

IN THE 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.

IPR2023-00538

PATENT NO. 10,137,915

ISSUED: NOVEMBER 27, 2018

TITLE: SYSTEM AND METHOD FOR DETECTING ANOMALIES
IN TRAIN CONSISTS AND RAILCARS

EXHIBIT 2006

DECLARATION OF MICHAEL I. SHAMOS, PH.D.

IN SUPPORT OF PATENT OWNER'S RESPONSE

AMSTED 2006
IPR2023-00540

TABLE OF CONTENTS

I. Introduction and Qualifications	1
II. Materials Considered	2
III. Compensation.....	2
IV. Summary of My Opinions.....	3
V. Legal Principles.....	3
VI. Level of Ordinary Skill in the Art.....	7
VII.Claim Construction	9
VIII.....Petitioner Has Not Shown a Reasonable Likelihood Of Prevailing On Any Ground.....	14
A. Ground 1: Petitioner has failed to show a reasonable likelihood that Claims 1, 22, 24-25, 27-30, 36, and 37 are obvious in view of Armitage and Barone	14
1. Claims 1, 22, 24-25, and 27-29	14
2. Armitage does not disclose the claimed filtering.....	14
3. The reasoning of the institution decision	18
4. Modifying Armitage in view of Barone would violate a principle of operation of Armitage	20
5. Claim 25	23
6. Claim 28	29
7. Claim 30	29
8. Claims 36 and 37.....	29
B. Ground 2: Petitioner has failed to show a reasonable likelihood that Claim 21 is obvious under 35 U.S.C. § 103(a) in view of Armitage, Barone, and LeFebvre	30
C. Ground 3: Petitioner has failed to show a reasonable likelihood that Claims 23 and 26 are obvious in view of Armitage, Barone, and Winfree.....	31
D. Ground 4: Petitioner has failed to show a reasonable likelihood that Claims 1, 21-22, 25, 27-30, 36, and 37 are obvious under in view of LeFebvre and Barone	31
1. LeFebvre does not disclose the claimed filtering	31

2. Modifying LeFebvre in view of Barone would violate a principle of operation of LeFebvre	33
3. Claims 1, 21-22, 25, 27-29	34
4. Claim 30	35
5. Claims 36 and 37	35
E. Ground 5: Petitioner has failed to show a reasonable likelihood that Claims 24 and 37 are obvious under 35 U.S.C. § 103(a) over LeFebvre in view of Barone and Armitage	35
1. Claim 24	35
2. Claim 37	36
F. Ground 6: Petitioner has failed to show a reasonable likelihood that Claims 23 and 26 are obvious under 35 U.S.C. § 103(a) over LeFebvre in view of Barone and Winfree	36
IX. Concluding Statement	36

1. I, Michael I. Shamos, declare as follows in connection with the proceedings identified above.

I. INTRODUCTION AND QUALIFICATIONS

2. I have been retained as an expert on behalf of Patent Owner to provide technical analysis and opinions relating to the Petition for *Inter Partes* Review (“Petition,” Paper 1) filed by Hum Industrial Technology, Inc. (“Hum” or “Petitioner”) challenging the validity of Claims 1, 21-30, 36, and 37 (the “Challenged Claims”) of U.S. Patent No. 10,137,915 (“the ’915 Patent” or “the Patent”). I have also been asked to provide opinions on the Declaration of Mr. Steven Ricca (“Ricca Declaration,” Ex. 1003) and opinions regarding Patent Owner’s Response.

3. I previously submitted a declaration in this matter entitled “Declaration of Michel I Shamos, Ph.D. on Behalf of Patent Owner, dated May 15, 2023) (Ex. 2001).

4. I am aware of contemporaneous litigation involving the parties in a case styled *Amsted Rail Company, Inc. v. Hum Industrial Technology, Inc. and Brett Wilson*, 4:22-cv-00445-AGF (E.D. Mo.) (the “Litigation”).

5. My background was described in ¶¶ 4-15 of Ex. 2001. My compensation was disclosed in ¶¶ 21-22 of Ex. 2001. The principles of law I was asked to follow were listed in ¶¶ 25-33 of Ex. 2001.

6. The statements made and opinions provided in this Declaration are based on my own personal knowledge and, if called as a witness, I could and would testify in a manner consistent with the material in this Declaration.

II. MATERIALS CONSIDERED

7. I have been asked by counsel for Patent Owner to address Petitioner's assertions that the Challenged Claims would have been obvious. Petitioner does not allege that any Challenged Claim is anticipated.

8. In preparing this Declaration, I have considered all the material filed prior to the date of this Declaration in this proceeding and any other materials cited in this Declaration.

9. I have also relied on my education, skill, training, and experience in the relevant fields of technology. I have further considered the viewpoint of a person of ordinary skill in the art ("POSITA") at the time of the invention of the '915 Patent.

10. I reserve the right to supplement my opinions as expressed in this Declaration to address any new information obtained in the course of this proceeding, or based on any new positions taken by Petitioner.

11. In this Declaration, all emphasis has been added unless otherwise noted.

III. COMPENSATION

12. I am being compensated at my regular rate of \$600/hour. My compensation is in no way dependent on the testimony I give or on the outcome of

this proceeding, and my compensation in no way affects the substance of my statements and opinions in this Declaration.

