

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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HUM INDUSTRIAL TECHNOLOGY, INC.,  
Petitioner,

v.

AMSTED RAIL COMPANY, INC.,  
Patent Owner.

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IPR2023-00539

PATENT NO. 9,981,673

ISSUED: MAY 29, 2018

**TITLE: SYSTEM AND METHOD FOR MONITORING  
RAILCAR PERFORMANCE**

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**EXHIBIT 2163**

**DECLARATION OF MICHAEL I. SHAMOS, PH.D.  
IN SUPPORT OF PATENT OWNER’S REVISED MOTION TO AMEND**

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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 1–18 and 20–32 (the “Challenged Claims”) of U.S. Patent No. 9,981,673 (“the ’673 Patent” or “the Patent”). I have also been asked to provide opinions relating to the Substitute Claims presented in Patent Owner’s Revised Motion to Amend (“RM TA,” Paper No. 17).

3. 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”).

4. I previously submitted a declaration in this matter entitled, “Declaration of Michael I. Shamos, Ph.D. on Behalf of Patent Owner,” dated May 15, 2023 (EX2001). My background, qualifications and compensation were set forth in ¶¶4-14 and 21-22 of EX2001. I also submitted a “Declaration of Michael I. Shamos, Ph.D. in Support Of Patent Owner’s Response” (EX2010) and a “Declaration of Michael I. Shamos, Ph.D. in Support Of Patent Owner’s Motion to Amend” (EX2158).

5. 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.

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

## **II. MATERIALS CONSIDERED**

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

8. 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 ’673 Patent.

9. 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.

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

## **III. COMPENSATION**

11. 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.

12. I have no financial interest in this case, the Litigation, Petitioner, or the '673 Patent.

#### **IV. SUMMARY OF MY OPINIONS**

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

| <b>Grd.</b> | <b>Sec.</b> | <b>References</b>            | <b>Challenged Claims</b> |
|-------------|-------------|------------------------------|--------------------------|
| 1           | § 103       | LeFebvre                     | 1–7, 10–18, 20–22        |
| 2           | § 103       | LeFebvre in view of Barone   | 8, 9                     |
| 3           | § 103       | Armitage                     | 1, 2, 4, 6–11, 13        |
| 4           | § 103       | Armitage in view of LeFebvre | 3, 5, 12–18, 20–22       |

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

#### **V. LEGAL PRINCIPLES**

15. Counsel for Patent Owner has informed me of the legal principles that apply to a motion to amend in an IPR.

16. I understand that each amendment must respond to a ground of unpatentability raised in the Petition.

17. I understand that an amended or substitute claim cannot introduce new matter or expand the scope of the claim being amended. Claim A expands the scope

of claim B if there is an instrumentality or process that would infringe claim A but would not infringe claim B.

18. I understand that the full scope of an amended or substitute claim must find written description support in the specification of the patent being amended.

19. I understand that a Patent Owner may only propose a reasonable number of substitute claims.

## **VI. WRITTEN DESCRIPTION SUPPORT FOR THE SUBSTITUTE CLAIMS**

20. The tables below identify written description support for all limitations of the Substitute Claims.

### **A. Claim 23 (Substitute for claim 1, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                              | Written Description Support                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <del>1-23.</del> A method of monitoring operational characteristics of a railcar comprising the steps of:                                                                                                                                                                                                     | EX1001 at 1:16-22; 2:15-22, 26-60; 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); EX1013 at [0001].                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| a. receiving data or processed information regarding <del>said</del> <u>an</u> operational characteristic of a railcar from one or more sensing units, <u>each mounted on a sidewall of a bearing adapter</u> on said railcar at the bearing adapter, said sensing units monitoring <del>an</del> <u>said</u> | EX1001 at 2:50-60; 3:56-62 (“In broad terms, a novel means for monitoring the performance and operation of a railcar is provided. This includes a system for monitoring the railcar and sensors mounted on the railcars for use with the system. ... The sensors monitor and/or collect data on particular parameters and conditions of the railcar.”); Fig. 3; 4:48-56 (“As one of ordinary skill would recognize, the <i>configuration of the notes 10</i> with respect to the sensor 20 <i>is dependent upon the type of sensor and the type of data desired</i> . Sensor 20 can be <i>any type of</i> |

