

**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 2158**

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

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IV. SUBSTITUTE CLAIMS 23 THROUGH 43 ARE PATENTABLE OVER  
LEFEBVRE, ARMITAGE, OR BARONE, ALONE OR IN COMBINATION ....17

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

## **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 Motion to Amend (“MTA”).

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 (“Shamos I”). My background, qualifications and compensation were set forth in ¶¶ 4-14 and 21-22 of Shamos I. Contemporaneous with this declaration, I am also submitting a “Declaration of Michael I. Shamos, Ph.D. in Support Of Patent Owner’s Response” (“Shamos 2,” Ex. 2010).

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

**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.

**I. 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.

### **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.

### **II. 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.

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

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

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                  | Support                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 4. <del>23.</del> A method of monitoring operational characteristics of a railcar comprising the steps of:                                                                                                                                                                                                                                        | Ex. 1001 at 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); Ex. 1013 at ¶1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 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, said sensing units monitoring <del>an</del> <u>said</u> operational characteristic of said railcar, <u>wherein</u> | Ex. 1001 at 3:57-62 (“The sensors monitor and/or collect data on particular parameters and conditions of the railcar.”); Fig. 3; 4:51-56 (“Sensor 20 can be any type of sensor, including for example, a temperature sensor, a pressure sensor, a load cell, a strain gauge, a hall effect sensor, a vibration sensor, an accelerometer, a gyroscope, a displacement sensor, an inductive sensor, a piezio [sic] resistive microphone or an ultrasonic sensor.”); 5:23-35; 5:42-59 (“The individual notes 10 are mounted on the areas of interest on a railcar 38. As an example, FIGS. 3 and 3A show a temperature sensing note ... |

|                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>the operational characteristic is a condition of a bearing and wherein the received data or processed information includes one or more calculated numeric values based on acceleration data obtained at the bearing adapter;</u>                                                                      | mounted to a bearing adapter.”); Ex. 1013 at ¶¶109-119, specifically ¶109 (“... many different types of sensors could be utilized by the mote, for example,... temperature, pressure, strain, magnetic, vibration, acceleration, etc. [T]he invention is not meant to be limited by the exemplary implementation.”); ¶115 (“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.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| b. applying a heuristic to said received data to determine deviations from nominal operating conditions, <u>wherein the heuristic includes a comparison of at least one of said calculated numeric values with a plurality of defined parameter values associated with the condition of the bearing;</u> | Ex. 1001 at Table spanning cols. 7-12. (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 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.”); Ex. 1013 at ¶¶64-76; 129-131. |
| 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 based on a deviation of at least one of the</u>                                                                             | Ex. 1001 at 12:40-61 (“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.”); 13:30-14:3; Ex. 1013 at ¶¶121-122.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>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; and</u> |                                                                                                                                                                                                                                                                                                 |
| d. determining an alarm condition based on said assigned severity level.                                                                                                                                                    | Ex. 1001 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.”); Ex. 1013 at ¶¶121-122. |

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

| Claim Limitation                                                                                                                                                                                                                                                                                            | Support                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <del>13.</del> <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>sensor</del> <u>sensing</u> units, a communication management unit, and a mobile or land base station. | Ex. 1001 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.”); Ex. 1013 at ¶¶117-118. |

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

| Claim Limitation                                                                                                                                                                                   | Support                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| <del>2.</del> <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. | Ex. 1001 at 2:61-64; Ex. 1013 at ¶117. |

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

| Claim Limitation                                                                                                                               | Support                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| <del>3.</del> <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. | Ex. 1001 at 5:24-28 (); Ex. 1013 at ¶117. |

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

| Claim Limitation                                                                                                                                         | Support                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <del>4.</del> <u>27.</u> The method of <del>claim 2</del> <u>claim 25</u> , wherein steps a-d are executed by a processing unit located on said railcar. | Ex. 1001 at 2:61-64; 8:14-17; Ex. 1013 at ¶¶117-118. |