13. I have no financial interest in this case, the Litigation, Petitioner, Patent Owner, or the '915 Patent.

IV. SUMMARY OF MY OPINIONS

14. The following table summarizes the grounds of challenge (“Grounds”) raised in the Petition:

Grd.	Sec.	References	Challenged Claims
1	§ 103	Armitage and Barone	1, 22, 24-25, 27-30, 36, 37
2	§ 103	Armitage, Barone, and LeFebvre	21
3	§ 103	Armitage, Barone, and Winfree	23, 26
4	§ 103	LeFebvre and Barone	1, 21-22, 25, 27-30, 36, 37
5	§ 103	Barone and Armitage	24, 37
6	§ 103	Barone and Winfree	23, 26

15. After a review of the '915 Patent and the alleged prior art asserted by Petitioner, it is my opinion that the Challenged Claims are not invalid under any of the Grounds. My opinions, and the bases therefor, are detailed throughout this Declaration.

V. LEGAL PRINCIPLES

16. Counsel for Patent Owner has informed me of the legal principles that apply in this proceeding.

17. A prior art reference can disclose a limitation that is not expressly disclosed in the reference if it is “inherently present” in the reference. I further understand that to be “inherently present,” the missing disclosure must necessarily and inevitably be present in the element or process described in the reference. It is my understanding that a limitation is not disclosed by inherency if the missing limitation is only probably present or if there is merely a possibility that it is present.

18. A claim is invalid as obvious under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter of the claim as a whole would have been obvious at the time of the patent’s filing date to a person having ordinary skill in the art. I have been informed that the following factors are used to determine whether or not the claimed subject matter would have been obvious: (i) the scope and content of the prior art; (ii) the differences between the prior art and the claimed invention; (iii) the level of ordinary skill in the field of the invention; and (iv) any relevant objective considerations of non-obviousness.

19. A party asserting obviousness based on a combination of prior art references must demonstrate that one of ordinary skill in the art would have been motivated to combine the teachings of those references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so. It is my understanding that it is not enough to show that one

skilled in the art could combine elements of multiple references, but instead there must be some reason that would have prompted a person of ordinary skill in the art to combine the elements in the way the claimed invention does. I understand that there must be some reasoned explanation as to why one of ordinary skill in the art would combine the references.

20. A combination of references would not have been obvious if the alleged modification(s) to be made to the reference(s) would have been inconsistent with a reference's stated goals or would have rendered the combination inoperable for its intended purpose. I further understand that for something to have been obvious, the party asserting obviousness must explain why a POSITA would have selected components for combination in the manner claimed.

21. It is my further understanding that obviousness cannot be based on a hindsight combination of components selected from prior art references. I also understand that an invention would not have been obvious simply because all of the elements of the invention may have been known separately in the prior art.

22. I understand that claims must be enabled by the original disclosure of the patent. For the claims to be enabled, the information contained in the disclosure must be sufficient to inform those skilled in the relevant art how to make and use the claimed invention without undue experimentation. I also understand the original disclosure must contain a written description of the claimed invention. I understand

that the written description requirement is separate and distinct from the enablement requirement. To satisfy the written description requirement, the original disclosure must describe (in writing or drawings) the claimed invention in sufficient detail that one skilled in the art can reasonably conclude the inventor had possession of the claimed invention. In other words, the question is whether one of skill in the art can discern or visualize, from the original disclosure, that the named inventor actually invented the subject matter later claimed.

23. I understand that a reference patent, i.e. an alleged prior art patent used in a ground to prove invalidity, is only entitled to claim the benefit of the filing date of its provisional application if the disclosure of the provisional application provides support for at least one claim in the reference patent in compliance with § 112 ¶ 1. In other words, to be entitled to the provisional priority date, therefore, the provisional application's written description must provide written description support for at least one claim of the later patent. Additionally, the subject matter relied upon in the ground must be effectively filed, i.e. be present, in the provisional application. If either of these requirements are not met, the reference is not entitled to its provisional filing date as an effective filing date.

24. I have been informed and I understand that claim construction is a matter of law and the construction of a claim term will be determined by the Board. In this declaration, I have been informed and I understand that the claim terms should

be interpreted under “the Phillips standard.” I have been informed and I understand that under the Phillips standard, claim terms are given their ordinary and customary meaning as understood by a person of ordinary skill in the art at the time of the invention in light of the claim language and the patent specification. I have been informed and I understand that the claim terms, as construed, encompass the embodiments disclosed in the specification. I have been informed and I understand that the patentee can serve as their own lexicographer. As such, if the specification provides a definition of a claim term, I understand that I should interpret that claim term in light of the particular definition provided in the specification. I further understand that different claim terms in a patent are presumed to have different meanings. I further understand that extrinsic evidence such as dictionaries are among the tools that can assist the Board in determining the meaning of particular claim terms to those of skill in the art.

VI. LEVEL OF ORDINARY SKILL IN THE ART

25. Petitioner defines a person of ordinary skill in the art (“POSITA”) as “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 railcar, train, vehicle, or any other similar monitoring systems for similar industrial equipment with rotating components. Less work experience could be compensated by a higher level of education, such as a master’s degree, and vice versa.” Pet., 15. Neither Petitioner

not its expert, Mr. Ricca, offers any explanation why this would be a correct characterization of a POSITA. Mr. Ricca says that he applied the criteria listed in ¶ 43 of his declaration, but does not explain which factors were applicable or how they led to the characterization.

26. In fact, Mr. Ricca's characterization in his ¶ 44 differs from that of Petitioner. Mr. Ricca says that a POSITA 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 railcar, train, vehicle, or any other similar monitoring systems. Less work experience could be compensated by a higher level of education, such as a master's degree, and vice versa. (strikethrough indicating the portion of Petitioner's characterization added to Mr. Ricca's. It is not clear which characterization was intended.

27. I note that Mr. Ricca has 24 years of experience in the field, which 12 times as much experience as he says a POSITA would have, thus classifying him as one of extraordinary skill. This is significant because that which may appear obvious to one of extraordinary skill would not necessarily be obvious to one of ordinary skill.