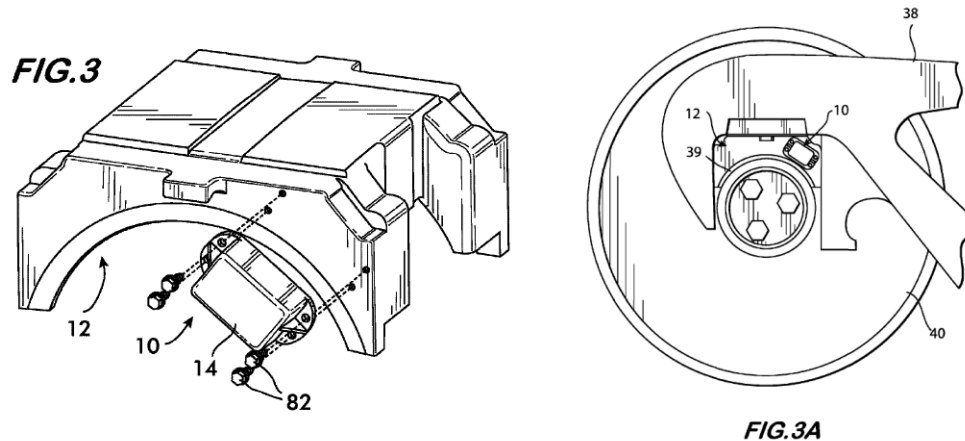
|                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>operational characteristic of said railcar, <u>wherein the operational characteristic is a condition of a bearing proximate to the bearing adapter</u>;</p>                                                                                                                                                 | <p><i>sensor</i>, including... <b><i>a vibration sensor, an accelerometer...</i></b>"); 5:10-18; 5:23-35; 5:42-59 ("The individual motes 10 are mounted on the areas of interest on a railcar 38. <b><i>As an example</i></b>, FIGS. 3 and 3A show a temperature sensing mote ... mounted to a bearing adapter."); 8:16-19; Table spanning cols. 8-11, specifically col. 9 "<b><i>adapter mounted accelerometer</i></b>"; 15:55-60 ("Various embodiments of the invention have been described in the context of various examples, however, <b><i>the invention is not meant to be limited in any way</i></b>. As one of skill in the art recognizes there may be many implementations that are within the scope of the invention..."); EX1013 at [0109]-[0119], specifically [0109] ("... many different types of sensors could be utilized by the mote, for example,... <b><i>acceleration</i></b>, etc. [T]he invention is <b><i>not meant to be limited by the exemplary implementation</i></b>."); [0115] ("The self-contained units are mounted on the areas of interest on a railcar. As an example, Figure 9 shows a temperature sensing unit mounted to a bearing adapter to measure the temperature of a wheel bearing of a railcar."); FIGs. 9, 10a.</p> |
| <p>b. <u>determining the condition of the bearing by applying a heuristic to said received data to determine deviations from nominal operating conditions, wherein the heuristic correlates one or more numeric values derived from the data or processed information to the condition of the bearing</u>;</p> | <p>EX1001 at 2:66-3:1 ("heuristics may be applied to determine potential failures based on statistical models and empirical data..."); 8:14-19; Table spanning cols. 8-11. (in particular "Bearing Temp: Adapter temperature is correlated to bearing cup temperature using empirical data."; "Bearing Fault Indicator: An adapter mounted accelerometer can be used to sample dynamic bearing data. An FFT can be used on data sets and plotted over time to isolate dominant modes and any shifting or relative amplification. Amplification at rolling frequency indicates a likely fault."; "Bearing Fault: An adapter mounted accelerometer can be used to sample dynamic bearing data. Kurtosis can be computed as an indicator of bearing damage. Kurtosis is measured in the time domain and requires computation of a</p>                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                             | probability density function.”; 11:51-58 (“Data collected from motes 10 may be sent to base station 44 for analysis and further action. The heuristics shown in the chart above may be performed by either mobile base station 42 or land-based base station 44.”); 12:48-65; EX1013 at [0064]-[0076]; [0129]-[0131]; <i>see also</i> step 23a, <i>supra</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| c. assigning a severity level to said deviations from nominal operating conditions, <u>wherein said severity level is one of a plurality of defined severity levels that are each assignable based on respective possible values for a magnitude of the deviations of one or more numeric values from nominal operating conditions for the bearing during operation of the railcar; and</u> | EX1001 at 11:59-12:65 (“alert messages are selected such that only actionable messages are sent to the locomotive 46, meaning that only those alarm <b>levels</b> that require the crew to take action are typically transmitted to the locomotive crew. For example, speed restrictions can be placed on the operation of the train at <b><i>tiered alarm levels</i></b> so that the train would be allowed to proceed to a siding or other appropriate stoppage point, allowing other traffic to continue on the mainline without inordinate delays or costs”); 13:30-14:3; <i>see also</i> Table spanning cols. 8-11; step 23b, <i>supra</i> (incorporated here); EX1013 at [0121]-[0122].                                                                                                                                            |
| d. determining an alarm condition based on said assigned severity level, <u>wherein said alarm condition defines one or more recommended actions to be taken with regard to the detected deviation from nominal operating conditions.</u>                                                                                                                                                   | EX1001 at 3:15-20; 3:56-67 (“If a problem is detected, alarms can be forwarded for further action.”); 11:59-14:3, and in particular 11:65-12:47 (“Each type of alert is accompanied by a recommended practice that the locomotive driver should take when an alert appears.... The action required to be taken by the locomotive driver varies based on the severity of the alert.”); 12:48-61 (“As such, alert messages are selected such that only actionable messages are sent to the locomotive 46, meaning that only those alarm levels that require the crew to take action are typically transmitted to the locomotive crew. In addition, rather than requiring the train to be stopped on the mainline, some alerts could be addressed by putting operating restrictions in place. For example, speed restrictions can be placed |

|  |                                                                                                                                                                                                                                                                                                                                                                                         |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | on the operation of the train at tiered alarm levels so that the train would be allowed to proceed to a siding or other appropriate stoppage point, allowing other traffic to continue on the mainline without inordinate delays or costs.”); 13:31-14:3 (“These are examples of various levels of alarms, based on severity, and the appropriate response.”); EX1013 at [0121]-[0122]. |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1. **“sensing units... mounted on a sidewall of a bearing adapter”**

21. Further, FIG. 3, reproduced below, shows mote 10 (sensor) mounted to the sidewall of bearing adapter 12.



22. The specification states that the sensor “*can be any type of sensor*” and expressly describes “[a]n *adapter mounted accelerometer*.” EX1001 at 4:51-52; Table, col. 9. This disclosure, together with the disclosures of FIGs. 3 and 3a provide support for a mote with an accelerometer mounted on a sidewall of a bearing adapter.

2. **“wherein the heuristic correlates one or more numeric values derived from the data or processed information to the condition of the bearing”**

23. Columns 8-11 contain a table of sample heuristics, several of which expressly state that the heuristic correlates calculated values to a condition of the bearing. For example, for the sensed parameter “Adapter Temp,” the heuristic states, “Adapter temperature is correlated to bearing cup temperature using empirical data.” For “Adapter acc.,” a heuristic states, “An adapter mounted accelerometer can be used to sample dynamic bearing data. An FFT can be used on data sets and plotted over time to isolate dominant modes and any shifting or relative amplification.” Also for “Adapter acc.,” another heuristic states, “An adapter mounted accelerometer can be used to sample dynamic bearing data. Kurtosis can be computed as an indicator of bearing damage. Kurtosis is measured in the time domain and requires computation of a probability density function.” Kurtosis is an indicator of the proportion of a distribution that consists of outliers, i.e., values that are significantly far from the mean and is a numeric value.

