



(51) International Patent Classification:

G01R 31/02 (2006.01) G06K 19/077 (2006.01)
G01R 31/04 (2006.01) G01R 1/067 (2006.01)

(21) International Application Number:

PCT/US2013/056701

(22) International Filing Date:

27 August 2013 (27.08.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

13/671,015 7 November 2012 (07.11.2012) US

(71) Applicant: EATON CORPORATION [US/US]; 1000
Eaton Boulevard, Cleveland, OH 44122 (US).(72) Inventor: SHEA, John, J.; 309 Highland Pines Drive,
Pittsburgh, PA 15237 (US).(74) Agents: HOUSER, Kirk, D. et al.; Eckert Seamans Cherin
& Mellott, LLC, 600 Grant Street, 44th Floor, Pittsburgh,
PA 15219 (US).(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report (Art. 21(3))

(54) Title: ELECTRICAL JOINT MONITORING DEVICE AND SYSTEM

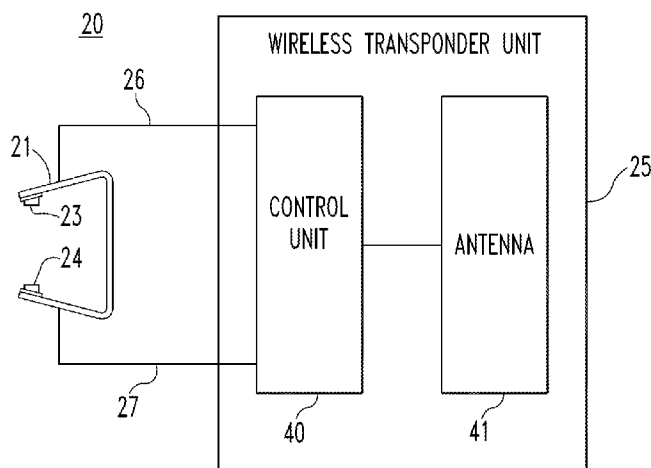


FIG. 3

(57) Abstract: An electrical joint monitoring device (20,20') including a mounting assembly (21,21') and a wireless transponder unit (25). The mounting assembly includes a first conductive contact (23,23') structured to electrically connect to a first conductive member of an electrical joint and a second conductive contact (24,24') structured to electrically connect to a second conductive member of the electrical joint. The wireless transponder unit includes a control unit (40) electrically connected to the first and second conductive contacts and an antenna (41) electrically connected to the control unit. The wireless transponder unit is configured to sense a voltage difference between the first and second conductive contacts, to generate information based on the voltage difference, and to output the information to a wireless reader unit (30) via the antenna.

ELECTRICAL JOINT MONITORING DEVICE AND SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

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This application claims priority from and claims the benefit of U.S. Patent Application Serial No. 13/671,015, filed November 7, 2012, which is incorporated by reference herein.

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BACKGROUND

Field

The disclosed concept pertains generally to electrical joints and, more particularly, to electrical joint monitoring.

Background Information

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Some typical types of electrical joints are formed by securing two conductive members together with, for example, a fastener. The electrical performance of the joint, and in particular, the conductivity of the joint, depends partially on the conductive members being secured together tightly. A loosening of the electrical joint reduces the conductivity of the electrical joint and can cause additional problems such as overheating.

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Due to the aforementioned problems, it is desirable to determine whether the conductive members in an electrical joint are properly secured together. However, verifying whether the conductive members in an electrical joint are properly secured together can consume a technician's time. In particular, when an electrical system includes numerous electrical joints, or if it is difficult to reach electrical joints, a large amount of technician's time can be taken verifying whether conductive members in electrical joints are properly secured together.

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There is room for improvement in the area of monitoring electrical joints.

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SUMMARY

These needs and others are met by embodiments of the disclosed concept, which provide an electrical joint monitoring device including a number of mounting assemblies and a wireless transponder unit.