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

| Claim Limitation                                                                                                                                                                     | Support                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| <del>5.</del> <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. | Ex. 1001 at 5:24-28; Ex. 1013 at ¶116. |

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

| Claim Limitation                                                                                                                                                                     | Support                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| <del>6.</del> <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. | Ex. 1001 at 11:40-44; Ex. 1013 at ¶¶118-119. |

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

| Claim Limitation                                                                                                                                                                                                                 | Support                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <del>7.</del> <u>30.</u> The method of <del>claim 2</del> <u>claim 25</u> , further comprising the step of transmitting said data received from said one or more sensing units to a location remote from said railcar <u>and</u> | Ex. 1001 at 3:4-14; 8:3-13; 11:40-58; Ex. 1013 at ¶¶117-121, Fig. 11. |

|                                                                        |  |
|------------------------------------------------------------------------|--|
| <u>performing steps b-d at said location remote from said railcar.</u> |  |
|------------------------------------------------------------------------|--|

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Support                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <p><del>8.</del> <u>31.</u> The method of <del>claim 2</del> <u>claim 25</u>, further comprising the steps of:</p> <ul style="list-style-type: none"> <li>a. receiving <u>acceleration</u> data from a plurality of railcars;</li> <li>b. applying a <u>the</u> heuristic to said received <u>acceleration</u> data to determine <u>the</u> deviations from nominal operating conditions;</li> <li>c. assigning a <u>the</u> severity level to said deviations from nominal operating conditions;</li> <li>d. determining <del>an</del> <u>the</u> alarm condition based on said assigned severity level; <u>and</u></li> <li>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 the assigned severity level.</u></li> </ul> | <p><i>See §IV.A (Claim 23) supra (incorporated by reference here)</i></p> |

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                              | Support                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <p><del>9.</del> <u>32.</u> The method of <del>claim 6</del> <u>claim 29</u>, further comprising the steps of</p> <ul style="list-style-type: none"> <li>a. determining a recommended course of action based on said alarm condition; and</li> <li>b. transmitting said recommended course of action to a display unit on a train of which said railcar is a part.</li> </ul> | <p>Ex. 1001 at 13:31-32; 11:59-12:40; Ex. 1013 at ¶121.</p> |

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

| Claim Limitation                                                                                                                       | Support                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <p><del>10.</del> <u>33.</u> A method of monitoring a temperature <u>and condition</u> of a desired part of a railcar, comprising:</p> | <p>Ex. 1001 at 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); Ex. 1013 at ¶68.</p> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (a) sensing the temperature of a part of the railcar other than the desired part by use of a temperature sensor in thermal communication with said other part <u>and sensing accelerations by use of an accelerometer attached to said other part;</u>                                                                                                                                                                                                          | Ex. 1001 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 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; Ex. 1013 at ¶¶110-112; <i>see also</i> §IV.A (Claim 23 step a), <i>supra</i> (incorporated here)                                                                                                                                                                                                         |
| (b) determining the temperature of the desired part by use of the temperature of <u>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 and calculating one or more calculated numeric values based on the accelerations sensed in step (a);</u>                                    | Ex. 1001 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).”); Ex. 1013 at ¶116, FIGs. 9, 10a; <i>see also</i> §IV.A (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 a plurality of defined parameter values associated with the desired part and detecting a condition of the desired part by comparing at least one of said calculated</u> | Ex. 1001 at Table spanning cols. 7-12; 11:51-58; Ex. 1013 at ¶¶64-76, 116; <i>see also</i> §IV.A (Claim 23 step b), <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><u>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</u></p>                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                   |
| <p>(d) transmitting an alarm if in step (c) it is determined that the temperature of the desired part is outside <del>an</del> <u>the acceptable range of temperatures and transmitting an alarm if in step (c) it is determined that the condition of the desired part falls within one of a plurality of severity levels defined by a deviation of at least one of the calculated numeric values determined for the condition of the desired part from a defined reference value or range of values indicating a severity of the detected condition of the desired part.</u></p> | <p>Ex. 1001 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.”); Ex. 1013 at ¶¶118-119; <i>see also</i> §IV.A (Claim 23 step c-d), <i>supra</i> (incorporated here)</p> |