28. The Patent defines the field of the invention at 1:13-17:

The present invention relates to the field of railcar and train safety management, and is specifically directed to a system and method for continuously collecting and analyzing operational parameters

of railcars and train consists to detect anomalous operating conditions.

29. The claims are drawn to sensor devices, wireless communication systems, including wireless mesh networks, and communication management systems.

30. In my opinion, a POSITA would be a person with at least a B.S. degree in electrical engineering or computer science or a related field, with at least two years' experience with sensing systems for railcars or similar industrial equipment, including familiarity with wireless networks. Less work experience could be compensated for by a higher level of relevant education, and vice versa.

VII. CLAIM CONSTRUCTION

31. I have accorded all of the claim terms their plain and ordinary meaning to a POSITA. In reviewing the meaning of certain terms in claims 25, 27, and 28 as apparently interpreted in the Petition, it is my opinion that Petitioner has not construed certain claim terms in a manner consistent with their plain and ordinary meaning. Accordingly, I provide an explanation for what a plain and ordinary meaning of select claim terms actually is.

32. “one or more digital filters” (claim 25). Petitioner misapprehends the term “digital filter.” For example, the Petition at 21 states: “Barone shows filtering accelerations with an electronic or digital filter was well-known in the art and

conventionally used in the field at the time of the invention.” That statement indicates a misunderstanding either of Barone or the term “digital filter.” I agree that Barone discloses electronic (i.e. analog) filters. However, nowhere does Barone disclose, or even hint at, a digital filter. Petitioner cites many paragraphs of Barone, to-wit, [0114]-[0115], [0150], [0172]-[0185]. The very first paragraph cited, [0114], discloses only an electronic filter: “the output of ... analog sensors ... are transmitted to signal conditioning 178, where the analog signals are amplified and/or filtered as appropriate, and then routed to fast analog to digital (A/D) converters 183.” That is, the **analog** signals are filtered before being converted to **digital** data. [0114] does not disclose a digital filter. [0115] refers to **analog**-to-digital conversion, but does not mention filters. [0115] refers to sampling, but does not mention filters. In [0172]-[0185], the only references to filters are in [0176]-[0179], which I reproduce below with the term “filter” highlighted:

*[0176] The signal in the preferred embodiment is split into two signals, each of which is sent through signal conditioning 178. One of these signals is conditioned as set out above for the microphone output except that it is sent through a high-pass **filter** that permits only frequencies of 200 or 300 Hz or above to pass, which transmits the accelerations of the axle that preferably have the resonance frequencies of the truck, which are*

*usually above about 300 Hz to about 900 Hz. A band pass **filter** may also be used instead of the high-pass **filter**, but preferably the upper limit of passed frequencies in the band-pass **filter** is 2 kHz or higher, the upper limit of the accelerometer detection being at 2.5 kHz max, and the **filter** should pass at least one resonant frequency of the truck. This **filtered** output signal is then transmitted to an amplifier and amplified with a gain of about 11. The amplified signal is sent to a half wave rectifier and load with a time constant of about 0.68 ms, yielding a rectified waveform signal. The rectified signal is sent through a low pass **filter** or band pass **filter** that **filters** out frequencies substantially above the highest frequencies of interest in the bearing degradation analysis, preferably, e.g., 290 or 300 Hz, yielding a signal that is composed of any periodic peaks in the accelerometer data that repeat below that frequency.*

*[0177] This type of conditioning is illustrated in FIG. 30. The raw analog output of the accelerometer is shown as R. This is a large amplitude wave made up of a frequency of about 500 or 600 Hz that repeats in pulses of intensity at about 37 Hz. (i.e., at interval T) The high-pass **filter** of the signal conditioner passes this high frequency out of the input, rectifies it, and then sends it through a low pass **filter** passing less than 300 Hz. The result is output S, which exhibits periodic repeating peaks at about 37*

Hz. This output can then be digitized and analyzed whether the bearing defect frequencies are present.

*[0178] Preferably, the other of the signals derived from the accelerometer is transmitted through a similar circuit, but without the initial high-pass **filter**, only the amplifier, rectifier and low-pass (or band-pass) **filter**, and the two conditioned digital signals are then combined and sampled by the microcontroller. The resulting samples are subjected to the discrete Fourier transform to identify therein the frequencies identified above, and determine if the accelerometer output includes any periodic peaks repeating at any of the listed defect frequencies.*

*[0179] Alternatively, a simple band-pass or low-pass **filter** transmitting only a range of frequencies that includes some of the major resonance spikes of the railroad truck, such as, for the truck of the preferred embodiment, 2000 Hz or less, and preferably below 800 Hz, and even a range wholly below approximately 300 Hz, can be used to condition the accelerometer output. ...*

33. The “filters” referred to in these paragraphs are all analog filters, as shown in Barone Fig. 8, which makes it clear that the signals from accelerometer 171 and microphone 173 are passed directly to Signal Conditioning unit 178 **before**

they are converted to digital data by A/D Converter 183. Barone discloses that Signal Conditioning 178 performs filtering, hence the signals are **analog prior to filtering** and are also **analog after filtering**, else they could not be pass to an A/D converter. Thus. Barone does not disclose any digital filtering at all.

34. Therefore, it appears that Petitioner has somehow equated “analog filter” with “digital filter,” which is erroneous on its face. A “digital filter” is a filter that filters digital data, not analog signals.

35. “one or more electronic filters” (claim 27). The Petition at 26 makes this correct statement: “Electronic filtering is a type of filtering which utilizes electrical circuits to process signals (i.e., analog signals), and includes a number of different types of filters.” I agree. An “electronic filter” is one that filters an analog signal using electronic circuitry.