These needs and others are also met by embodiments of the disclosed concept, which provide an electrical joint monitoring system including an electrical joint monitoring device and a wireless reader unit.

In accordance with embodiments of the disclosed concept, an electrical joint monitoring device for an electrical joint including a first conductive member and a second conductive member comprises: a mounting assembly including a first conductive contact structured to electrically contact the first conductive member of the electrical joint and a second conductive contact structured to electrically contact the second conductive member of the electrical joint; and a wireless transponder unit including a control unit electrically connected to the first and second conductive contacts and an antenna electrically connected to the control unit, the wireless transponder unit being configured to sense a voltage difference between the first and second conductive contacts, to generate information based on the voltage difference, and to output the information to a wireless reader unit via the antenna.

In accordance with other embodiments of the disclosed concept, an electrical joint monitoring device for a number of electrical joints comprises: a number of mounting assemblies, each of the number of mounting assemblies including a first conductive contact structured to electrically contact a first conductive member of one of the number of electrical joints and a second conductive contact structured to electrically contact a second conductive member of the one of the number of electrical joints; and a wireless transponder unit including a control unit electrically connected to the first and second conductive contacts of each of the number of mounting assemblies and an antenna electrically connected to the control unit, the wireless transponder unit being configured to sense a plurality of voltage differences between the first and second conductive contacts of each of the number of mounting assemblies, to generate information based on the voltage differences, and to output the information to a wireless reader unit via the antenna.

In accordance with other embodiments of the disclosed concept, an electrical joint monitoring system comprises: a number of electrical joints, each of the number of electrical joints including a first conductive member and a second conductive member; a number of mounting assemblies, each of the number of mounting assemblies corresponding to one of the number of electrical joints and

including a first conductive contact structured to electrically connect to the first conductive member of the corresponding one of the number of electrical joints and a second conductive contact structured to electrically connect to the second conductive member of the corresponding one of the number of electrical joints; and a wireless transponder unit including a control unit electrically connected to the first and second conductive contacts of each of the number of mounting assemblies and an antenna electrically connected to the control unit, the wireless transponder unit being configured to sense a plurality of voltage differences between the first and second conductive contacts of each of the number of mounting assemblies, to generate information based on the voltage differences, and to output the information via the antenna; and a wireless reader unit structured to receive the information.

BRIEF DESCRIPTION OF THE DRAWINGS

A full understanding of the disclosed concept can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

Figures 1 and 2 are elevation views of an electrical joint monitoring system in accordance with an example embodiment of the disclosed concept.

Figures 3 and 4 are diagrams of electrical joint monitoring devices in accordance with some embodiments of the disclosed concept.

Figure 5 is a diagram of an electrical joint monitoring system in accordance with another example embodiment of the disclosed concept.

Figure 6 is an example display in accordance with some embodiments of the disclosed concept.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Directional phrases used herein, such as, for example, left, right, front, back, top, bottom and derivatives thereof, relate to the orientation of the elements shown in the drawings and are not limiting upon the claims unless expressly recited therein.

As employed herein, the term “fastener” refers to any suitable connecting or tightening mechanism expressly including, but not limited to, screws,

bolts and the combinations of bolts and nuts (e.g., without limitation, lock nuts) and bolts, washers and nuts.

As employed herein, the statement that two or more parts are “coupled” together shall mean that the parts are joined together either directly or
5 joined through one or more intermediate parts.

As employed herein, the term “number” shall mean one or an integer greater than one (i.e., a plurality).

Referring to Figures 1 and 2, an electrical joint monitoring system 1 is shown. The electrical joint is formed by securing first and second conductive
10 members 2,4 together with one or more fasteners 10. The first and second conductive members 2,4 can be, for example and without limitation, bus bars. The electrical joint monitoring system 1 includes an electrical joint monitoring device 20 and a wireless reader unit 30. The electrical joint monitoring device 20 includes a mounting
assembly 21 that includes first and second conductive contacts 23,24 structured to
15 electrically connect to the first and second conductive members 2,4, respectively. The electrical joint monitoring device 20 also includes a wireless transponder unit 25 that is configured to wirelessly communicate with the wireless reader unit 30.

