US010814857B2

(12) **United States Patent**
**Buchberger et al.**

(10) **Patent No.: US 10,814,857 B2**
(45) **Date of Patent: Oct. 27, 2020**

(54) **WIRELESS AIR BRAKE TESTING AND INSPECTION**

(71) Applicants: **Klaus Buchberger**, Oconomowoc, WI (US); **Steven Novak**, Oconomowoc, WI (US)

(72) Inventors: **Klaus Buchberger**, Oconomowoc, WI (US); **Steven Novak**, Oconomowoc, WI (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/296,963**

(22) Filed: **Mar. 8, 2019**

(65) **Prior Publication Data**

US 2019/0202427 A1 Jul. 4, 2019

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 15/700,656, filed on Sep. 11, 2017, now abandoned.

(51) **Int. Cl.**

| | |
|---|---|
| ***B60T 17/22*** | (2006.01) |
| ***G01M 17/08*** | (2006.01) |
| *G07C 5/00* | (2006.01) |
| *B60T 13/66* | (2006.01) |

(52) **U.S. Cl.**

CPC ..... ***B60T 17/228*** (2013.01); ***B60T 17/226*** (2013.01); *B60T 13/665* (2013.01); *G01M 17/08* (2013.01); *G07C 5/008* (2013.01); *G07C 2205/02* (2013.01)

(58) **Field of Classification Search**

CPC ..... B60T 13/665; B60T 17/008; B60T 17/08; B60T 17/22; B60T 17/226; B60T 17/228; G07C 2205/02

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 4,847,770 | A * | 7/1989 | Kane | B60T 13/665 701/20 |
| 5,747,685 | A * | 5/1998 | Skantar | B60T 17/228 303/3 |
| 6,126,247 | A * | 10/2000 | Paul | B60T 13/665 303/128 |

(Continued)

FOREIGN PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| WO | WO-9407729 | A1 * | 4/1994 | B60T 17/228 |

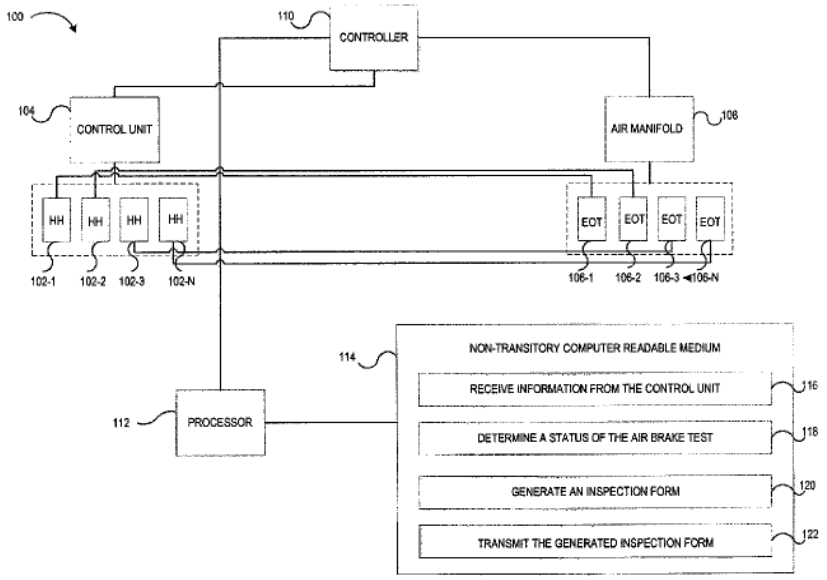
*Primary Examiner* — Nguyen Q. Ha

(74) *Attorney, Agent, or Firm* — Joseph S. Heino; Erin E. Kaprelian

(57) **ABSTRACT**

A system comprises a plurality of handheld devices including a plurality of transceivers. A control unit may be coupled to a handheld device of the plurality of handheld devices. The system may further include a plurality of end-of-train air devices coupled to a plurality of air brakes. An air manifold may be coupled to the plurality of air brakes. The system may include a controller coupled to the control unit and to the air manifold. A processor may be coupled to the controller and the control unit, and a non-transitory computer readable medium may be coupled to the processor. The non-transitory computer readable medium may include instructions executable to receive information from the control unit corresponding to an air brake test performed on the plurality of end-of-train air devices, determine a status of the air brake test, generate an inspection form based on the received information and the determined status, and transmit the generated inspection form for printing.