36. “one or more software filters configured to isolate one or more types of accelerations” (claim 28), The Petition at 26 makes the following partially correct statement: “Digital filtering uses software to manipulate and filter data to decrease unwanted signals and increase signals from a particular area of interest.” I agree that software filtering is a form of digital filtering, because software only operates on digital data and digital filtering produces digital data. My disagreement with Petitioner’s characterization is that not all digital filtering requires software. Digital

filter can be performed by customized computer hardware, but that is not an issue in this case.

37. Despite having defined “electronic filter” and “software filter” correctly, Petitioner’s apparent construction of “digital filter” is incorrect, as explained in my analysis of Petitioner’s citations to Barone, above.

VIII. PETITIONER HAS NOT SHOWN A REASONABLE LIKELIHOOD OF PREVAILING ON ANY GROUND

A. Ground 1: Petitioner has failed to show a reasonable likelihood that Claims 1, 22, 24-25, 27-30, 36, and 37 are obvious in view of Armitage and Barone

1. Claims 1, 22, 24-25, and 27-29

38. Claim 1 is independent. Claims 22, 24-25, and 27-29 depend directly from claim 1.

39. As explained below, the combination of Armitage and Barone fails to disclose, teach, or suggest every limitation of claim 1.

2. Armitage does not disclose the claimed filtering

40. Petitioner argues that Armitage discloses “filtering through sampling of data, which a PHOSITA would understand requires a filter.” Petition, 20 (*citing* Armitage, [0045]). That statement is incorrect. Armitage [0045] reads, in pertinent part:

At high sampling rates of the accelerometer, the sampling only occurs for a portion of a wheel rotation,

*and radial acceleration or vibration (x-axis or y-axis)
data could be ignored.*

41. A POSITA would recognize that the term “sampling” as used in Armitage [0045] refers to an action that is performed during the original acquisition of vibration data and does not involve filtering. According to the Microsoft Computer Dictionary, Fifth Edition (2002), an authoritative source, “sampling” in this context means “conversion of analog signals to a digital format; samples are taken at periodic intervals to measure and record some parameter, such as a signal from a temperature sensor or a microphone.” Accelerations occur constantly. However, an information system must sample such input at discrete times, as it would be impossible to process data every nanosecond, picosecond, etc. “Sampling” refers to choosing which data items to consider. In contrast, “filter[ing] a portion of the accelerations” within the context of claim 1 occurs only after the samples have been collected. For example, the ’915 patent discloses that the signal that “originates with accelerometer hardware ... is passed to one or more sensor sections [that] select the data to be analyzed using a digital data filter ..., and passes this data on to a feature detector” Ex. 1001 at 13:15-20. Armitage does not disclose “one or more filters configured to filter at least a portion of the accelerations.”

42. A function of a “filter” is to remove unwanted content, such as noise. Another function of a “filter” is smoothing, to remove bumps or peaks. For example, the shock absorbers on an automobile are filters that perform a smoothing function.

43. The specification discloses two main types of filters: (1) “mechanical filters” (e.g., of the shock absorber type); and (2) “software filters” and “digital filters.” A “software filter” is a type of “digital filter,” as explained at 5:40-42: “The software filter used is a digital filter to decrease noise from unwanted acceleration frequencies and increase signals from acceleration frequencies of interest.” That is not a definition of “software filter” but merely explains that a software filter is a digital filter.

44. However, not all digital filters are software filters. A digital filter can be implemented entirely in hardware, e.g., by the use of circuits with discrete logic gates. A distinguishing feature of a digital filter is that it operates on digital, rather than analog, inputs and produces a digital output. The specification also uses the term “digital data filter” at 13:18, making it clear that what a digital filter is filtering is “data.” Mechanical filters are analog filters. That is, they filter analog inputs and produce analog outputs.

45. Claim 27 recites “one or more electronic filters.” The specification does not refer to an “electronic filter,” but a POSITA would understand an “electronic filter” to be an analog filter. Even though a digital processor is an

electronic device, an “electronic filter” operates on analog signals. Claim 28 recites “one or more digital filters.” Thus, the Patent distinguishes “electronic filters” from “digital filters,”

46. The specification at 5:38-40 discloses “software filtering performed by software executing on a processor on main PC board 402a.”

47. The term “filter” does not appear in Armitage, nor does any term of similar import, and filtering is not inherent in Armitage. As explained above, sampling is the obtaining of data at discrete intervals. All data output by the sensor during the sampling interval is obtained and none of it is filtered. Filtering implies the processing, removal, or suppression of data that has already been obtained. Thus, a POSITA would not consider “sampling,” in the context of Armitage’s disclosure, as any sort of “filtering.”

48. To take a familiar example, a television camera “samples” a scene at 30 frames per second. It would be infeasible to take video input continuously, as no channel could possibly have enough bandwidth to transmit an infinite amount of video data or, say, even millions of frames per second. Such sampling is not filtering.

49. The Petition mistakenly takes “ignoring” data as some kind of filtering. The Petition at 25 asserts that Armitage discloses “sampling accelerations for only a portion of a wheel rotation, and filters out radial

accelerations.” However, what Armitage actually says is that the radial accelerations are “ignored” as a result of the sampling process, which only captures data for a portion of a single wheel rotation. Armitage, [0045] This is not filtering, either, but is analogous to TV camera sampling.