3. **“said severity level is one of a plurality of defined severity levels that are each assignable based on respective possible values for a magnitude of the deviations of at the one or more numeric values from nominal operating conditions for the bearing during operation of the railcar”**

24. The specification describes the “severity levels” as “tiered alarm levels.” EX1001, 12:57-58. It also states that “[t]he action required to be taken by the locomotive driver varies based on the severity of the” detected condition. *Id.* 12:44-47. Among the heuristics identified in the Table spanning columns 8-11 is for

calculating a “Bearing Fault Indicator,” which is used to “to isolate dominant modes and any shifting or relative amplification” and explains that “amplification at rolling frequency indicates a likely fault.” A POSITA would understand from this disclosure that a severity level for such a bearing fault indicator is based on “a magnitude of the deviation[] **of one or more numeric values from nominal operating conditions for the bearing during operation of the railcar.**”

4. **“wherein the operational characteristic is a condition of a bearing proximate to the bearing adapter”**

25. The specification describes “a real-time monitoring and analysis system for railcars” which “gathers data regarding various operating parameters and conditions from remote sensors....” EX1001 at 1:16-19; 2:15-22, 26-60; 3:56-67. The specification expressly states that a condition of a bearing is an operational characteristic that is monitored using an accelerometer at a bearing adapter, as shown in the Table at column 9:

| Parameter<br>Sensed | Sensor Type   | Output                     | Heuristic                                                                                                                                                                                                                                                                                              |
|---------------------|---------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adapter Acc.        | Accelerometer | Bearing Fault<br>Indicator | An adapter mounted<br>accelerometer can be used<br>to sample dynamic bearing<br>data. An FFT can be used<br>on data sets and plotted<br>over time to isolate<br>dominant modes and any<br>shifting or relative<br>amplification.<br>Amplification at rolling<br>frequency indicates a<br>likely fault. |

**B. Claim 24 (Substitute for claim 13, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                               | Support                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>24.</u> The method of <del>claim 1</del> <u>claim 23</u> , wherein steps (a) through (d) can be carried out at different event engines distributed among at least two of said <del>sensors</del> <u>sensing units</u> , a communication management unit, and a mobile or land base station. | EX1001 at 3:9-14 (“The analysis of the data collected can be carried out at any of the different event engines distributed among the various components in the present invention, including the sensor units, CMU, and mobile or land base stations.”); EX1013 at [0117]-[0118]. |

**C. Claim 25 (Substitute for claim 2, if found unpatentable)**

| Claim Limitation                                                                                                                                                                     | Support                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| <u>25.</u> The method of <del>claim 1</del> <u>claim 23</u> , further comprising the initial step of establishing wireless communication with said one or more remote sensing units. | EX1001 at 2:61-64; EX1013 at [0117]. |

**D. Claim 26 (Substitute for claim 3, if found unpatentable)**

| Claim Limitation                                                                                                                 | Support                              |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| <u>26.</u> The method of <del>claim 2</del> <u>claim 25</u> , wherein said one or more remote sensing units form a mesh network. | EX1001 at 5:24-28; EX1013 at [0117]. |

**E. Claim 27 (Substitute for claim 4, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                         | Support                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <u>4.</u> <u>27.</u> The method of <del>claim 2</del> <u>claim 25</u> , wherein <u>the received data or processed information includes one or more numeric values based on data obtained by an accelerometer in said sensing unit at the bearing adapter and</u> wherein | EX1001 at 2:61-64; 8:14-17; EX1013 at [0117]-[0118]. |

|                                                                      |  |
|----------------------------------------------------------------------|--|
| steps a-d are executed by a processing unit located on said railcar. |  |
|----------------------------------------------------------------------|--|

1. **“one or more numeric values based on data obtained by an accelerometer in said sensing unit at the bearing adapter”**

26. As explained below at ¶28-29, the specification discloses a system that monitors vibrations at a bearing adapter to identify and predict various operational characteristics of the bearing. As explained above at ¶23-24, the specification discloses calculating multiple numeric values based on accelerometer data. A POSITA would “recognize[] there may be many implementations that are within the scope of the invention” as recited in the claims. *Id.* at 15:57-60. The specification also lists various operations used in distributed sensor signal processing, such as average and standard deviation. See, e.g., EX1001 at 14:10-15:45. A POSITA would have recognized that that a number of standard analysis techniques could be applied to the data by heuristic. These include, for example, time domain parameters such as RMS (square root of the mean square), peak, crest factor (difference between peak and average), clearance factor (peak divided by RMS), impulse factor (peak divided by mean), and shape factor (RMS divided by the mean of the absolute values), just to name a few. Any of these techniques would have been known to a POSITA at the time of the invention and can be used to generate “one or more numeric values based on data obtained by an accelerometer in said sensing unit at the bearing adapter.”

F. **Claim 28 (Substitute for claim 5, if found unpatentable)**

| Claim Limitation                                                                                                                                                       | Support                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| <u>28.</u> The method of <del>claim 4</del> <u>claim 27</u> , wherein said processing unit located on said railcar is a part of <del>said</del> <u>a</u> mesh network. | EX1001 at 5:24-28; EX1013 at [0116]. |

**G. Claim 29 (Substitute for claim 6, if found unpatentable)**

| Claim Limitation                                                                                                                                                       | Support                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| <u>29.</u> The method of <del>claim 2</del> <u>claim 25</u> , further comprising the step of transmitting said alarm condition to a location remote from said railcar. | EX1001 at 11:40-44; EX1013 at [0118]-[0119]. |

**H. Claim 30 (Substitute for claim 7, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Support                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <u>30.</u> The method of <del>claim 2</del> <u>claim 25</u> , further comprising the step of transmitting said data <u>or processed information</u> received from said one or more sensing units to a location remote from said railcar <u>and performing steps b-d at said location remote from said railcar, wherein said data or processed information received from said one or more sensing units includes one or more numeric values based on data obtained by an accelerometer in said sensing unit at the bearing adapter.</u> | EX1001 at 3:4-14; 8:3-13; 11:40-58; EX1013 at [0117]-[0121], Fig. 11. |

**1. “performing steps b-d at said location remote from said railcar”**

27. Petitioner argued in its Opposition that “performing steps b-d at said location remote from said railcar” is not disclosed in the specification because there is no embodiment in which steps b-d were performed at a remote location. Paper 25 at 6. First, I do not understand that a claim is required to read on any specific

disclosed embodiment. Further, the specification states that “[d]ata collected from motes 10 may be sent to [land-based] base station 44 for analysis and further action” and that “heuristics shown in the chart above may be performed by... land-based base station 44.” EX1001, 11:51-54. This disclosure is clear that any or all data from motes may be processed at a location remote from the railcar.