**4 Claims, 2 Drawing Sheets**



(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 6,227,625 | B1 * | 5/2001 | Gaughan | B60T 13/665 303/15 |
| 2004/0122566 | A1 * | 6/2004 | Horst | B60T 17/228 701/2 |
| 2014/0081512 | A1 * | 3/2014 | Fugiel | B60T 7/16 701/33.2 |

* cited by examiner

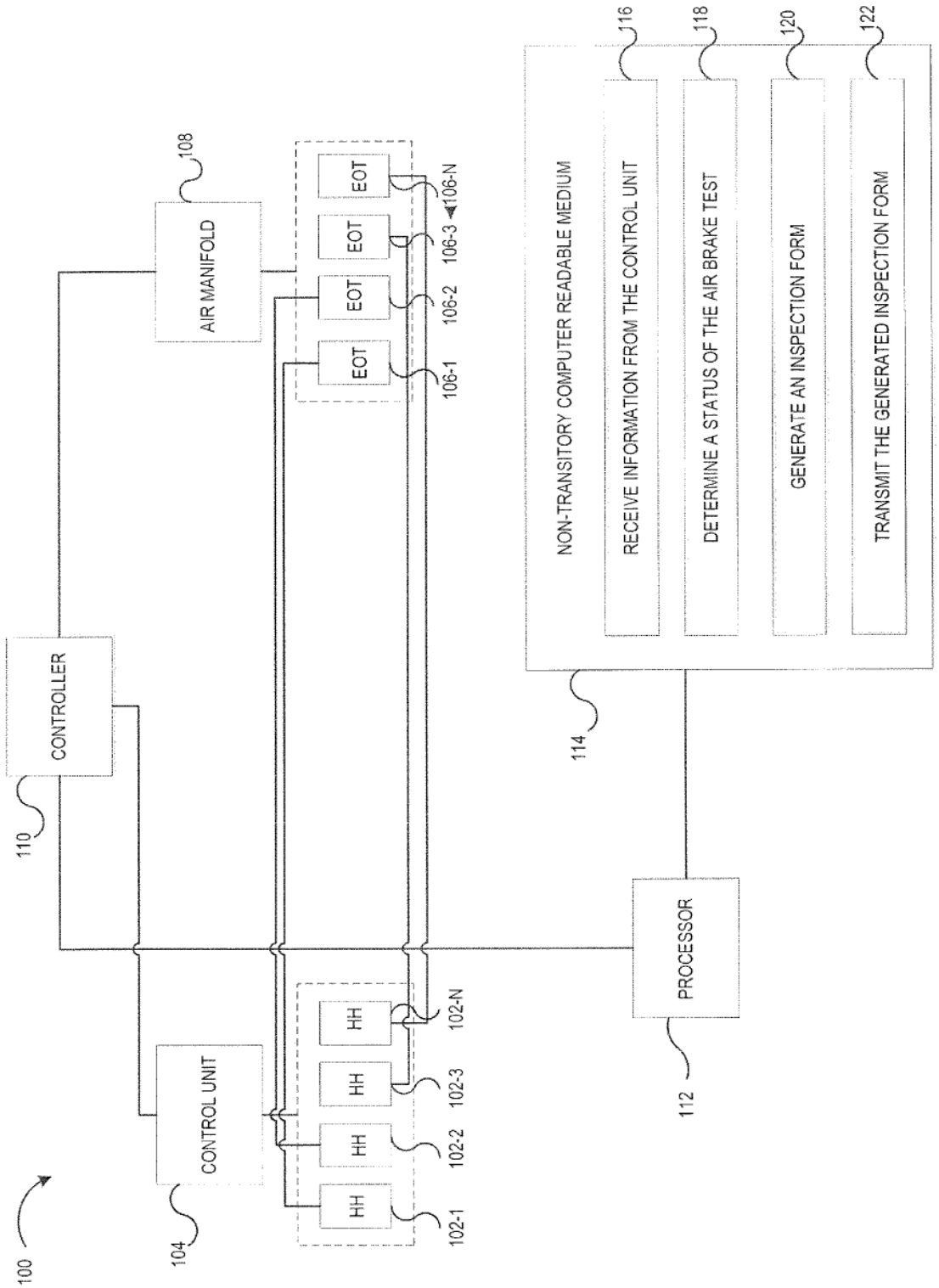

100
104
CONTROL UNIT
108
AIR MANIFOLD
110
CONTROLLER
HH
102-1
102-2
102-3
102-N
EOT
106-1
106-2
106-3
106-N
112
PROCESSOR
114
NON-TRANSITORY COMPUTER READABLE MEDIUM
116
RECEIVE INFORMATION FROM THE CONTROL UNIT
118
DETERMINE A STATUS OF THE AIR BRAKE TEST
120
GENERATE AN INSPECTION FORM
122
TRANSMIT THE GENERATED INSPECTION FORM