50. Petitioner points to Armitage’s disclosure at ¶[0056] of “amplifiers, analog-to-digital-converters, [and] microcontrollers.” Petitioner asserts that the presence of such devices necessarily “would mean the sensor is capable of filtering at least a portion of accelerations.” Petition at 26. One might program a microcontroller to perform filtering, but microcontrollers do not necessarily perform filtering. Petitioner does not explain why a POSITA would arrive at the incorrect conclusion that amplifiers, analog-to-digital-converters, and microcontrollers must perform, or even suggest, filtering. Petitioner does not identify anything in the disclosure of Armitage which a POSITA would understand to be filtering, other than its erroneous statement that “Armitage discloses filtering through sampling of data” at p. 20 of the Petition. Petitioner does not argue that any of the disclosure in Armitage filters “at least a portion of the accelerations” after the data has been detected by the sensors.

3. The reasoning of the institution decision

51. Independent claim 1 requires that “at least a portion of accelerations of the railcar,” which were measured by a sensor, are filtered by a filter. The

Board noted that claim 1 “appears to be broad enough to include ‘mechanical filters’” and pointed to claim 26 and the disclosure of mechanical filters in the ’915 patent as evidence that a POSITA would understand Barone’s disclosure to fall within the scope of claim 1. See Paper 10 at 26-27. Neither Barone nor Armitage discloses any mechanical filters. However, even if a mechanical filter were deemed to be used by Armitage or Barone, accelerations removed by a mechanical filter of claim 26 would necessarily be removed **before** they are sensed by any accelerometer because that is how a mechanical filter works. Claim 1 requires the filters to filter output of the “one or more sensors configured to measure accelerations of the railcar.” At best, a mechanical filter, if it even existed, would filter accelerations before they were even sensed by the sensors, so they would not “filter at least a portion of the accelerations,” i.e., accelerations measured by the sensors, as claimed.

52. Further, I believe that claim 26 contains a drafting error. The literal language of claim 26, “The system of claim 1, wherein the one or more filters comprise one or more mechanical filters” does not comport with the specification. The “one or more filters” of claim 1 filter accelerations after they are sensed by sensors. A mechanical filter filters accelerations before they are even sensed. While claim 26 clearly refers to mechanical filters, it would only make sense if it read, “The system of claim 1, further comprising one or more mechanical filters.”

4. **Modifying Armitage in view of Barone would violate a principle of operation of Armitage**

53. As explained above, Armitage does not disclose any filters. Barone discloses analog filters. A POSITA would not be motivated to combine the filters of Barone with Armitage because doing so would violate the principle of operation of Armitage and render the Armitage invention unsatisfactory for its intended purpose, which is accurately identifying outlier sensor data. Armitage at [0042] states, “Likewise, outliers for sensor nodes on an entire side of railway car 310 could indicate a cornering failure, or an off-track condition.” One of the functions of Barone’s filters is to remove noise such as outliers. Therefore, Barone’s filters would remove the very signal artifacts that Armitage is looking for.

54. Armitage passes all of the accelerometer data from a plurality of sensors to a Data Correlation Unit (DCU) for analysis. Armitage [0030], [0041]-[0043]. The analysis in Armitage relies on a specific type of analysis that requires using **all** of the sampled data from the accelerometers. Armitage explains that, in an embodiment, an entire population of sensor nodes transmits sensor data collectively to establish a “moving average” of the population. Id.,[0030]. Armitage then compares the individual sensor data against the moving average to identify outliers. Filtering outlier would completely frustrate this purpose.

55. Armitage explains that “[w]hen one or more of the sensor nodes begin to deviate from the others in the population, then a failure condition could be

determined.” Id., [0030]. A POSITA would recognize that this embodiment requires that all of the sensor data from each respective sensor be passed along to the DCU to establish the “moving average” and identify outlier readings. A POSITA would recognize that including the filters taught by Barone would (a) remove important sensor data and thus impact the moving average analysis (thereby altering the principle of operation of Armitage), and (b) potentially remove sensor data that should have served as the basis for identification of an outlier (thereby rendering Armitage unsatisfactory for the intended purpose of accurately identifying outliers).

56. Further, Armitage explains that “[i]n 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.” Armitage, [0041]. Also “when only one of sensor nodes 320-327 indicates outlier data as shown in FIG. 4, it could be determined that a wheel bearing or hotbox condition for a single wheel has occurred. A single wheel sensor anomaly might also 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. Taking sensor node 325 as an outlier in this example, then the right wheel of wheel assembly 314 could have a failure.” Armitage,

[0042]. A POSITA would recognize that this embodiment requires that all of the sampled sensor data from each respective sensor must be passed along to the DCU to establish the standard deviation and identify outlier sensor(s).

57. A POSA would recognize that including in Armitage the filters disclosed by Barone would remove some sensor data and (a) impact the standard deviation metric (thereby altering the principle of operation), and (b) potentially remove sensor data that should have served as the basis for identification of an outlier (thereby rendering Armitage unsatisfactory for the intended purpose of accurately identifying outlier sensors).

58. In another embodiment, Armitage explains “Some examples describe a dynamic normalization, where the application of a sensor network on each railway car is employed to dynamically define norms of operation for each of the critical mechanical components. In the example shown in graph 400, the cluster of data from sensor nodes 320-324 and 326-327 could be considered the norm, while the data for sensor 325 could be considered a deviation or outlier.” Armitage at [0043]. A POSA would recognize that this embodiment requires that all of the sensor data from each respective sensor be passed along to the DCU to establish the “dynamic normalization” metric and identify outlier sensor(s).

59. In my opinion, Petitioner has not established that independent claim 1 is obvious over Armitage and Barone. Each of claims 22, 24-25, and 27-29 depend

from independent claim 1 and therefore Petitioner has not established that they are obvious.

5. Claim 25

60. Claim 25 depends from claim 1 and is patentable at least by dependency. Claim 25 is further patentable because it adds an element not disclosed in either Armitage or Barone combination, i.e., a software filter.