The example fasteners 10 each include a bolt 11 and a nut 12.
However, it is contemplated that any suitable fastener may be used to secure the first
20 and second conductive members 2,4 together.

The mounting assembly 21 is structured to couple with the electrical joint. In the example embodiment shown in Figures 1 and 2, the mounting assembly 21 is a spring clip that attaches onto the first and second conductive members 2,4.
The mounting assembly 21 may also be an elastic clip that biases the first and second
25 conductive contacts 23,24 against the first and second conductive members 2,4 when the mounting assembly 21 is coupled with the electrical joint. It is also contemplated that the mounting assembly 21 may be structured to couple with the electrical joint in any suitable manner. For example and without limitation, the mounting assembly 21 may be structured as a clamp, a vice, a bolt, a spring loaded pin, or any other suitable
30 structure for coupling with the electrical joint.

The first and second conductive contacts 23,24 are disposed on the mounting assembly 21 such that when the mounting assembly 21 is coupled to the

electrical joint the first conductive contact 23 electrically contacts the first conductive member 2 and the second conductive contact 24 electrically contacts the second conductive member 4. In the example embodiment shown in Figures 1 and 2, the first and second conductive contacts 23,24 are shaped to make flush electrical contact with the first and second conductive members 2,4. It is contemplated that in other non-limiting embodiments, the first and second conductive contacts 23,24 can have other shapes such as, for example and without limitation, spherical shapes or other shapes suitable for electrically contacting the first and second conductive members 2,4.

The mounting assembly 21 electrically insulates the first and second conductive contacts 23,24 from each other. The mounting assembly 21 further includes first and second conductors 26,27. The first and second conductors 26,27 electrically connect the first and second conductive contacts 23,24 to the wireless transponder unit 25, respectively.

The wireless transponder unit 25 senses a voltage difference between the first and second conductive contacts 23,24. The wireless transponder unit 25 then generates information based on the sensed voltage difference and outputs the information.

The wireless reader unit 30 communicates with the wireless transponder unit 25 and is configured to receive the output of the wireless transponder unit 25. In one non-limiting example embodiment, the wireless transponder unit 25 is a passive transponder that responds to interrogation by the wireless reader unit 30. In another non-limiting example embodiment, the wireless transponder unit 25 includes a power source or receives power from a power source other than the wireless reader unit 30, and can provide an output without being interrogated by the wireless reader unit 30. The wireless transponder unit 25 may be, for example and without limitation, a radio frequency identification (RFID) tag and the wireless reader unit 30 may be, for example and without limitation, an RFID reader.

Referring to Figure 3, the wireless transponder unit 25 includes a control unit 40 and an antenna 41. The first and second conductive contacts 23,24 are electrically connected to the control unit 40 by the first and second conductors 26,27, respectively. The control unit 40 generates the information based on the sensed voltage difference and outputs the information via the antenna 41.

The information generated by the control unit 40 may be information representing the voltage difference between the first and second conductive contacts 23,24. In another non-limiting example embodiment, the control unit 40 calculates a risk level of the electrical joint from the sensed voltage difference and generates

5 information representing the calculated risk level of the electrical joint. In another non-limiting example embodiment, the control unit 40 determines a quality of the electrical joint based on the sensed voltage difference and generates information representing the calculated quality of the electrical joint. In another non-limiting example embodiment, the control unit 40 determines a conductivity of the electrical

10 joint based on the sensed voltage difference and generates information representing the calculated conductivity of the electrical joint. In yet another non-limiting example embodiment, the control unit 40 determines a conductivity of the electrical joint based on the sensed voltage difference and generates information representing the calculated conductivity of the electrical joint over a period of time. It is also contemplated that

15 the above-described calculations can also be performed by the wireless reader unit 30 without departing from the scope of the disclosed concept.