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                     | Support                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| <p><del>11. 34.</del> <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> <u>a</u> temperature of the ambient air, which temperature is used in the determination of step (b).</p> | <p>Ex. 1001 at 5:53-58;<br/>Ex. 1013 at ¶¶116-117.</p> |

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

| Claim Limitation                                                                                                                                                                                                                                                     | Support                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <del>12.</del> <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. | Ex. 1001 at 2:61-64; 8:14-17; Ex. 1013 at ¶¶118-119. |

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

| Claim Limitation                                                                                                                                                                                                                                                  | Support                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <del>14.</del> <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:                                                                                       | Ex. 1001 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.”); Ex. 1013 at ¶¶1, 118-119. |
| a. wirelessly receiving <u>acceleration</u> 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;                                                  | Ex. 1001 at 5:23-42, Fig. 3; Ex. 1013 at ¶¶44-45, FIGs. 9, 10a; <i>see also</i> §IV.A (Claim 23 step a), <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                                                                               |
| b. heuristically analyzing said received <u>acceleration</u> data to<br>determine <u>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</u> | Ex. 1001 at Table spanning cols. 7-12; 11:51-58; Ex. 1013 at ¶¶64-76; 129-131; <i>see also</i> §IV.A (Claim 23 step b), <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                                                                |

|                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><u>values associated with the bearing adapter of the railcar that specify operating conditions expected for the bearing during operation of the railcar, and</u></p>              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>determine if an actual failure exists on said railcar or to predict potential or imminent failures based on a statistical analysis of said received <u>acceleration</u> data;</p> | <p>Ex. 1001 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 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.”); Ex. 1013 at ¶¶129-130.</p> |
| <p><u>Assign a severity level to said determined actual failure or said predicted potential or imminent failures, wherein the</u></p>                                                | <p>Ex. 1001 at 12:40-61; 13:31-14:3 (“These are examples of various levels of alarms, based on severity.”); Ex. 1013 at ¶¶121-122;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                                                                                                                                                   |                                                                                                                                                                                |
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| <u>severity level is based on deviations of the value for the condition of the bearing from a defined reference value or range of values; and</u> | <i>see also §IV.A (Claim 23 step c), supra (incorporated here)</i>                                                                                                             |
| c. communicating the results of said analysis <u>performed in step (b)</u> to an off-railcar location.                                            | Ex. 1001 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.”); Ex. 1013 at ¶¶118-119. |

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Support for Substitute Claim 37                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><del>15. 37.</del> The method of <del>claim 14</del> <u>claim 36</u>, wherein each of said sensing units can make a determination of an alarm condition based on data collected by the sensing unit, said method further comprising the step of:</p> <p style="padding-left: 40px;">a. 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>Ex. 1001 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. ...</p> <p>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.”); Ex. 1013 at ¶¶117-119.</p> |

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

| Claim Limitation                                                                                                                                                                                                                                                    | Support for Substitute Claim 38                                                                                                                                                                                                                                                                                  |
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| <p><del>16. 38.</del> 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 determination of an alarm condition based on data received from two or more of said sensing units; and</p> | <p>Ex. 1001 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</p> |

|                                                                   |                                                                                                                                                                                                                                             |
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| b. communicating said alarm condition to an off-railcar location. | 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.”); Ex. 1013 at ¶¶118-119. |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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

| Claim Limitation                                                                                                                                                                                                                                                               | Support for Substitute Claim 39                                                                                                                                                                                                                                                                                                                                                                    |
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| <del>17.</del> <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. | Ex. 1001 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.”); Ex. 1013 at ¶¶44-45. |