61. The '915 Patent discloses four types of filters: (1) a mechanical filter, which filters physical artifacts and does not have any electronic or digital components; (2) electronic filters, which filter artifacts from **analog** signals; and (3) digital filters, which operate on digital data, usually obtained from analog data through analog-to-digital conversion; and (4) software filters, which are a species of digital filter implemented in software. Thus, (3) includes (4). A digital filter may be, but is not necessarily, a software filter, because a digital filter can be implemented in hardware, e.g., by dedicated digital circuitry.

62. As its name implies, a software filter “is a type of filter that utilizes a processor capable of executing a computer program that is capable of processing and passing selected data.” In the context of claim 25, a software filter utilizes computer executable code (i.e., software) that acts on digital data representative of one or more types of accelerations of a railcar.

63. Petitioner alleges that “A PHOSITA would understand Armitage’s teachings of sampling and ignoring certain data points equates to filtering data.” Petition, 27. However, per the discussion above, a POSITA would understand that sampling and filtering are entirely different methods and that sampling by no means “equates” to filtering.

64. Possibly realizing the failing, Petitioner resorts to Barone at FIG. 8, [0114]-[0115], [0150], and [0172]-[0185] with respect to claim 25. Petition, 37-38 Petitioner reasons incorrectly that “combining the sampling of data (i.e., filtering) in Armitage and the electronic and digital filtering taught in Barone would have predictably resulted in the filtering of accelerations data.” Petition 27. However, as I explain below in detail, there is no disclosure at all in Barone of a digital filter or a software filter.

65. Instead, Barone exclusively discloses conventional electronic circuits, not digital processors, , e.g., high pass and low pass filters, that filter analog signals and thus are **analog** filters.

66. Barone does not teach the claim 25 limitation, “wherein the firmware comprises one or more software filters configured to isolate one or more types of accelerations,” and but instead only discloses signal conditioning of analog signals from an analog sensor using analog circuitry. No filtering steps disclosed by Barone are performed by software and there is no disclosure of any hardware that

corresponds to a digital filter. Referring to FIG. 8 of Barone, it is clear that the signal conditioning steps are performed solely in the analog domain because signal conditioning 178 occurs prior to the conversion from the analog domain to the digital domain using analog-to-digital converter 183.

67. Barone's disclosed accelerometer 171, microphone 173, and temperature sensor 175 are all analog devices that only output analog signals. EX. 1007, [0109]-[0112], [0114], [0138], [0158], [0167], [0171], [0173], [0175], and [0177].

68. Petitioner is simply wrong in asserting that an analog-to-digital converter is a digital filter. An analog-to-digital converter transforms an analog signal to a series of digital readings measured at periodic intervals. For example, the voltage output by a sensor may be a continuous signal. In analog-to-digital conversion, the voltage is sampled, e.g., at 1 millisecond intervals, and the output is a digital representations of a series of numbers representing the sampled voltage. No filtering occurs during this process, or the analog-to-digital conversion would be unfaithful and unreliable.

69. Petitioner cites no evidence in Barone (or anywhere else) that an analog-to-digital converter performs any filtering. See Petition, 36-38 (addressing claim 25). A POSITA would not recognize that performing bandwidth calculations and data manipulation is necessarily a form of digital filtering (let

alone software filtering) but rather is a type of data analysis that does not necessarily filter anything. Furthermore, Petitioner mistakenly relies on [0114]-[0115] of Barone to support the incorrect argument that an analog-to-digital (“A/D”) converter performs filtering. See Petition 27. Barone states that “the fast A/D converters 183 coupled with the high-speed processor 183 allow all high speed, wide bandwidth calculations and data manipulations to occur on the node, thus eliminating the need for wide bandwidth wireless communication.” EX 1007, [0114]-[0115]. First, a POSITA would immediately recognize that the quotation from Barone contains a typographical error. Referring to Fig. 8, it is clear that 183 is indeed an A/D converter, but 183 is not also a “high-speed processor.” Instead, the processor in Fig. 8 is identified by numeral 177, not 183. A POSITA would also recognize that this disclosure does not suggest that a processor is embodied in or upstream of the A/D converter that performs any digital filtering or software filtering. The fact that a processor performs data manipulation does not imply that such data manipulations are necessarily filtering, and Barone contains no contrary suggestion.

70. Barone at [0192]-[0237] and in Fig. 8 explains in detail that processor 177 analyzes the digitized signal downstream of the A/D converter. The analysis must be downstream because the signal entering the A/D converter is **analog**, while data entering the processor is **digital**. A POSITA reading these paragraphs,

would readily understand that the analysis of Barone involves sampling of data to identify defect frequencies that may be indicative of bearing degradation. While this analysis is performed by a software program, the software program does not perform filtering, but applies a Fourier transform to a digitized signal that was already filtered by an analog filter. Accordingly, there is no need to filter the digitized signal. Barone explicitly acknowledges this at ¶ 234: “If the above-described signal conditioning is used, there is no aliasing problem because the output of the conditioning circuit is filtered for frequencies below about 290 or 300 Hz.”

71. Computing a Fourier transform is not filtering. This is easy to demonstrate because a Fourier transform is invertible. That is, the original input to the Fourier transform can be recovered from its output by applying the inverse Fourier transform. If the data were filtered (i.e., some data were removed) by the Fourier transform, inversion would not be possible because data would have been lost.

72. Barone discloses that the Fourier transform is applied to identify 16 defect frequencies. EX. 1007 [0202]-[0222]. Then “[a]n array of data values is loaded with a magnitude value for each of the frequencies pulled out of the sample data by the Fourier transform.” Id., [0231]. Barone then explains that “[d]etection of defects is accomplished by screening the Fourier data for peaks that are

characteristic of the various types of defects and degrees of bearing degradation according to the methods described above.” Id., [0236]. In short, nothing in Barone is filtered after A/D conversions is performed, so Barone does not disclose digital filtering at all.