FIG. 1

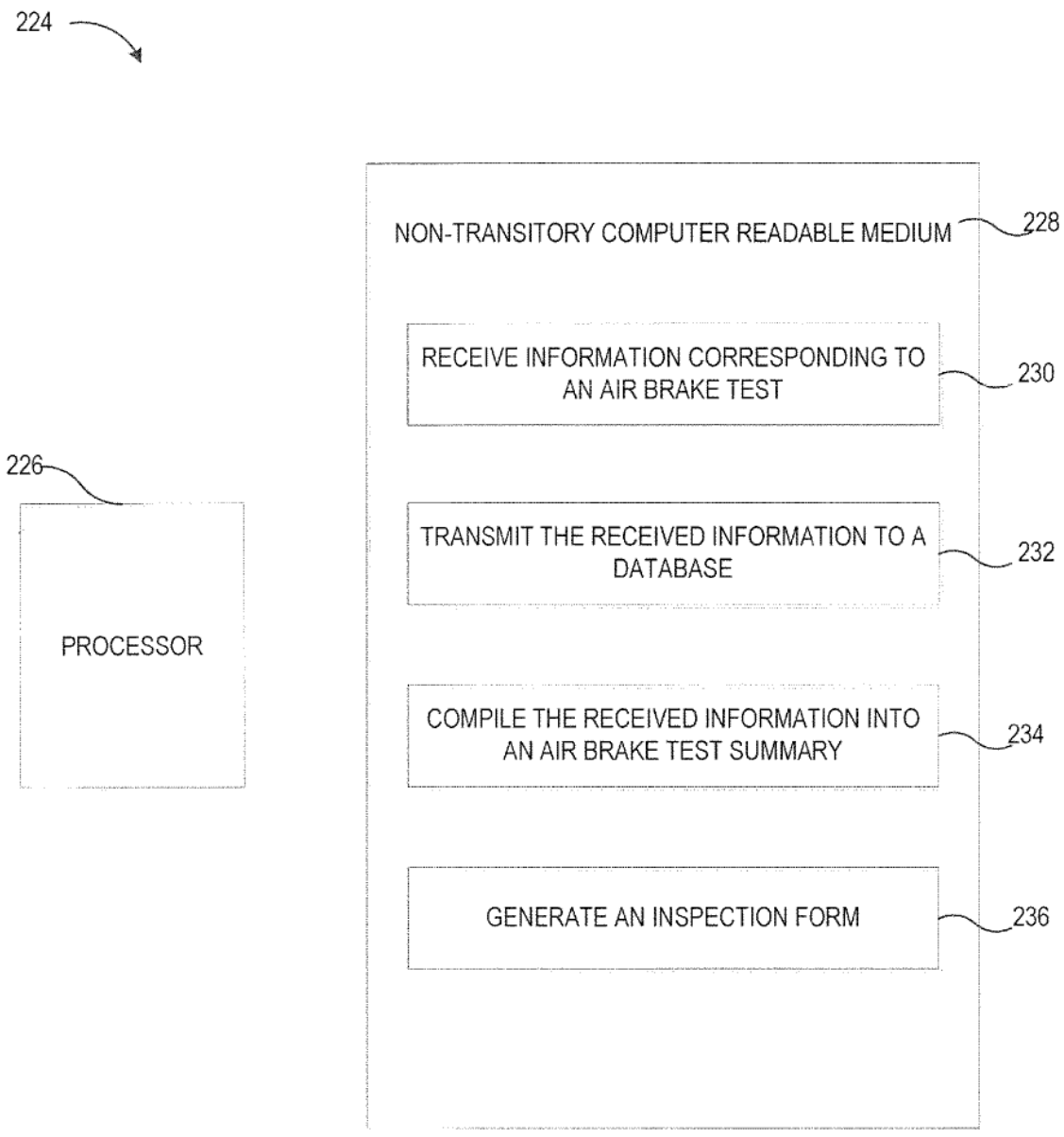

224
NON-TRANSITORY COMPUTER READABLE MEDIUM
228
RECEIVE INFORMATION CORRESPONDING TO AN AIR BRAKE TEST
230
226
TRANSMIT THE RECEIVED INFORMATION TO A DATABASE
232
PROCESSOR
COMPILE THE RECEIVED INFORMATION INTO AN AIR BRAKE TEST SUMMARY
234
GENERATE AN INSPECTION FORM
236

FIG. 2

# WIRELESS AIR BRAKE TESTING AND INSPECTION

## PRIORITY

This application is a continuation-in-part of U.S. patent application Ser. No. 15/700,656, filed Sep. 11, 2017, and which claims priority from Provisional Application No. 62/393,482, filed on Sep. 12, 2016.

## BACKGROUND

Air braking is used in multiple industries, including the railroad industry. When used as part of a train, air brakes are required to undergo regular testing and certification of proper function. Such testing and certification ensures proper function of the air brakes and compliance with applicable safety standards.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an example system for wireless air brake testing and inspection consistent with the present disclosure.

FIG. **2** is another example system for wireless air brake testing and inspection consistent with the present disclosure.

## DETAILED DESCRIPTION

The use of air brakes is widely used in a number of industries. As used herein, an air brake refers to a type of friction brake, generally for vehicles, that relies on compressed air pressing on a piston to apply pressure to a break pad. An air brake may either be a parking brake, used to keep a vehicle from moving, or a service brake, used when a vehicle is in motion and needs to be slowed

One industry that relies heavily on air brakes is the railway industry. Rail cars, such as those that make up a train when joined together, often have a number of air brakes. When joined to another rail car, the air brakes are also electronically joined, such that they are able to operate as a single system, allowing the train to safely brake when necessary.