2. **“one or more sensing units includes one or more numeric values based on data obtained by an accelerometer in said sensing unit at the bearing adapter”**

28. Petitioner argued in its Opposition that the limitations “one or more sensing units” having an accelerometer and “mounted on a sidewall of the bearing adapter” are not disclosed in the specification. However, the specification, which incorporates EX1013 by reference, discloses the claimed sensing unit (referred to as a “mote”) and mounted as such.

29. The specification states that a POSITA “would recognize the configuration of the motes 10 with respect to the sensor 20 is dependent upon the type of sensor and the type of data desired” and that “[s]ensor 20 *can be any type of sensor*, including ... *a vibration sensor, an accelerometer*.” EX1001 at 4:48-56. The specification also discloses that “many different types of sensors could be utilized by the mote, for example, ... *acceleration*” and that “the invention is *not meant to be limited by the exemplary implementation*.” EX1013 at [0109] (incorporated by reference in EX1001 at 1:6-12).

**I. Claim 31 (Substitute for claim 8, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Support                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| <u>31.</u> The method of <del>claim 2</del> <u>claim 25</u> , further comprising the steps of:<br>a. receiving <u>acceleration</u> data from a plurality of railcars;<br>b. applying <u>athe</u> heuristic to said received <u>acceleration</u> data to determine <u>the</u> deviations from nominal operating conditions;<br>c. assigning <u>athe</u> severity level to said deviations from nominal operating conditions;<br>d. determining <del>an</del> <u>the</u> alarm condition based on said assigned severity level; <u>and</u><br>e. transmitting <del>said</del> <u>a</u> raised alarm to a display unit on a train of which said plurality of railcars are a part, <u>said raised alarm comprising an action to be taken with regard to the detected deviation from nominal operating conditions.</u> | <i>See Claim 23, supra, (incorporated by reference here)</i> |

**J. Claim 32 (Substitute for claim 9, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                     | Support                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <u>32.</u> The method of <del>claim 6</del> <u>claim 29</u> , further comprising the steps of<br>a. determining a recommended course of action based on said alarm condition; and<br>b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part. | EX1001 at 13:31-32; 11:59-12:40; EX1013 at [0121]. |

**K. Claim 33 (Substitute for claim 10, if found unpatentable)**

| Claim Limitation                                                                             | Support                                                                                                                               |
|----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <u>33.</u> A method of monitoring a temperature of a desired part of a railcar, comprising:  | EX1001 at 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); EX1013 at [0068].         |
| (a) sensing the temperature of a part of the railcar other than the desired part by use of a | EX1001 at 4:35-48 (“FIGS. 1 and 2 show a temperature sensor 20 a, which is thermally coupled to heat transfer element 22. ... In this |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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| temperature sensor in thermal communication with said other part;                                                                                                                                                                                                                                                                                                                                                                                                                                         | embodiment, the mote 10 will be mounted to place the brass plug 22 in thermal communication with the portion of the railcar for which a temperature reading is desired.”); 5:42-53; EX1013 at [0110]-[0112]; <i>see also</i> Claim 23 step a, <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                                                                                                             |
| (b) determining the temperature of the desired part by use of the temperature <u>of the part sensed in step (a) and calibrated correlations between a plurality of temperature values for the desired part and a plurality of temperatures that are expected for the part during standard operations of the railcar</u> ;                                                                                                                                                                                 | EX1001 at 5:59-6:4 (“the device is calibrated so that the temperature reading is indicative of the bearing temperature. This calibration takes into account the temperature of the bearing adapter at the point measured (see FIG. 3a), the ambient temperature as measured by the second temperature sensor mote mounted elsewhere on the rail car so as to sense ambient temperature (see FIG. 4), and information about the type of bearing adapter (different models have different sizes and configurations).”); EX1013 at [0116], FIGs. 9, 10a; <i>see also</i> Claim 23 steps a-b, <i>supra</i> (incorporated here) |
| (c) determining if said temperature of the desired part is outside an acceptable range of temperatures <u>indicating operating conditions expected for the desired part during the operation of the railcar by comparing the temperature of the desired part determined in step (b) and at least one defined temperature value associated with the desired part, wherein an acceptable range of temperatures is a defined range of temperatures expected during normal operation of the railcar</u> ; and | EX1001 at Table spanning cols. 98-11; 11:51-58; EX1013 at [0064]-[0076], [0116]; <i>see also</i> Claim 23 step b, <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

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| <p>(d) transmitting an alarm <u>condition</u> if in step (c) it is determined that the temperature of the desired part is outside <del>an</del> <u>the</u> acceptable range of temperatures and <u>transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside the acceptable range of temperatures and is within one of a plurality of severity levels defined by a deviation of said temperature from a predetermined reference temperature value, wherein said deviation indicates a severity of a detected condition of the desired part, wherein said alarm condition defines one or more recommended actions to be taken with regard to the detected condition of the desired part.</u></p> | <p>EX1001 at 11:59-64 (“When an alert is detected, it is preferably sent to a display unit in the locomotive 46 or at the land-based base station 44.”); EX1013 at [0118]-[0119]; <i>see also</i> Claim 23 step c-d, <i>supra</i> (incorporated here)</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**1. “acceptable range of temperatures”**

30. Petitioner argued in the Opposition that “[l]imitation 33(c) introduces a new claim term,” “which is defined in the claim as ““a defined range of temperatures expected during normal operation of the railcar’,” and that PO “has not identified any disclosure in the specification that provides a “defined range of temperatures” as required by the claim.” Paper 25 at 7. I note that the term “acceptable range of temperatures” appeared in originally presented claims 47 and therefore finds written description support. EX2004 at 36.

31. Further, the specification references temperature thresholds when discussing alerts and alarms. See EX1001, 5:10-22, 6:15-18, 6:51-54, 13:49-51 (“a temperature a predetermined amount above ambient”). “A predetermined above ambient” discloses an acceptable range of temperatures from ambient at the low end to “a predetermined amount above ambient at the high end. *See also id.*, 14:1-2 (“a predetermined bearing temperature”). Further, the specification discusses “alarm thresholds” and “tiered alarm levels,” that indicate ranges of acceptable and unacceptable levels. See *id.*, 12:49-65. Therefore, a POSITA would have understood the specification to disclose “an acceptable range of temperatures.”