Table 1 – Example Decision Table for Joint Quality and Risk of Overheating

Sensed Voltage Difference V_{diff} (mV_{rms})	Current (A_{rms})	Joint Quality	Risk of Overheating
$V_{diff} < 1.5$	500	Excellent	Very Low
$1.5 < V_{diff} < 2.5$	500	Good	Low
$2.5 < V_{diff} < 5$	500	Sub Par	Medium
$5 < V_{diff} < 7.5$	500	Poor	High
$V_{diff} > 7.5$	500	Very Poor	Very High
$V_{diff} < 3.0$	1000	Excellent	Very Low
$3.0 < V_{diff} < 5.0$	1000	Good	Low
$5.0 < V_{diff} < 10.0$	1000	Sub Par	Medium
$10.0 < V_{diff} < 15.0$	1000	Poor	High
$V_{diff} > 15.0$	1000	Very Poor	Very High

Table 1 shows an example decision table which can be employed by the control unit 40 or wireless reader unit 30 to determine the quality or risk of overheating of the electrical joint based on the sensed voltage difference. In the example shown in Table 1, the voltage difference was measured across the electrical joint for 0.5 minutes while the joint was electrically connected to a 60 Hz alternating current (AC) power source. As shown in Table 1, the current through the electrical joint can be considered in the determination of the joint quality and the risk of overheating. If the current through the electrical joint is taken into account in the determination of the joint quality of the risk of overheating, the current through the electrical joint can be sensed by any suitable means.

In addition to generating the information based on the sensed voltage difference, the control unit 40 can also generate identification information. For example and without limitation, the identification information can include information for identifying the electrical joint or mounting assembly 21 corresponding to the information based on the sensed voltage difference. The identification information can also include information for identifying the wireless transponder unit 25.

In some non-limiting example embodiments, the wireless transponder unit 25 is disposed on the mounting assembly 21 (Figures 1 and 2). When the wireless transponder unit 25 is disposed on the mounting assembly 21, it can be disposed at any suitable location on the mounting assembly 21. In other non-limiting example embodiments, the wireless transponder unit 25 is separated from the mounting assembly 21.

It is contemplated that any number of mounting assemblies 21 can correspond to one wireless transponder unit 25 without departing from the scope of the disclosed concept. For example and without limitation, one mounting assembly 21 can correspond to one wireless transponder unit 25, as shown in Figure 3, or a plurality of mounting assemblies 21 can correspond to one wireless transponder device 25, as shown in Figure 4.

Referring to Figure 5, another non-limiting example embodiment of an electrical joint monitoring system 1' is shown. In the example embodiment of Figure 5, electrical joints are formed by battery terminals 5a,5b and battery terminal connectors 6a,6b. The battery 7 provides power to a load 8 through the battery

terminal connectors 6a,6b. The electrical joint monitoring system 1' includes an electrical joint monitoring device 20' and a wireless reader unit 30'. The electrical joint monitoring device 20' includes mounting assemblies 21' corresponding to each of the battery terminals 5a,5b. The mounting assemblies 21' are electrically
5 connected to the load 8 and are each electrically connected to a wireless transponder unit 25'. The wireless transponder unit 25' is configured to communicate with the wireless reader unit 30'.

Each mounting assembly 21' has the form of a washer assembly and is disposed between a portion of one of the battery terminals 5a,5b and one of the
10 battery terminal connectors 6a,6b. Each mounting assembly 21' includes a first conductive washer 23' structured to electrically contact one of the battery terminals 5a,5b and a second conductive washer 24' structured to electrically contact one of the battery terminal connectors 6a,6b. Each mounting assembly 21' further includes an insulating washer 28 disposed between the first and second conductive washers
15 23',24'.

The first and second conductive washers 23',24' are each electrically connected with the wireless transponder unit 25'. The wireless transponder unit 25' senses a voltage difference between the first and second conductive washers 23',24'. The wireless transponder unit 25' generates and outputs information based on the
20 sensed voltage difference to the wireless reader unit 30'.