Many railcars use a triple-valve system of air brakes. In a triple-valve system, the railcar brakes remain immovable when there is no air pressure applied. As long as there is no air pressure, the train will remain at rest. In order to release the brakes, and thus allow the train to move, the system must be pressurized. The pressurization of the triple-valve system may be referred to as charging and is the first function in the triple-valve system. Once the system is charged, i.e., has reached its required operating pressure, the brakes are freed, allowing the train to move.

When the train is moving, it may be slowed or stopped using the 'applying' function of the triple-valve system. The applying function uses decreases in air pressure to apply the brakes. As air pressure in the system decreases, the brakes move into an applied position. Once the system is fully depressurized, the brakes are fully applied, and only a re-pressurization will permit movement of the train again.

Due to the importance of being able to safely brake a train, including each of its component railcars, air brake testing is mandated by the Federal Railroad Administration. Air brake tests must be carried out on a regular basis and the results must be transferred to a report that is then carried within the train itself to certify a successful test. Such reports are generally filled out by hand during or immediately after the air brake test. This hand-filling of the reports increases the risk of accidental or purposeful misreporting of results, illegible results, and adds to the amount of time already used to perform an air brake test.



By contrast, the system of the present disclosure includes a wireless air brake testing system that includes generation and printing of a report. A plurality of handheld devices may be coupled to a control unit and a controller; the control unit and controller may further be coupled to a processor. As an air brake test is performed using the plurality of handheld devices, the results may be transmitted to the processor by the control unit and controller. Once the processor receives the information, instructions may determine a status of the air brake test, generate an inspection form, and transmit the generated form for printing or digital storage. In this way, the air brake test is able to be performed more quickly as it is entirely wireless, and the issues inherent in a handwritten report are eliminated.