**L. Claim 34 (Substitute for claim 11, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                   | Support                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| <u>34.</u> A method of monitoring a temperature <u>and condition</u> of a desired part of a railcar in accordance with <del>claim 10</del> <u>claim 33</u> , further comprising the step of determining <del>the</del> temperature of the ambient air, which temperature is used in the determination of step (b). | EX1001 at 5:53-58; EX1013 at [0116]-[0117]. |

**M. Claim 35 (Substitute for claim 12, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                      | Support                                              |
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| <u>35.</u> A method of monitoring a temperature <u>and condition</u> of a desired part of a railcar in accordance with <del>claim 10</del> <u>claim 33</u> , wherein steps (a) through (d) are carried out by a single unit attached to said railcar. | EX1001 at 2:61-64; 8:14-17; EX1013 at [0118]-[0119]. |

**N. Claim 36 (Substitute for claim 14, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                | Support                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| <p><u>36.</u> A method for monitoring the operation of a railcar performed by a communication management unit disposed on said railcar comprising the steps of:</p>                                                                                                                             | <p>EX1001 at 2:61-3:3 (“The CMU is capable of wirelessly collecting data from each of the motes and performing higher-level analysis of the data to detect imminent or actual failures. ... The CMU is also capable of communicating both the data and the results of any analysis to a receiver remote from the railcar.”); 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); EX1013 at [0001], [0118]-[0119].</p> |
| <p>a. wirelessly receiving data from one or more sensing units which periodically collect readings from one or more sensors disposed <u>on a sidewall of a bearing adapter</u> on said railcar;</p>                                                                                             | <p>EX1001 at 5:23-42, Fig. 3; EX1013 at [0044]-[0045], FIGs. 9, 10a; <i>see also</i> Claim 23 step a, <i>supra</i> (incorporated here).</p>                                                                                                                                                                                                                                                                                                                         |
| <p>b. heuristically analyzing said received data to</p> <p style="padding-left: 40px;"><u>(i) determine a condition of a bearing proximate to the bearing adapter based on correlations between the data and a plurality of possible values indicative of the condition of the bearing;</u></p> | <p>EX1001 at Table spanning cols. 8-11; 11:51-58; EX1013 at [0064]-[0076]; [0129]-[0131]; <i>see also</i> Claim 23 step b, <i>supra</i> (incorporated here).</p>                                                                                                                                                                                                                                                                                                    |
| <p style="padding-left: 40px;"><u>(ii) determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received data; and</u></p>                                                                                    | <p>EX1001 at 1:16-21; 2:3-22 (“The current systems, however, lack the ability to apply heuristics to act on data gathered from more than one sensor or to detect operational deviations or trends which show deviations from nominal operating parameters... Therefore, it would be desirable to have a system which addresses these current deficiencies.”); 2:59-3:3 (“The CMU is capable of wirelessly collecting data from</p>                                  |

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|                                                                                                                                                                                                                                                           | each of the motes and performing higher-level analysis of the data to detect imminent or actual failures.”); 3:15-20 (It is therefore an objective of this invention to provide a comprehensive system which allows the wireless collections of data and the analysis of that data to predict operational failures and to provide adequate warning of those failures to allow for human intervention before a catastrophic failure occurs.”) ; 3:56-64; 11:54-56 (“In addition, either station 42, 44 may utilize train-wide heuristics to predict train-wide failures, or to spot train-wide trends...”); 12:61-65 (“Low level (Level 1/Stage 1) alerts, however, can still be monitored at base station 44 to make determinations about repeat temperature offenders and/or trending events that would signify an impending problem, although not imminent.”); EX1013 at [0129]-[0130] ; <i>see also</i> Table spanning cols. 8-11; Claim 36 step b, <i>supra</i> (incorporated here). |
| <u>(iii) assign a severity level to said determined actual failure or said predicted potential or imminent failures, wherein the severity level is based on deviations of the condition of the bearing from an expected condition of the bearing; and</u> | EX1001 at 12:40-61; 13:31-14:3 (“These are examples of various levels of alarms, based on severity.”); EX1013 at [0121]-[0122]; <i>see also</i> Claim 23 step c, <i>supra</i> (incorporated here).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <u>c. determine an alarm condition based on data collected by the one or more sensing units, wherein said alarm condition defines a specific action to be taken with regard to the bearing based on said assigned severity level;</u>                     | EX1001 at 11:59-14:3, in particular 12:40-47 (“The action required to be taken by the locomotive driver varies based on the severity of the alert.”); 13:31-14:3 (“These are examples of various levels of alarms, based on severity, and the appropriate response.”); EX1013 at [0121]-[0122]; <i>see also</i> Claim 23 step d, <i>supra</i> (incorporated here).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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| d. communicating the results of said analysis <u>performed in step (b)</u> to an off-railcar location. | EX1001 at 11:59-64 (“When an alert is detected, it is preferably sent to a display unit in the locomotive 46 or at the land-based base station 44.”); EX1013 at [0118]-[0119]. |
|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1. **“one or more sensors disposed on a sidewall of a bearing adapter”**

32. See the discussion at ¶¶21-25, which is applicable here.

2. **“determine a condition of a bearing proximate to the bearing adapter based on correlations between the data and a plurality of possible values indicative of the condition of the bearing”**

33. See the discussion at ¶25, which is applicable here. The specification discloses various heuristics to determine the condition of a bearing proximate to the bearing adapter based on correlations between the sensed data and various values (e.g., a temperature threshold.) For a heuristic to have any value for determining bearing condition, there must necessarily be a correlation between the values computed by the heuristic and that condition.

3. **“determine if an actual failure exists on said railcar or predict potential or imminent failures based on a statistical analysis of said received data”**

34. The table of heuristics at cols. 8-11 of EX1001 discloses that FFT analysis can be used to determine “likely faults” and kurtosis analysis can be used “as an indicator of bearing damage.” EX1001 at p. 13. See also ¶23, above.