73. Petitioner states, but provides no evidence, that “Barone further teaches the use of a high-pass, low-pass, and/or band-pass filters, all of which can utilize both electronic and digital filters .” Petition, 28. Petitioner is incorrect. A POSITA would recognize that the **analog** high-pass, low-pass, and/or band pass filters disclosed in Barone are not digital filters or software filters because they condition electrical signals **before** those signals undergo A/D conversion and therefore are still analog.

74. The Board recognized that Petitioner does not provide any evidence to show that a POSITA would consider modifying the analog filters of Barone to include a digital filter, See Petition, 36-38 (addressing claim 25) and the Institution Decision, 31: “First, the combination seeks to improve the operation of Armitage by incorporating Barone’s filter, not altering Barone.” Instead, Petitioner asserts that “a PHOSITA would be motivated to include the filtering taught by Barone to remove unwanted data and/or amplify particularly relevant accelerations data. Again, filtering could occur at various points within the system.” Petition, 28. As

previously discussed, adding Barone’s filtering to Armitage would defeat the object of Armitage, which is to detect outliers.

75. Further, merely incorporating the “filtering taught by Barone,” which is **analog** filtering, would not yield the claimed **software filters**. Likewise, the allegation that a POSITA might recognize that filtering “could occur” at various points within the system does not explain why or how a POSITA would modify Barone’s analog filtering so that it would be performed **after** A/D conversion (as would be required for digital or software filters) since the filtering of Barone is performed **before** A/D conversion.

6. Claim 28

76. Claim 28 recites: “The system of claim 1, wherein the one or more filters comprise one or more digital filters.” This claim is patentable by dependence from claim 1. Further, it is patentable because neither Armitage nor Barone teaches or suggests any “digital filter.” *See* the detailed discussion of claim 25 above (incorporated here by reference).

7. Claim 30

77. Claim 30 is independent. In my opinion, Petitioner has not established that independent claim 30 is obvious over Armitage and Barone for the same reasons explained above with respect to claim 1.

8. Claims 36 and 37

78. Claim 36 is independent. In my opinion, Petitioner has not established that independent claim 36 is obvious over Armitage and Barone for the same reasons explained above with respect to claim 1. Claim 37 depends from independent claim 36, so Petitioner has not established that it is obvious, either.

79. I have previously explained that a POSITA would not be motivated to incorporate the filters of Barone into Armitage because that would interfere with the objective of Armitage to detect outliers.

80. Further, a POSITA would not have been motivated to modify Armitage in view of Barone to save electrical power for the simple reason that adding filtering and also adding another processor to Armitage would increase, not decrease, power consumption. Even assuming that a POSITA would have found it desirable to modify Armitage to reduce its power usage, adding filtering to Armitage (a function not present at all in Armitage) would not achieve that goal, so the purported reason for the combination fails.

B. Ground 2: Petitioner has failed to show a reasonable likelihood that Claim 21 is obvious under 35 U.S.C. § 103(a) in view of Armitage, Barone, and LeFebvre

81. Claim 21 depends from independent claim 1.

82. As shown above, Petitioner has not established that independent claim 1 is obvious over Armitage and Barone. Petitioner does not rely on LeFebvre for any limitation of claim 1. Therefore, Petitioner has not shown that the Armitage-

Barone-LeFebvre combination remedies any deficiencies of the Armitage-Barone combination with respect to claim 1.

83. Consequently, Petitioner has not shown a reasonable likelihood that claim 21 is obvious over Armitage, Barone and LeFebvre.

C. Ground 3: Petitioner has failed to show a reasonable likelihood that Claims 23 and 26 are obvious in view of Armitage, Barone, and Winfree

84. Claims 23 and 26 depend from independent claim 1.

85. As shown above, Petitioner has not established that independent claim 1 is obvious over Armitage and Barone. Petitioner does not rely on Winfree for any limitation of claim 1. Therefore, Petitioner has not shown that the Armitage-Barone-Winfree combination remedies any deficiencies of the Armitage-Barone combination with respect to claim 1.

D. Ground 4: Petitioner has failed to show a reasonable likelihood that Claims 1, 21-22, 25, 27-30, 36, and 37 are obvious under in view of LeFebvre and Barone

1. LeFebvre does not disclose the claimed filtering

86. As with Armitage, discussed above in connection with Ground 1, LeFebvre discloses a similar “sampling,” which a POSITA would understand to be a different process from “filtering.” LeFebvre does not use the term “filtering,” or any other term of similar import. Instead, LeFebvre discusses sampling at [0034]:

The rational for the choice of sampling frequencies and the selection of sensors to be read is based on the type of

behavior being monitored and the particular application.
Sampling should be at a frequency several times the
highest frequency to be detected from the data. More
frequent sampling will gain no further intelligence but
increase power consumption.

87. This simply teaches taking enough samples per second to ensure that the relevant frequencies will be detected. No filtering occurs.

88. Petitioner argues that LeFebvre's discussion of sending only "essential indicative information" discloses the claimed "filtering." Petition at 54 (citing LeFebvre, [0053]). However, this disclosure refers to post-processing logical decisions whether or not to send data. LeFebvre, [0053] (discussing the "burden of transmitting all the data that might be sampled" and procedures "to reduce the radio traffic to manageable proportions"). A POSITA would not consider the selective transmission of data for data reduction purposes in LeFebvre to be filtering, as opposed to downsampling.