FIG. **1** is an example system **100** for wireless air brake testing and inspection consistent with the present disclosure. System **100** includes a plurality of handheld units **102-1**, **102-2**, **102-3** . . . **102**-N (collectively, handheld units **102**). As used herein, a handheld unit refers to a handheld device, such as a mobile phone, tablet computer, or other similar portable device. Although four handheld units **102** are shown in FIG. **1**, examples are not so limited and any number of handheld units may be used.

Handheld devices **102** may include a plurality of transceivers. As used herein, a transceiver refers to a device that comprises both a transmitter and a receiver. Because the transceiver includes both a transmitter component and a receiver component, a transceiver is able to both send and receive communications and signals, such as radio signals. The plurality of transceivers may be integrated into the plurality of handheld units **102** and, in some examples, each handheld unit of the plurality of handheld units **102** may include a separate transceiver.

System **100** may further include a control unit **104**. Control unit **104** may be coupled to at least one handheld unit of the plurality of handheld units **102**. In some examples, control unit **104** may be coupled to handheld unit **102** wirelessly and may communicate with the handheld unit **102** by the transceiver located therein. Although a single control unit **104** is shown, examples are not so limited and multiple control units **104** may be used. In such examples, each control unit **104** may be coupled to a separate handheld unit of the plurality of handheld units **102**.

System **100** may include a plurality of end-of-train (EOT) devices **106-1**, **106-2**, **106-3** . . . **106**-N (collectively end-of-train devices **106**). As used herein, an EOT device refers to a device designed to send a pressure reading metric from an air brake located on a railcar to a control unit and to a handheld device, such as control unit **104** and handheld device **102**. Although four EOT devices **106** are shown in FIG. **1**, examples are not so limited, and any number of EOT devices **106** may be used. The number of EOT devices **106** and the number of handheld devices **102** may be the same; that is, there may be one EOT device **106** for each handheld device **102**.

EOT devices **106** may be manufactured as a stand-alone unit, used when a client does not have an existing EOT device to monitor air pressure, or may be an integrated device, such as an integrated chip set, designed to be incorporated into an existing EOT device. In either case, EOT devices **106** may include a transceiver or other means of wireless communication, and may be coupled to an air brake located on a railcar.

EOT devices **106** may be coupled to handheld devices **102**. In some examples, EOT devices **106** may be wirelessly coupled to, and thus communicate with, handheld devices **102**, through transceivers, Wi-Fi, or any other wireless connection and communication method. A single EOT device **106** may be coupled to a corresponding handheld device **102**; for example, EOT device **106-1** may be coupled to handheld device **102-1**; however, examples are not so limited, and multiple EOT devices **106** may be coupled to a single handheld device **102**, or vice versa.

An air manifold **108** may be coupled to EOT devices **106**. As used herein, an air manifold refers to a structure designed to supply air, and air pressure, to a location as desired. In the present system **100**, air manifold **108** may provide air pressure to the plurality of air brakes located on a railcar. More particularly, air manifold **108** may be used to provide air pressure to air brakes as part of a wireless air brake test (discussed further herein).

System **100** may further include a controller **110**. As used herein, a controller refers to a device used to operate, regulate, or otherwise control a portion, or entirety, of a system. Controller **110** may be coupled to air manifold **108** and may thus be used to control when air pressure is provided by the air manifold **108** to air brakes, as well as the amount of air pressure provided. This connection may be wireless or wired. Controller **110** may further be coupled to control unit **104**, either wirelessly or by a wired connection.

To perform an air brake test using system **100**, a handheld device **102** and an EOT device **106** (or a plurality thereof) are taken to an end of a railcar. As previously mentioned, the particular handheld device **102** and EOT device **106** may be matched, or coupled to one another such that they are in communication. Moreover, handheld device may be coupled to control unit **104**. Handheld device **102** may receive an input to begin a test, which may be transmitted to the control unit **104**. The control unit **104** may then transmit instructions to the controller **110** to begin the test. As discussed previously, the air manifold **108** may be coupled to the controller **110** and, when controller **110** receives instructions to begin an air brake test, controller **110** may transmit a signal to air manifold **108** to an air brake. The EOT device **106** may be coupled to the air brake such that, as the air brake is both receiving air and as air is being removed from the air brake during the test, EOT device **106** is able to monitor the air pressure. These pressure readings may be transmitted from the EOT device **106** to its corresponding handheld device **102** and/or to controller **110**.