In the example embodiment shown in Figure 5, the mounting assemblies 21' are mounted to the positive and negative terminals 5a,5b of the battery 7. In one non-limiting example embodiment, the wireless transponder unit 25' receives and uses power from the battery 7 to output the information based on the
25 sensed voltage difference. By using the power of the battery 7, the wireless transponder unit 25' is able to output information a greater distance.

In one non-limiting example embodiment, the battery 7 is a uninterruptible power supply (UPS) battery. However, it is contemplated that the electrical joint monitoring device 20' can be used with other types of batteries without
30 departing from the scope of the disclosed concept. Additionally, it is contemplated that the electrical joint monitoring device 20' can be used in conjunction with other

types of power source terminals and terminal connectors without departing from the scope of the disclosed concept.

Referring to Figure 6, an example of a meter 9 which can be displayed by the wireless reader unit 30,30' is shown. The wireless reader unit 30,30' can, for example and without limitation, indicate the risk level, quality level, conductivity level, or other information regarding an electrical joint being monitored on the displayed meter 9. However, it is contemplated that any suitable manner of displaying or outputting information can be employed by the wireless reader unit 30,30' without departing from the scope of the disclosed concept.

While specific embodiments of the disclosed concept have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the disclosed concept which is to be given the full breadth of the claims appended and any and all equivalents thereof.

What is Claimed is:

1. An electrical joint monitoring device (20,20') for an electrical joint including a first conductive member (2,5a,5b) and a second conductive member (4,6a,6b), said device comprising:

a mounting assembly (21,21') including a first conductive contact (23,23') structured to electrically contact the first conductive member of said electrical joint and a second conductive contact (24,24') structured to electrically contact the second conductive member of said electrical joint; and

a wireless transponder unit (25) including a control unit (40) electrically connected to said first and second conductive contacts and an antenna (41) electrically connected to said control unit, the wireless transponder unit being configured to sense a voltage difference between said first and second conductive contacts, to generate information based on said voltage difference, and to output said information to a wireless reader unit (30) via said antenna.

2. The electrical joint monitoring device (20) of claim 1, wherein said mounting assembly (21) is structured as a clip member, and said first and second conductive contacts (23,24) are disposed on said clip member; wherein said mounting assembly (21) is structured as an elastic clip member configured to bias said first and second contacts against said first and second conductive members, respectively; or wherein said mounting assembly is structured as one of a clamp, a vice, a bolt, and a spring loaded pin.

3. The electrical joint monitoring device (20) of claim 1, wherein said wireless transponder unit is disposed on said mounting assembly.

4. The electrical joint monitoring device (20') of claim 1, wherein said mounting assembly includes an insulating washer (28); wherein said first conductive contact (23') is a first conductive washer disposed on a first surface of said insulating washer and said second conductive contact (24') is a second conductive washer disposed on a second surface of said insulating washer; and wherein said second surface is opposite said first surface.

5. The electrical joint monitoring device (20) of claim 1, wherein said first conductive member (2) is a first bus bar and said second conductive member (4) is a second bus bar.

6. The electrical joint monitoring device (20) of claim 1, wherein said electrical joint is formed by a power source terminal (5a,5b) and a terminal connector (6a,6b).

7. The electrical joint monitoring device (20,20') of claim 1, wherein said wireless transponder unit is a radio frequency identification unit.

8. The electrical joint monitoring device (20,20') of claim 1 wherein said electrical joint is a number of electrical joints; wherein said mounting assembly is a number of mounting assemblies (21,21'), each of said number of mounting assemblies including a first conductive contact (23,23') structured to electrically contact a first conductive member of one of said number of electrical joints and a second conductive contact (24,24') structured to electrically contact a second conductive member of said one of said number of electrical joints; wherein said control unit (40) is electrically connected to said first and second conductive contacts of each of the number of mounting assemblies; wherein said voltage difference is a plurality of voltage differences between the first and second conductive contacts of each of the number of mounting assemblies; and wherein the wireless transponder unit is configured to sense the voltage differences and to generate said information based on said voltage differences.