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

| Claim Limitation                                                                                                                                                                                     | Support for Substitute Claim 40                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <del>18.</del> <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. | Ex. 1001 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.”); Ex. 1013 at ¶116. |

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

| Claim Limitation | Support for Substitute Claim 41 |
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| <p><del>20- 41.</del> <u>The system method of claim 14 claim 36, further comprising the steps of:</u></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 readings of said data stored in memory.</p> | <p>Ex. 1001 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>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> <p>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.”); Ex. 1013 at ¶¶128-131.</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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

| Claim Limitation                                                                                                                                                                                                                                                                                                                                                                                                                   | Support for Substitute Claim 43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| <p><del>21- 42.</del> <u>A method for monitoring the operation of a railcar comprising:</u></p>                                                                                                                                                                                                                                                                                                                                    | <p>Ex. 1001 at 3:56-57 (“a novel means for monitoring the performance and operation of a railcar is provided.”); Ex. 1013 at ¶1.</p>                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p>a. <u>collecting data at periodic intervals about one or more operating parameters of said railcar using one or more sensor units provided on a sidewall of a bearing adapter on said railcar, wherein the one or more operating parameters comprise a condition of a bearing and wherein the collected data includes one or more calculated numeric values based on acceleration data obtained at the bearing adapter;</u></p> | <p>Ex. 1001 at Table spanning cols. 7-12 (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; Ex. 1013 at ¶¶44-45, 70, 97, 130, 131, FIGs. 9, 10a.</p> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                          |
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| b. communicating said collected data to a communication management unit;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ex. 1001 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.”); Ex. 1013 at ¶¶116-117.                                                                                                                                                                                 |
| c. analyzing said collected data by applying heuristics thereto to (i) determine if an actual failure exists and (ii) to predict potential or imminent failures based on a statistical analysis of said collected data;                                                                                                                                                                                                                                                                                                                                                      | Ex. 1001 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 and empirical data.”); Ex. 1013 at ¶¶118-119. |
| <u>wherein the heuristics include a comparison of at least one calculated numeric value with a plurality of defined parameter values associated with the condition of the bearing, wherein application of the heuristics produces a value for the condition of the 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 of the railcar that specify operating conditions expected for the bearing during operation of the railcar; and</u> | Ex. 1001 at Table spanning cols. 7-12.; 11:51-58; Ex. 1013 at ¶¶64-76.; <i>see also</i> §IV.A (Claim 23 step b), <i>supra</i> (incorporated here)                                                                                                                                                                                                                                                        |
| <u>wherein a result of said statistical analysis comprises a deviation of the value for the condition of the bearing from a defined reference value or range</u>                                                                                                                                                                                                                                                                                                                                                                                                             | Ex. 1001 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                                                                                                                                                                               |

|                                                                                                                      |                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>of values indicating operating conditions expected for the bearing during standard operations of the railcar.</u> | operating parameters... Therefore, it would be desirable to have a system which addresses these current deficiencies.”); Ex. 1013 at ¶¶118-122; <i>see also</i> §IV.A (Claim 23 step c), <i>supra</i> (incorporated here) |
|----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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

| Claim Limitation                                                                                                                                                                                                                                            | Support for Substitute Claim 43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| <del>22. 43.</del> The method of <del>claim 21</del> claim 42, further comprising the steps of:<br>assessing the collected data to determine if an alarm condition exists; and<br>wirelessly communicating said alarm condition to an off railcar location. | Ex. 1001 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....<br><br>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 Communication Management Unit (CMU) 32”); Ex. 1013 at ¶¶117-119. |

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

21. 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 (Ex. 1013, the “’661 Provisional”), filed June 19, 2012, to which the ’673 Patent claims priority.

**A. Independent Substitute Claim 23**

22. 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.

23. 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.”

24. 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.

25. 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.”