O. **Claim 37 (Substitute for claim 15, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Support for Substitute Claim 37                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| <p><u>37</u>. The method of <del>claim 14</del> <u>claim 36</u>, wherein each of said sensing units can make a said determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of:</p> <p style="padding-left: 40px;">wirelessly receiving notice of said alarm condition from said sensing unit; and</p> <p style="padding-left: 40px;">b. communicating said alarm condition to an off-railcar location.</p> | <p>EX1001 at 2:50-3:3 (“In some instances, a mote may also have the capability to perform low-level analysis of the data to determine if an alarm needs to be raised, and the ability to communicate the alarm to an external receiver. ... The CMU is capable of wirelessly collecting data from each of the motes and ... communicating both the data and the results of any analysis to a receiver remote from the railcar.”); EX1013 at [0117]-[0119].</p> |

**P. Claim 38 (Substitute for claim 16, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                 | Support for Substitute Claim 38                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><u>38</u>. The method of <del>claim 14</del> <u>claim 36</u>, further comprising the steps of:</p> <p style="padding-left: 40px;">a. making a <del>said</del> determination of an alarm condition based on data received from two or more of said sensing units; and</p> <p style="padding-left: 40px;">b. communicating said alarm condition to an off-railcar location.</p> | <p>EX1001 at 2:61-3:3 (“Each railcar also can be equipped with a communication management unit (CMU) which communicates with each of the motes deployed on the railcar. The CMU is capable of wirelessly collecting data from each of the motes and performing higher-level analysis of the data to detect imminent or actual failures.”) 8:14-20 (“CMU 32 is capable of performing advanced data analysis, using data collected from multiple motes 10, and may apply heuristics to draw conclusions based on the analysis.”); EX1013 at [0118]-[0119].</p> |

**Q. Claim 39 (Substitute for claim 17, if found unpatentable)**

| Claim Limitation | Support for Substitute Claim 39 |
|------------------|---------------------------------|
|------------------|---------------------------------|

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| <p><u>39.</u> The method of <del>claim 14</del><u>claim 36</u>, further comprising the step of placing said one or more sensing units in a stand-by state when said one or more sensing units is not reading data from any of said sensors or transmitting data.</p> | <p>EX1001 at 5:36-42 (“Mote 10 also includes a long-term power source 34, preferably a military grade lithium-thionyl chloride battery. Daughter board 30 includes power conditioning and management circuitry and may include a feature to conserve battery life which keeps mote 10 in a standby state and periodically wakes mote 10 to deliver readings from sensor 20.”); EX1013 at [0044]-[0045].</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**R. Claim 40 (Substitute for claim 18, if found unpatentable)**

| Claim Limitation                                                                                                                                                                           | Support for Substitute Claim 40                                                                                                                                                                                                                                                                                                                                                                                     |
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| <p><u>40.</u> The method of <del>claim 14</del><u>claim 36</u>, further comprising the step of joining a mesh network consisting of one or more sensing units located on said railcar.</p> | <p>EX1001 at 5:23-35 (“The main board 28 also includes circuitry for wireless communications. Preferably, each mote 10 on a railcar is formed into an ad-hoc mesh network with other motes 10 on the same railcar. ... The ad-hoc mesh network is preferably formed using the Time Synchronized Mesh Protocol, a communications protocol for self organizing networks of wireless devices.”); EX1013 at [0116].</p> |

**S. Claim 41 (Substitute for claim 20, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                           | Support for Substitute Claim 41                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><u>41.</u> The <del>system</del><u>method</u> of <del>claim 14</del><u>claim 36</u>, further comprising the steps of:</p> <p style="padding-left: 40px;">a. saving data received from said one or more sensing units in memory; and</p> <p style="padding-left: 40px;">b. comparing data received with said saved data to identify trends or deviations from normal</p> | <p>EX1001 at 2:3-16 (“The current systems, however, lack the ability to apply heuristics to act on data gathered from more than one sensor or to detect operational deviations or trends which show deviations from nominal operating parameters.</p> <p style="text-align: center;">...</p> <p>Therefore, it would be desirable to have a system which addresses these current deficiencies.”); 8:7-19 (“CMU 32 is preferably a single unit that would ... have its own circuitry, CPUs, processors, memory, power source, etc. ...</p> |

|                                         |                                                                                                                                                                                                      |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| readings of said data stored in memory. | CMU 32 is capable of performing advanced data analysis, using data collected from multiple motes 10, and may apply heuristics to draw conclusions based on the analysis.”); EX1013 at [0128]-[0131]. |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**T. Claim 42 (Substitute for claim 21, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                                                                                                    | Support for Substitute Claim 43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>42.</u> A method for monitoring the operation of a railcar comprising:                                                                                                                                                                                                                                           | EX1001 at 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); EX1013 at [0001].                                                                                                                                                                                                                                                                                                                                                                                                                  |
| a. collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided <u>on a sidewall of a bearing adapter on said railcar, wherein the one or more operating parameters comprise a condition of a bearing proximate to the bearing adapter;</u> | EX1001 at Table spanning cols. 8-11 (multiple references to “sampled data”); 14:11-14 (“The Level 2 algorithms use temperature data that had been collected every minute while the railcar had been moving during a period of days directly preceding this analysis.”); 14:60-62 (“The Level [3] algorithms use temperature data that has been collected every minute while the railcar is moving for the previous 30 days directly preceding this analysis.”); Fig. 3; EX1013 at [0044]-[0045], [0070], [0097], [0130], [0131], FIGs. 9, 10a. |
| b. communicating said collected data to a communication management unit;                                                                                                                                                                                                                                            | EX1001 at 7:14-18, 8:1-6 (“To communicate data collected by the motes 10, each mote is in two-way communication with a CMU 32 mounted on the railcar 38, which collects data from each mote.”); EX1013 at [0116]-[0117].                                                                                                                                                                                                                                                                                                                       |
| c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) <del>to</del> predict potential or imminent failures based on a statistical analysis of said collected data, <u>wherein application of the heuristics</u>                                     | EX1001 at 1:16-21; 2:15-22; 2:59-3:3; 3:56-64, specifically, 2:61-3:1 (“The CMU is capable of wirelessly collecting data from each of the motes and performing higher-level analysis of the data to detect imminent or actual failures. During such data analysis, heuristics may be applied to determine potential failures based on statistical models                                                                                                                                                                                       |

|                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <u>correlates the data to the condition of the bearing;</u>                                                                                                                                    | and empirical data.”); EX1013 at [0118]-[0119].                                                                                                                                                                                                                                                                                                                                                                                               |
| <u>d. assigning a severity level to the condition of the bearing, wherein said severity level is one of three or more defined severity levels based on the one or more numeric values; and</u> | EX1001 at Table spanning cols. 8-11.; 11:51-58; EX1013 at [0064]-[0076]; <i>see also</i> Claim 23 step b, <i>supra</i> (incorporated here).                                                                                                                                                                                                                                                                                                   |
| <u>e. determining an alarm condition, wherein said alarm condition defines a specific action to be taken with regard to the bearing based on said assigned severity level.</u>                 | EX1001 at 2:3-16 (“The current systems, however, lack the ability to apply heuristics to act on data gathered from more than one sensor or to detect operational deviations or trends which show deviations from nominal operating parameters... Therefore, it would be desirable to have a system which addresses these current deficiencies.”); EX1013 at [0118]-[0122]; <i>see also</i> Claim 23 step c, <i>supra</i> (incorporated here). |