9. The electrical joint monitoring device (20) of claim 8, wherein at least one of the number of mounting assemblies (21) is structured as a clip member; and wherein said first and second conductive contacts (23,24) are disposed on said clip member; or wherein at least one of the number of mounting assemblies (21) is structured as an elastic clip member configured to bias said first and second conductive contacts against said first and second conductive members, respectively, of said one of said number of electrical joints.

10. The electrical joint monitoring device (20') of claim 8, wherein at least one of said mounting assemblies (21') includes an insulating washer (28); wherein said first conductive contact (23') is a first conductive washer disposed on a first surface of said insulating washer and said second conductive contact (24') is a second conductive washer disposed on a second surface of said insulating washer; and wherein said second surface is opposite said first surface.

11. The electrical joint monitoring device (20') of claim 8, wherein one of said number of electrical joints is a positive terminal (5a) of a power source (7) and another one of said number of electrical joints is a negative terminal (5b) of said power source; and wherein said wireless transponder unit is configured to receive power from said power source and to use said power to output said information.

12. The electrical joint monitoring device (20') of claim 11, wherein said power source is a uninterruptible power supply (UPS) battery.

13. An electrical joint monitoring system (1,1') comprising:
said number of electrical joints of claim 8, each of said number of electrical joints including a first conductive member (2,5a,5b) and a second conductive member (4,6a,6b);

said number of mounting assemblies (21,21'), each of said number of mounting assemblies corresponding to one of the number of electrical joints and including the first conductive contact (23,23') structured to electrically connect to the first conductive member of the corresponding one of the number of electrical joints and the second conductive contact (24,24') structured to electrically connect to the second conductive member of the corresponding one of the number of electrical joints; and