System **100** may further include a processor **112**. Processor **112** may be one or more central processing units (CPUs), microprocessors, and/or other hardware devices suitable for retrieving and executing instructions stored on a storage medium. As an alternative, processor **112** may include one or more electronic circuits containing a number of electronic components for performing functionality of the stored instructions. Processor **112** may be coupled to controller **110** such that controller **110** is able to communicate with processor **112**. The communication may occur wireless or via a wired connection between processor **112** and controller **110**.

Processor **112** may be coupled to a non-transitory computer readable medium **114**. As used herein a non-transitory computer readable medium may be any electronic, magnetic, optical, or other physic storage device that stores executable instructions. Thus, non-transitory computer readable medium **114** may be, for example, RAM, an Electronically-Erasable Programmable Read-Only Memory (EEPROM), a storage drive, an optical disc, and the like. Non-transitory computer readable medium **114** may further be a portable, external, or remote storage medium that allows processor **112** to download instructions from said storage medium. Non-transitory computer readable medium **114** may include instructions, such as instructions **116**, **118**, **120**, and/or **122**, for wireless air brake testing and inspection consistent with the present disclosure.

Instructions **116** may include instructions executable by processor **112** to receive information from the control unit **104**. The control unit **104** may transmit information via controller **110**, which may in turn be coupled to processor **112**, as shown in FIG. **1**. In some examples, the information received from the control unit **104** may be information corresponding to an air brake test performed on the air brakes at the plurality of EOT devices **106**.

Instructions **116** may further comprise instructions executable by processor **112** to obtain information corresponding to an air brake test at control unit **104**. As previously described, control unit **104** may be in communication with handheld devices **102**, which may in turn be in communication with EOT devices **106**. In some examples, information may be received from the control unit concurrent with the air brake test. That is, instructions **116** may comprise instructions executable to obtain information corresponding to an air brake test during the performance of the air brake test. In other examples, instructions **116** may include instructions to store the obtained information corresponding to the air brake test for a duration of the air brake test. In such examples, the obtained information may be stored at the control unit **104** for the duration of the air brake test, or may be stored within processor **112**.

Instructions **116** may further include instructions executable by processor **112** to transmit the obtained information from the control unit **104** to the non-transitory computer readable medium **114**. The transmission of the obtained information to the non-transitory computer readable medium **114** may occur as information is received at the control unit **104** or may occur once the air brake test is complete. Regardless of when the obtained information is transmitted to computer readable medium **114**, instructions **116** may further include instructions to compile the obtained and received information.

Instructions **118** may include instructions executable by processor **112** to determine a status of the air brake test. Instructions **118** may include instructions to determine an amount of air leakage. The amount of air leakage may be determined based on the information received at instructions **116**, from the control unit **104**. Instructions **118** may further include instructions to determine whether the amount of air leakage is above or below a threshold amount of air leakage. As used herein, a threshold amount of air leakage refers to an amount of air leakage determined to be acceptable or safe, with such determination generally made by a regulating body.

If, at instructions **118**, a determination is made that the amount of air leakage is above a threshold amount of leakage, instructions **118** may include instructions executable to determine that the air brake test is a failed test. The determined status of the air brake test is thus "fail". However, if a determination is made that the amount of air leakage is below a threshold amount of leakage, instructions **118** may include instructions executable to determine that the air brake test is a passed test. The determined status of the air brake test is thus "pass".

Instructions **120**, when executed by processor **112**, may include instructions executable to generate an inspection form. The inspection form may be an inspection form similar to the ones currently filled out by hand for air brake

inspections, and may comport with any regulations and requirements set by safety agencies. Instructions **120** may include instructions executable to retrieve an inspection form. The inspection form may be retrieved from, for example, an oversight body's website or from a stored set of inspection forms.