26. Support for these limitations, as well as the remainder of the limitations of Substitute Claim 23 are provided at least in Ex. 1001 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, Ex. 1013 at ¶¶ 1; 64-76; 109-119; 121-122, 128-131; Figs. 9, 10a; see also § VI, above.

27. In particular, the '673 Patent and the '661 Provisional disclose the use of an accelerometer to sense accelerations of a railcar. See, e.g., Ex. 1001 at 4:51-56 ("Sensor 20 can be any type of sensor, including for example,... a vibration sensor [or] an accelerometer...."); Ex. 1013 at ¶ 109 ("[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 Ex. 1001, table spanning cols. 7-12; Ex. 1013 at ¶¶ 64-76; 129-131. A POSITA would understand 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.

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

29. Fundamentally, LeFebvre compares readings from a sensor with contemporaneous readings from other sensors on the railcar. As I have pointed out

in Shamos I and Shamos 2, 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.

30. 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 ¶¶ 36, 56. However, this discloses monitoring relative changes in temperature of a bearing against other bearings to infer the condition of that bearing. *Id.* at ¶¶ 58-59.

31. 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.

32. Furthermore, LeFebvre discloses only one type of severity for a bearing, namely that something is amiss (alternatively described as unsatisfactory behavior or impending failure). LeFebvre at ¶¶ 35-36, 95. 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*.

33. 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 ¶¶ 42, 44. 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.

34. Petitioner relies on Barone merely for disclosing a plurality of railcars. Ex. 1001 at 11. 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**

35. 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.

36. 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 calculated numeric values based on the accelerations sensed in step (a).”

37. 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 including severity level determinations on the calculated values from the acceleration data. 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 ¶¶ 22 ff, above. Thus, the limitations of claim 33 are also not taught by Lefebvre, Armitage, or Barone.

**C. Independent Substitute Claim 36**

38. Independent Substitute Claim 36 corresponds to claim 14 of the '673 Patent. It further limits 14[a] by requiring “receiving acceleration data” instead of just “receiving data” and requires that the “one or more sensors” be “disposed on a sidewall of a bearing adapter.”

39. It 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.”

40. 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. See ¶¶ 22 ff, above.

41. 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.

#### **D. Independent Substitute Claim 42**

42. Independent Substitute Claim 42 corresponds to claim 21. It further limits 21[a] by requiring the “one or more sensor units” to be “mounted on a sidewall of a bearing adapter” and “wherein the one or more operating parameters comprise a condition of a bearing and wherein the collected data includes one or more calculated numeric values based on acceleration data obtained at the bearing adapter.”

43. It further limits 21[c] by adding two entirely new limitations: (1) “wherein the heuristics include a comparison of at least one calculated numeric value with a plurality of defined parameter values associated with the condition of the bearing, wherein application of the heuristics produces a value for the condition of the 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 of the railcar that specify operating conditions expected for the bearing during operation of the railcar”; and (2) “wherein a result of said statistical analysis comprises a deviation of the value for the condition of the bearing from a defined reference value or range of values indicating operating conditions expected for the bearing during standard operations of the railcar.”

44. Substitute Claim 42 requires the heuristic analysis to include comparison of at least one calculated numeric value with a plurality of defined parameter values associated with the condition of the bearing. Similar to independent substitute claim 23, the heuristic analysis of Substitute Claim 42 requires specific steps that are not taught by Lefebvre or Armitage. See ¶¶ 22 ff, above.

45. Substitute Claim 42 adds limitations not taught by Lefebvre, Armitage, or Barone, alone or in combination. Therefore, dependent Substitute

Claim 43 is patentable over Lefebvre, Armitage, or Barone, alone or in combination.

**CONCLUDING STATEMENT**

46. 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.

47. 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.

48. 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.

49. 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

Declaration of Michael I. Shamos

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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 October 19, 2023 at Pittsburgh, PA.

  
Michael I. Shamos