¶ 111; EX1028, ¶ 74.

Grounds 5 and 6: The limitations in dependent claim 45, corresponding to original claim 29, are disclosed by LeFebvre and Barone. *See* Pet. at 66; EX1003 at ¶ 182; EX1028, ¶ 75.

viii. Dependent Claim 48

Grounds 1 and 2: The limitations in dependent claim 48, corresponding to original claim 37, are disclosed by Armitage and Barone. *See* Pet. at 40-44; EX1003 at ¶¶ 126-134; EX1028, ¶ 76.

Grounds 5 and 6: The limitations in dependent claim 48, corresponding to original claim 37, are disclosed by LeFebvre, Barone, and Armitage. *See* Pet. at 74-77; EX1003 at ¶¶ 215-224; EX1028, ¶ 77.

To the extent claim 48 has been amended to require a “tri-axis sensor,” this limitation is discussed above with respect to independent claim 47, from which claim 48 depends.

II. CONCLUSION

Petitioner respectfully requests that the Board deny the Motion to Amend.

Case No. IPR2023-00540
US Patent No. 10,137,915

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that on this 26th day of January 2024, the foregoing was served via electronic mail to the attorneys of record for the '915 Patent at the following address:

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LISTING OF CLAIMS

Claim Limitation	Claim Language
Claim 38 Preamble	A system for detecting operational anomalies on a train consist or railcar, comprising:
Limitation 38(a)	(a) one or more communication management units mounted on one or more railcars;
Limitation 38(b)	(b) one or more <u>wireless sensor</u> [[s]] <u>nodes</u> located on said one or more railcars <u>and</u> configured to sense an operational parameter of said one or more railcars, said <u>one or more wireless sensor</u> [[s]] <u>nodes</u> being in communication with said one or more communication management units, wherein the one or more <u>wireless sensor</u> [[s]] <u>nodes</u> comprise <u>a tri-axis ~~one or more~~ sensor</u> [[s]] configured to measure accelerations of the railcar <u>along a plurality of axes comprising a first axis extending along a length of the railcar, a second axis extending across a width of the railcar, and a third axis extending along a height of the railcar;</u> and
Limitation 38(c)	(c) one or more sensor sections that are provided with the <u>one or more wireless sensor nodes</u> and that comprise a <u>plurality of filters that are each</u> configured to filter at least a portion of the accelerations <u>by receiving an output signal directly from the tri-axis sensor and selecting ones of the accelerations in the output signal that were measured in a dimension represented by a respective axis of the plurality of axes,</u> wherein said communication management units perform the functions of:
Limitation 38(d)	(i) collecting, from the <u>one or more wireless sensor nodes,</u> data regarding said ~~one or more railcar~~ operational parameter[[s]] <u>of said one or more railcars;</u>
Limitation 38(e)	(ii) analyzing said collected data <u>to detect a</u> [[for]] <u>trend</u> [[s]] or event[[s]] indicative of an anomalous operational condition of said one or more railcars; and
Limitation 38(f)	(iii) communicating a message to a remote receiver when said trend or event is detected.

Claim 39	The system of claim <u>38</u> [[1]], wherein at least one of said communication management units includes at least one of ~~said~~ sensor[[s]] <u>configured to measure accelerations of the railcar.</u>
Claim 40	The system of claim <u>38</u> [[1]], further comprising a powered wireless gateway configured to control a train-based network that includes said powered wireless gateway and a plurality of said communication management units.
Claim 41	The system of claim <u>38</u> [[1]], wherein the one or more <u>wireless sensor nodes</u> ~~further filters~~ comprise one or more mechanical filters that include a resilient material configured to filter out undesirable accelerations from the accelerations, wherein the one or more mechanical filters are disposed to remove the undesirable accelerations before the undesirable accelerations reach the <u>tri-axis</u> ~~one or more~~ sensor[[s]] that <u>is</u> [[are]] configured to measure accelerations.
Claim 42	The system of claim <u>38</u> [[1]], ~~further comprising one or more wireless sensor nodes in communication with at least one of the communication management units, wherein the one or more sensors form part of the one or more wireless sensor nodes,~~ wherein one or more of the wireless sensor nodes comprise a protective housing, wherein the <u>tri-axis</u> ~~one or more~~ sensor[[s]] <u>is</u> [[are]] mounted within the protective housing, wherein the protective housing comprises a <u>potting</u> material configured to tune the wireless sensor nodes by absorbing at least a portion of undesirable accelerations.
Claim 43	The system of claim <u>38</u> [[1]], ~~further comprising one or more wireless sensor nodes in communication with at least one of the communication management units, wherein the one or more sensors form part of the one or more wireless sensor nodes,~~ wherein one or more of the wireless sensor nodes comprises a microprocessor configured to execute firmware to control operation of the one or more of the wireless sensor nodes, wherein the firmware comprises one or more software filters configured to isolate one or more types of accelerations.
Claim 44	The system of claim <u>38</u> [[1]], wherein the one or more <u>wireless sensor nodes</u> ~~filters further~~ comprise one or more mechanical filters.