Instructions **120** may further include instructions executable to populate the inspection form. Population of the inspection form may include populating the inspection form with identifying information, such as the name of the company, the location of the rail yard where the air brake test is being performed, and the number of railcars making up the train. Of course, examples are not so limited, and other or additional identifying information may be included.

Population of the inspection form at instructions **120** may further include populating the inspection form with the information received at instructions **116** and/or the determined status of the air brake test determined at instructions **118**. In some examples, the status of the air brake test may include a statement that the train referred to by the populated identifying information has passed or failed the required test. In the case of a failed test, the generated instruction form may include information regarding which particular railway car or cars had an amount of leakage above the threshold amount and the degree to which the amount of leakage was above the threshold amount.

Upon complete population of the inspection form, instructions **120** may include instructions executable to transmit the generated inspection form to a third party computing device. The third party computing device may, for example, be a central computing device of a rail yard or may be a computing device connected to a regulation agency. Transmission of the generated instruction form may occur wireless or may occur via a wired connection between the third party computing device and processor **112**.

Instructions **122**, when executed by processor **112**, may include instructions executable to transmit the generated inspection form for printing. Printing may occur at a printing device located on a rail yard or located at a remote location. Instructions **122** may transmit the generated inspection form for printing concurrent with, or prior or subsequent to, transmission of the generated inspection form to a third party computing device at instructions **120**.

FIG. **2** is another example system **224** for wireless air brake testing and inspection consistent with the present disclosure. System **224** may include a processor **226**. Processor **226** may be one or more central processing units (CPUs), microprocessors, and/or other hardware devices suitable for retrieving and executing instructions stored on a storage medium. As an alternative, processor **226** may include one or more electronic circuits containing a number of electronic components for performing functionality of the stored instructions.

Processor **226** may be coupled to a non-transitory computer readable medium **228**. As used herein a non-transitory computer readable medium may be any electronic, magnetic, optical, or other physic storage device that stores executable instructions. Thus, non-transitory computer readable medium **228** may be, for example, RAM, an Electronically-Erasable Programmable Read-Only Memory (EEPROM), a storage drive, an optical disc, and the like. Non-transitory computer readable medium **228** may further be a portable, external, or remote storage medium that allows processor **226** to download instructions from said storage medium. Non-transitory computer readable medium **228** may include instructions, such as instructions **230**, **232**, **234**, and/or **236** for wireless air brake testing and inspection consistent with the present disclosure.

Instructions **230**, when executed by a processor such as processor **226**, may include instructions to receive information corresponding to an air brake test of a train. In some examples, the information corresponding to the air brake test may be received from a remote handheld device, such as handheld devices **102**, discussed previously with respect to FIG. **1**. As discussed with respect to FIG. **1**, handheld devices such as handheld devices **102** may include a transceiver, allowing information to be transmitted, and thus received, wirelessly. However, examples are not so limited and the information corresponding to the air brake test may be received over a wired connection.

Instructions **232** may include instructions executable by processor **226** to transmit the received information to a database. As used herein, a database refers to a collection of information that is kept together in a particular location for easy access and reference. The database may include prior received information for a particular train. Said differently, the database may include previous air brake test results over a period of time for the particular train being tested. In some examples, each train on a rail yard may have its own database, with previous air brake tests being stored in each train's particular database. The database may further be accessible outside of performance of an air brake test; for example, an overseer of a rail yard or a company employee may be able to access the database for one or multiple trains to track historical performance and trends.

Instructions **232** may further include instructions executable to store the received information. In such examples, the received information may be stored at, for example, processor **226** for a period of time. For instance, the received information may be stored for the duration of the air brake test. When the air brake test is complete, instructions **232** may include instructions executable to receive a confirmation that the air brake test is complete. This confirmation may originate with a handheld device, such as handheld device **102**, or from a controller, such as controller **110**, both discussed previously with respect to FIG. **1**.

Upon receipt of the confirmation that the air brake test is complete, instructions **232** may include instructions executable to transmit the received, and stored, information to the database. Thus, information corresponding to the entirety of the air brake test is transmitted at one time. However, examples are not so limited. Instructions **232** may alternately include instructions executable to continuously transmit the received information to the database. That is, instructions **232** may include instructions to transmit the received information simultaneously with performance of the air brake test, allowing information to be transmitted to the database as soon as it is received, throughout the duration of the air brake test. This may be desirable when storage space is limited.