**1. “one or more sensor units provided on a sidewall of a bearing adapter”**

35. See the discussion at ¶¶21-25, which is applicable here.

**U. Claim 43 (Substitute for claim 22, if found unpatentable)**

| Claim Limitation                                                                                                                                                                                                                             | Support for Substitute Claim 43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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| <del>43.</del> <u>The method of claim 24</u> , further comprising the steps of:<br>assessing the <del>collected data</del> <u>one or more numeric values</u> to determine if an alarm condition exists; and<br>wirelessly communicating said | EX1001 at 5:15-22 (“Main board 28 may also include intelligence sufficient to perform low-level analysis of the data, and may accept parameters from outside sources regarding when alarms should be raised. For example, for the mote 10 shown in FIGS. 1 and 2, with a temperature sensor 20, may be programmed to raise an alarm when the sensed temperature exceeds a certain threshold for several consecutive readings. ... Preferably, each mote 10 on a railcar is formed into an ad-hoc mesh network with other motes 10 on the same railcar and with a |

|                                             |                                                                    |
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| alarm condition to an off railcar location. | Communication Management Unit (CMU) 32”); EX1013 at [0117]-[0119]. |
|---------------------------------------------|--------------------------------------------------------------------|

1. **“includes one or more numeric values based on data obtained at the bearing adapter”**

36. See the discussion at ¶¶23-25, which are applicable here.

**VII. SUBSTITUTE CLAIMS 23 THROUGH 43 ARE PATENTABLE OVER LEFEBVRE, ARMITAGE, OR BARONE, ALONE OR IN COMBINATION**

37. I am not aware of any prior art that would anticipate or render obvious proposed substitute claims 23 through 43. Further, substitute claims 23 through 43 find written description support in the Provisional Application 61/661,661 (EX1013, the “’661 Provisional”), filed June 19, 2012, to which the ’673 Patent claims priority.

**A. Independent Substitute Claim 23**

38. Independent Substitute Claim 23 corresponds to claim 1 of the ’673 Patent. It further narrows limitation 1[a] by (1) requiring the “one or more sensing units” to be mounted on a sidewall of a bearing adapter; and (2) limiting the “operational characteristic” to “a condition of a bearing”; and (3) requires the “received data or processed information” to include one or more calculated numeric values based on acceleration data obtained at the bearing adapter.

39. Substitute Claim 23 further narrows limitation 1[b] by requiring the “applied heuristic” to include a “comparison of one or more calculated numeric

values with a plurality of defined parameter values associated with the condition of the bearing.”

40. The received data is recited in 23[a] as based on acceleration data obtained at the bearing adapter and indicates the condition of a bearing. The received data is compared with defined values associated with the condition of the bearing to determine deviations from nominal operating conditions associated with the bearing.

41. Substitute Claim 23 further narrows limitation 1[c] limiting the “severity level” to “one of a plurality of defined severity levels that are based on a deviation of at least one of the calculated numeric values determined for the condition of the bearing from a defined reference value or range of values indicating nominal operating conditions for the bearing during operation of the railcar.”

42. Support for these limitations, as well as the remainder of the limitations of Substitute Claim 23 are provided at least in EX1001 at 1:16-21; 2:15-22; 2:59-3:3; 3:56-64; 4:51-56; 5:23-35; 5:42-59; 11:59-14:3; 12:40-61; 13:31-14:3; Fig. 3, EX1013 at [0001]; [0064]-[0076]; [0109]-[0119]; [0121]-[0122], [0128]-[0131]; Figs. 9, 10a.

43. In particular, the '673 Patent and the '661 Provisional disclose the use of an accelerometer to sense accelerations of a railcar. See, e.g., EX1001 at 4:51-56 (“Sensor 20 can be any type of sensor, including for example,... a vibration sensor [or] an accelerometer....”); EX1013 at [0109] (“[M]any different types of sensors

could be utilized by the mote, for example,... vibration, acceleration, etc. [T]he invention is not meant to be limited by the exemplary implementation.”). The ’673 Patent and the ’661 Provisional disclose numerous heuristics that utilize sensed acceleration data. See EX1001, table spanning cols. 8-11; EX1013 at [0064]-[0076]; [0129]-[0131]. A POSITA would have understood that these heuristics could be used to determine actual or potential faults in the bearing. Examples given include the use of kurtosis and FFT (fast Fourier transform) calculations on sampled data.

44. I now show that these limitations are not taught or suggested by Lefebvre, Armitage, or Barone, either alone or in combination.

45. Fundamentally, LeFebvre compares readings from a sensor with contemporaneous readings from other sensors on the railcar. As I have pointed out in EX2001 and EX2010, this can result in inability to detect a failure because all of the sensors may agree, but all may deviate from nominal conditions. This flaw is remedied in Substitute Claim 23 by comparing sensor readings with known, defined values.

46. Petitioners assert that LeFebvre’s use of “inference engine techniques” teaches the claimed application of a heuristic. Petition at 21. Petitioners cite portions of LeFebvre that disclose a data control unit programmed to compare information aggregated from all the trucks on the railcar and using “inference engine techniques to identify unsatisfactory behavior such as swaying, bouncing or even partial

derailment.” LeFebvre at [0036], [0056]. However, this discloses monitoring relative changes in temperature of a bearing against other bearings to infer the condition of that bearing. *Id.* at [0058]-[0059].