Claim 45	The system of claim 38[[1]], wherein said remote receiver is located off-train.
Claim 46 Preamble	A method for detecting operational anomalies on a train consist or railcar comprising the steps of:
Limitation 46(a)	sensing, by <u>a ~~one or more~~ tri-axis sensor[[s]] of one or more wireless sensor nodes</u> located on one or more railcars, one or more operational parameters of the one or more railcars, wherein the one or more operational parameters comprise one or more accelerations <u>and the tri-axis sensor is configured to measure accelerations of the ~~one or more~~ railcar[[s]] along a plurality of axes comprising a first axis extending along a length of the railcar, a second axis extending across a width of the railcar, and a third axis extending along a height of the railcar;</u>
Limitation 46(b)	filtering, by <u>each of a plurality of ~~one or more~~ filters of one or more sensor sections</u> that are provided with the one or more wireless sensor nodes, at least a portion of the accelerations <u>by receiving an output signal directly from the tri-axis sensor and selecting ones of the accelerations in the output signal that were measured in a dimension represented by a respective axis of the plurality of axes; and</u>
Limitation 46(c)	by one or more communication management units associated with the one or more railcars: <u>collecting, from the one or more wireless sensor nodes, data regarding said ~~one or more railcar~~ operational parameters of said one or more railcars;</u>
Limitation 46(d)	analyzing said collected data <u>to detect a[[for]] trend[[s]] or event[[s]]</u> indicative of an anomalous operational condition of said one or more railcars; and
Limitation 46(e)	communicating a message to a remote receiver when said trend or event is detected.
Claim 47 Preamble	A system for detecting operational anomalies on a railcar that is part of a train consist comprising:
Limitation 47(a)	(a) at least one communication management unit (CMU) mounted on the <u>[[a]] railcar</u> in said train consist;

Limitation 47(b)	(b) at least two <u>wireless sensor</u> [[s]] <u>nodes</u> located on the [[said]]railcar <u>and</u> [[for]] configured to sense operational parameters of the railcar, said <u>wireless sensor</u> [[s]] <u>nodes</u> being in communication with said communication management unit, wherein the <u>at least two</u> ~~one or more~~ <u>wireless sensor</u> [[s]] <u>nodes</u> comprise a <u>tri-axis</u> ~~one or more~~ <u>sensor</u> [[s]] configured to measure accelerations of the railcar <u>along a plurality of axes comprising a first axis extending along a length of the railcar, a second axis extending across a width of the railcar, and a third axis extending along a height of the railcar; and</u>
Limitation 47(c)	(c) one or more <u>sensor sections</u> that are provided with the <u>one or more wireless sensor nodes</u> and that <u>comprise a plurality of filters that are each</u> configured to filter at least a portion of the accelerations <u>by receiving an output signal directly from the tri-axis sensor and selecting ones of the accelerations in the output signal that were measured in a dimension represented by a respective axis of the plurality of axes,</u> wherein said communication management unit performs the following functions:
Limitation 47(d)	(i) receiving data from said <u>at least two wireless sensor</u> [[s]] <u>nodes</u> ;
Limitation 47(e)	(ii) drawing inferences from the data received from at least two <u>wireless</u> ~~of the~~ <u>sensor</u> [[s]] <u>nodes</u> regarding the performance of the railcar; and
Limitation 47(f)	(iii) communicating a message to a remote receiver when an anomaly is detected.
Claim 48 Preamble	The system of claim <u>47</u> [[36]],
Limitation 48(a)	wherein said <u>tri-axis</u> sensors comprise accelerometers positioned at different locations of the railcar,
Limitation 48(b)	wherein said step of drawing inferences comprises the comparison of data from ~~two or more of~~ said accelerometers,
Limitation 48(c)	wherein said accelerometers are positioned on the railcar to provide data for carrying out one or more of the following functions:
Limitation 48(d)	(i) compare accelerations from one railcar wheel with that of another railcar wheel on the same axle but opposite side of the railcar,

Limitation 48(e)	(ii) compare accelerations from one railcar wheel with that of at least one other wheel on the same side of said railcar, and
Limitation 48(f)	(iii) compare accelerations from one railcar wheel with that of at least one other railcar wheel on the same side of said one railcar wheel and which other wheel is on another railcar of the same train consist.