89. Petitioner argues that the "preliminary analysis" of LeFebvre is equivalent to filtering. Petition, 54 (citing Ex. 1005, [0043]-[0046]). This disclosure in LeFebvre, however, merely discusses power management and sampling periodicities. For example, LeFebvre discloses that the instrumented pad is "normally in a passive, low power state" but periodically turns on to conduct "preliminary analysis," in a manner similar to sampling. Ex. 1005, [0034]. The

purpose of the preliminary analysis is to “activate the [pad’s] microprocessor” and conduct additional readings if a problem is detected by the preliminary analysis.

Power management is not filtering as required by limitation 1(d). Further, Petitioner tacitly acknowledges that LeFebvre does not disclose filtering by introducing Barone. Petition, 55 (“LeFebvre does not explicitly require a ‘filter’....”).

2. Modifying LeFebvre in view of Barone would violate a principle of operation of LeFebvre

90. Petitioner asserts that “a PHOSITA would have been motivated to include the filter taught by Barone with LeFebvre because the advantage of filtering is to remove unwanted data and/or amplify particularly relevant data, and the purpose of both systems is to analyze data in a train monitoring system to accurately predict anomalous conditions and avoid false or inaccurate data processing.” Petition, 57. That is not correct. A POSITA would not be motivated to import the filters of Barone into LeFebvre because that would violate a principle of operation of LeFebvre and render the LeFebvre invention unsatisfactory for its intended purpose, which is accurately identifying sensor data of such magnitude as to indicate an alarm condition. EX 1005, [0052], [0055]. A POSITA, based on the specification of LeFebvre, would understand that LeFebvre primarily uses accelerometer data “for triggering certain analysis modes or verifying readings made by the pad and providing information on a variety of car body motions.” EX

1005, [0037]. Thus, LeFebvre does not principally rely on an accelerometer to identify defects with a railcar, but rather to validate the identification of defects by other types of sensors.

91. LeFebvre does not disclose any filtering of accelerometer data at all nor does LeFebvre suggest doing so would be advantageous, because it would not be. A POSITA would recognize that incorporating the high pass, low pass, and/or band pass filters of Barone would exclude portions of accelerations data that are relied upon by LeFebvre to identify the very alarm conditions LeFebvre is trying to detect. By filtering out the upper and lower portions of accelerometer data as taught by Barone would prevent LeFebvre from identifying accelerometer data having a magnitude sufficient to warrant an alarm. Hence, modifying LeFebvre to include the filters disclosed by Barone would fundamentally change the principle of operation of LeFebvre and doing so would render LeFebvre unsatisfactory for its intended purpose.

3. Claims 1, 21-22, 25, 27-29

92. Claim 1 is independent. Claims 21-22, 35 and 27-29 depend from claim 1.

93. In my opinion, Petitioner has not established that independent claim 1 is obvious over the combination of LeFebvre and Barone because, as explained above, LeFebvre does not disclose any filtering and modifying LeFebvre in view

of Barone would violate a principle of operation of LeFebvre. Because claims 21, 22, 25, and 27-29 depend from claim, Petitioner has not established that those claims are obvious.

4. Claim 30

94. Claim 30 is independent.

95. In my opinion, Petitioner has not established that independent claim 30 is obvious over LeFebvre and Barone for the same reasons explained above.

5. Claims 36 and 37

96. Claim 36 is independent. Claim 37 depends directly from claim 36.

97. In my opinion, Petitioner has not established that independent claim 36 is obvious over Armitage and Barone. Claim 37 depends from independent claim 36, so Petitioner has not established that it is obvious.

E. Ground 5: Petitioner has failed to show a reasonable likelihood that Claims 24 and 37 are obvious under 35 U.S.C. § 103(a) over LeFebvre in view of Barone and Armitage

1. Claim 24

98. Claim 24 depends from independent claim 1. Petitioner in Ground 1 was unable to show that claim 1 is obvious over Barone and Armitage. Petitioner in Ground 4 was unable to show that claim 1 is obvious over LeFebvre and Barone. Therefore, Petitioner has not shown that claim 1 is obvious over any valid combination of Armitage, LeFebvre and Barone. In my opinion, Petitioner has not

established that dependent claim 24 is obvious over Armitage, LeFebvre and Barone for the same reasons explained above.

2. Claim 37

99. Claim 37 depends from independent claim 36.

100. Petitioner in Ground 1 was unable to show that claim 36 is obvious over Barone and Armitage. Petitioner in Ground 4 was unable to show that claim 36 is obvious over LeFebvre and Barone. Therefore, Petitioner has not shown that claim 36 is obvious over Armitage, LeFebvre and Barone. In my opinion, Petitioner has not established that dependent claim 37 is obvious over Armitage, LeFebvre and Barone for the same reasons explained above.

F. Ground 6: Petitioner has failed to show a reasonable likelihood that Claims 23 and 26 are obvious under 35 U.S.C. § 103(a) over LeFebvre in view of Barone and Winfree

101. Claims 23 and 26 depend from independent claim 1.

102. Petitioner does not rely on Winfree for any limitations of claim 1. In Ground 4, Petitioner was unable to show that claim 1 is obvious over LeFebvre and Barone. In my opinion, Petitioner has not established that dependent claims 23 and 26 are obvious over Barone and Winfree.

IX. CONCLUDING STATEMENT

103. Relying on my education, experience, skill, and training in the relevant field of art, and after reviewing the materials identified above, it is my opinion that Petitioner has not established that any of the Challenged Claims is invalid.

104. In signing this declaration, I recognize that the 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 recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination remotely within the United States during the time allotted for such cross-examination at a time and place agreed by counsel.

105. I reserve the right to supplement my opinions in the future to respond to any arguments that Petitioner raises and to take into account new information as it becomes available to me.

106. I declare that all 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 the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed November 2, 2023 at Pittsburgh, Pennsylvania.


Michael I. Shamos