47. Therefore, LeFebvre discloses comparing relative temperatures (at different instrumented pads) to infer the condition of a bearing, and spectral analysis of load measurements from a single instrumented pad to identify a failing bearing. However, LeFebvre does not disclose comparing readings against ***defined*** values to determine deviations from nominal operating conditions. Thus, LeFebvre fails to teach or suggest at least the following limitations of substitute claim 23: receiving a calculated numeric value (which is based on acceleration data obtained at the bearing adapter relating to the condition of a bearing), and comparing at least one of the calculated numeric values with a defined value (associated with the condition of the bearing) to determine deviations from nominal operating conditions.

48. Furthermore, LeFebvre discloses only one type of severity for a bearing, namely that something is amiss (alternatively described as unsatisfactory behavior or impending failure), and not any “levels” of severity. LeFebvre at [0035]-[0036], [0095]. A notice that the bearing is not actually or potentially defective is, by very definition, not a severity level. Thus, LeFebvre also fails to teach or suggest at least the following limitations of substitute claim 23: assigning a severity level to said deviations wherein said severity level is one of ***a plurality of defined severity***

*levels*. The claims recite that the severity level is assigned to the “deviations from nominal operating conditions.” In the Patent, alarm conditions are only determined based on the severity level, which in turn are based on deviations from nominal operating conditions. Therefore, the lack of any alert in LeFebvre indicating that bearings are not actually or potentially defective is, by definition, not a severity level. Thus, LeFebvre fails to teach or suggest assigning “severity levels.”

49. Petitioner also asserts that Armitage’s statistical methods teach the claimed application of a heuristic. Pet. at 55. In support, Petitioner cites portions of Armitage disclosing that “a standard deviation metric is employed to determine when data from one or more sensor nodes becomes an outlier from a main cluster of sensor node data, such as when data from a sensor node deviates by more than three standard deviations,” and “outliers for sensor nodes on an entire side of railway car 310 could indicate cornering failure, or an off-track condition.” Armitage at [0042], [0044]. This process scales the operational values for an undercarriage element in real-time. However, as with LeFebvre, Armitage fails to teach or suggest comparing acceleration data to *defined* values to determine deviations from nominal operating conditions. Thus, Armitage fails to cure the deficiencies of LeFebvre.

50. Claim 23 further recites an “alarm condition” that “defines one or more recommended actions to be taken with regard to the detected deviation from nominal operating conditions.” None of the prior art of record discloses this limitation.

51. Petitioner relies on Barone merely for disclosing a plurality of railcars. Pet. at 12. Otherwise, Petitioner characterizes Barone as similar to LeFebvre. *Id.* at 42-43. Thus, Barone also fails to cure the deficiencies of LeFebvre and Armitage with respect to Substitute Claim 23.

**B. Independent Substitute Claim 33**

52. Independent Substitute Claim 33 corresponds to claim 10 of the '673 Patent. It narrows the preamble of claim 10[a] by requiring monitoring both the temperature **and condition** of a desired part.

53. It further limits 10[a] by adding that accelerations must be sensed. It further limits 10[b] by requiring determining “calibrated correlations between a plurality of temperature values for the desired part and a plurality of temperatures that are expected for the part during standard operations of the railcar” and, in addition, “calculating one or more numeric values based on the accelerations sensed in step (a).”

54. It further narrows 10[c], which recites “determining if said temperature of the desired part is outside an acceptable range” by replacing it with “determining if said temperature of the desired part is outside an acceptable range of temperatures indicating operating conditions expected for the desired part during the operation of the railcar by comparing the temperature of the desired part determined in step (b) and at least one defined temperature value associated with the desired part and

detecting a condition of the desired part by comparing at least one of said calculated numeric values with a plurality of defined parameter values associated with the condition of the desired part, wherein an acceptable range of temperatures is a defined range of temperatures expected during normal operation of the railcar; and limits step (d) by requiring the alarm condition to define one or more recommended actions to be taken with regard to the detected condition of the desired part and including severity level determinations by a deviation of said temperature from a predetermined reference temperature value, wherein said deviation indicates a severity of a detected condition of the desired part. Just as in independent Substitute Claim 23, Substitute Claim 33 is limited to comparing sensor-based information against defined values to determine deviations from expected operating conditions. See ¶26, above. Thus, the limitations of claim 33 are also not taught by Lefebvre, Armitage, or Barone.

**C. Independent Substitute Claims 36 and 42**

55. Independent Substitute Claim 36 and 42 correspond, respectively, to claims 14 and 21 of the '673 Patent. They limit the heuristic analysis to determining a condition of a bearing based on correlations between received data and a plurality of different values indicative of the condition of the bearing. Similar to that of independent Substitute Claim 23, the heuristic analyses of claims 36 and 42 are limited to specific objects and correlations that are not taught by Lefebvre or

Armitage. *See also supra* ¶¶23-25. Claims 36 and 42 recite an “alarm condition” that “defines a specific action to be taken with regard to the bearing.” None of the prior art of record discloses this limitation.

56. Substitute claim 36 further limits 14[b] by referring to the “received acceleration data” instead just “received data” and by adding two entirely new limitations: (1) “determine a value for a condition of a bearing based on correlations between a plurality of different values for the condition of the bearing and a plurality of defined parameter values associated with the bearing adapter that specify operating conditions expected for the bearing during operation of the railcar”; and (2) “assign a severity level to said determined actual failure or said predicted potential or imminent failures, wherein the severity level is based on deviations of the value for the condition of the bearing from a defined reference value or range of values.”

57. Substitute Claim 36 requires the severity level to be “based on deviations of the value for the condition of the bearing from a defined reference value or range of values.” Similar to independent Substitute Claim 23, the heuristic analysis of Substitute Claim 42 requires specific steps that are not taught by Lefebvre or Armitage.

58. Substitute Claim 36 adds limitations not taught by Lefebvre, Armitage, or Barone, alone or in combination. Therefore, dependent Substitute Claims 37-41 are patentable over Lefebvre, Armitage, or Barone, alone or in combination.

59. Substitute Claim 42 adds limitations not taught by Lefebvre, Armitage, or Barone, alone or in combination. Therefore, Substitute Claim 43 is also patentable over Lefebvre, Armitage, or Barone, alone or in combination.

### **VIII. CONCLUDING STATEMENT**

60. 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 the Substitute Claims find written description support in the '673 Specification and '661 Provisional. Further, the Substitute Claims are patentable over the prior art applied in the Petition.

61. 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.

62. 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.

63. 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 February 22, 2024 at Pittsburgh, PA.

  
Michael I. Shamos