Instructions **234**, when executed by a processor such as processor **226**, may include instructions executable to compile the received information into an air brake test summary. As described with respect to FIG. **1**, the air brake test summary may include information such as whether the train passed or failed the air brake test. The air brake test summary may also include information such as duration of time taken to perform the air brake test, location of the train, and date and time of the air brake test itself. In some examples, instructions **234** may include instructions to retrieve identifying information for the train, such as location, owner, and number of railcars making up the train.

Instructions **236** may include instructions executable by processor **226** to generate an inspection form. As described with respect to FIG. **1**, the inspection form may be a standardized-type form for reporting and tracking the passage or failure of an air brake test by a train. The inspection form may be generated based on the information received and compiled at instructions **230**, **232**, and/or **234**. In some examples, the generated information form may include a prior result of an air brake test taken from the database. This may be used to show a change in result or to track leakage over time for a particular railcar or train.

System **224** may further include instructions executable by processor **226** to transmit the generated inspection form to a printing device. As discussed with respect to FIG. **1**, the printing device may be local, e.g., on the rail yard, or may be remote, e.g., located in an office. Once the generated inspection form is transmitted to the printing device, the printing device may print the generated inspection form for future use.

System **224** may include instructions executable by processor **226** to transmit the generated inspection form to a remote computing device. The remote computing device may be located within the rail yard or may be outside the rail yard. In either example, transmission of the generated inspection form to the remote computing device may occur wirelessly or through a wired connection. Moreover, transmission of the generated inspection form to the remote computing device may occur prior to transmission to the printing device, subsequent to transmission to the printing device, or simultaneously with transmission to the printing device.

In some examples, a handheld device, such as handheld devices **102**, may communicate with a system such as system **224** through a mobile application. As used herein, a mobile application, or app, refers to a set of instructions designed to fulfill a discrete and particular purpose, such as coordinating performance of an air brake test. In such examples, the app may receive the information from the EOT devices, such as EOT devices **106**, and may transfer the information through the app to a processor, such as processor **112**, discussed with respect to FIG. **1**, or processor **226**.

In the foregoing detailed description of the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration how examples of the disclosure may be practiced. These examples are described in sufficient detail to enable those of ordinary skill in the art to practice the examples of this disclosure, and it is to be understood that other examples may be utilized and that process and/or structural changes may be made without departing from the scope of the present disclosure.

The figures herein follow a numbering convention in which the first digit corresponds to the drawing figure number and the remaining digits identify an element or component in the drawing. Elements shown in the various figures herein can be added, exchanged, and/or eliminated so as to provide a number of additional examples of the present disclosure. In addition, the proportion and relative scale of the elements provided in the figures are intended to illustrate the examples of the present disclosure and should not be taken in a limiting sense.

The invention claimed is:

**1**. A non-transitory computer readable medium including instructions executable by a processor to:

receive information corresponding to an air brake test of a train from a remote handheld device;

determine a status of the air brake test;

transmit the received information to a database, wherein the database includes prior received information for the train;

compare the received information to the prior received information for the train, wherein comparing the received information to the prior received information further comprises:

determining a change in a result of the air brake test; and

tracking an amount of leakage over time for the train;

compile the received information into an air brake test summary, wherein the air brake test summary includes the comparison of the received information to the prior received information; and

generate an inspection form based on the received and compiled information.

**2**. The non-transitory computer readable medium of claim **1**, further comprising instructions executable to:

transmit the generated inspection form to a printing device; and

transmit the generated inspection form to a remote computing device.

**3**. The non-transitory computer readable medium of claim **1**, wherein the instructions to transmit the received information to a database include instructions executable to:

store the received information;

receive a confirmation that the air brake test is complete; and

transmit the received information upon receipt of the confirmation of completion of the air brake test.

**4**. The non-transitory computer readable medium of claim **1**, wherein the instructions to transmit the received information to a database include instructions executable to continuously transmit the received information throughout a duration of the air brake test.

* * * * *