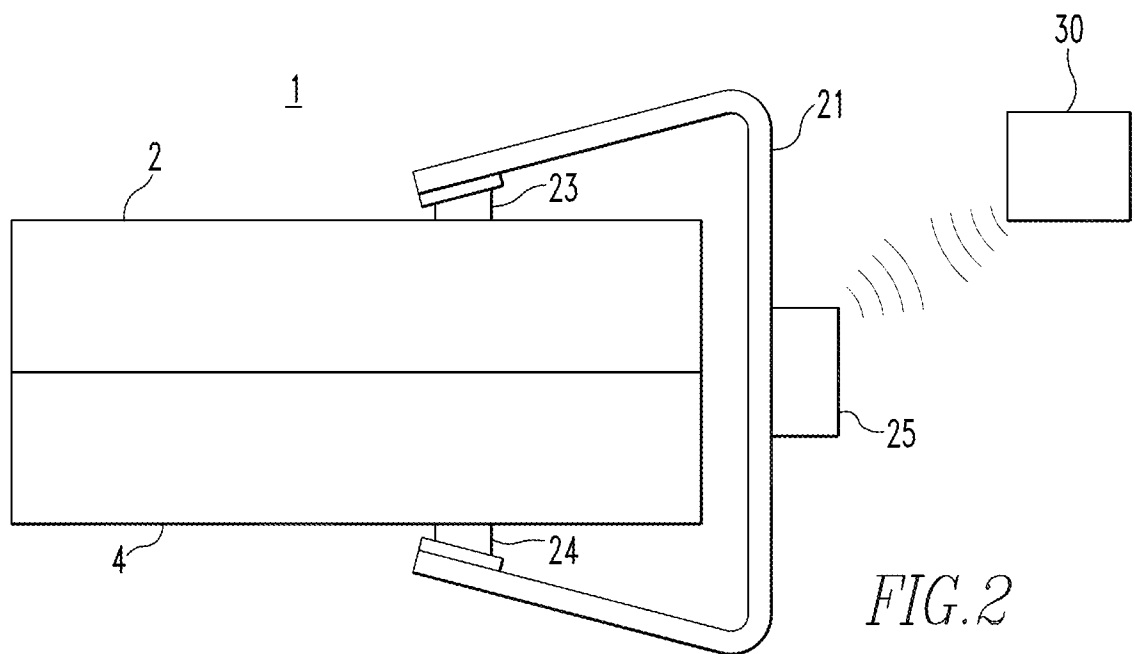
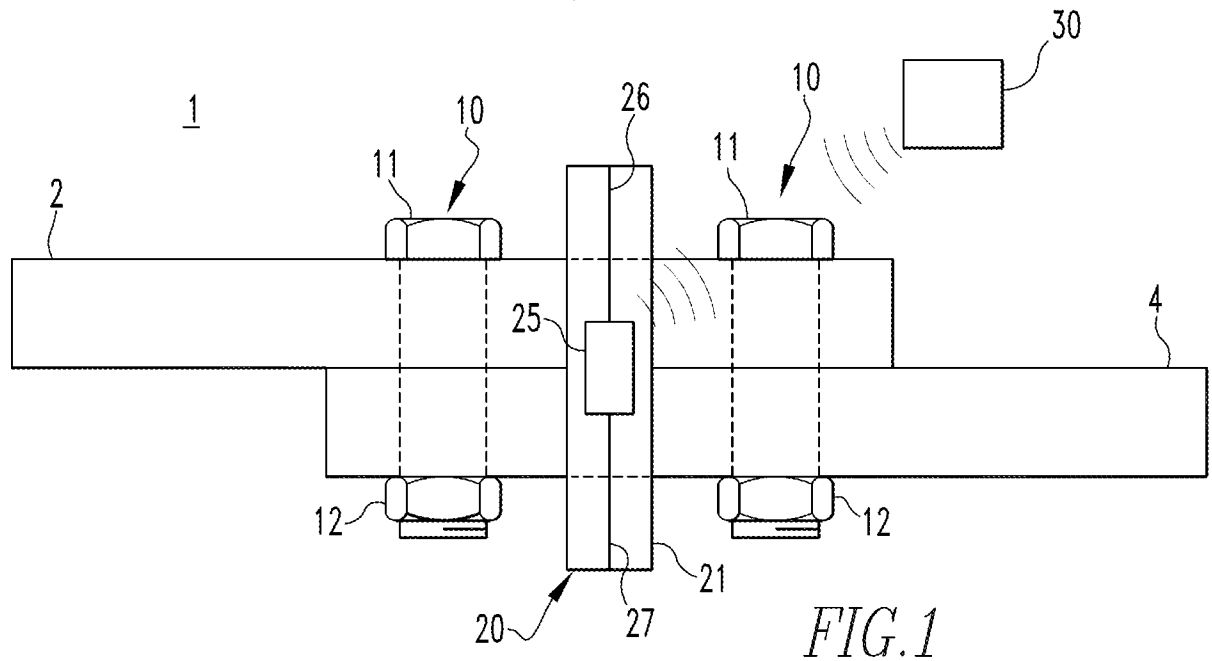
said wireless transponder unit (25) including said control unit (40) electrically connected to said first and second conductive contacts of each of the number of mounting assemblies and said antenna (41), said wireless transponder unit being configured to sense a plurality of said voltage differences between the first and second conductive contacts of each of the number of mounting assemblies; and

said wireless reader unit (30) structured to receive said information.

14. The electrical joint monitoring system (1,1') of claim 13, wherein the information based on said voltage differences is one of information representing said voltage differences, information representing risk levels of each of the number of electrical joints, information representing quality levels of each of the number of electrical joints, and information representing conductivity levels of each of the number of electrical joints; and wherein the wireless reader unit outputs said information based on said voltage differences.

15. The electrical joint monitoring system (1,1') of claim 13, wherein said wireless transponder unit is a radio frequency identification unit; and wherein said wireless reader unit is a radio frequency identification reader unit.

1/3



2/3

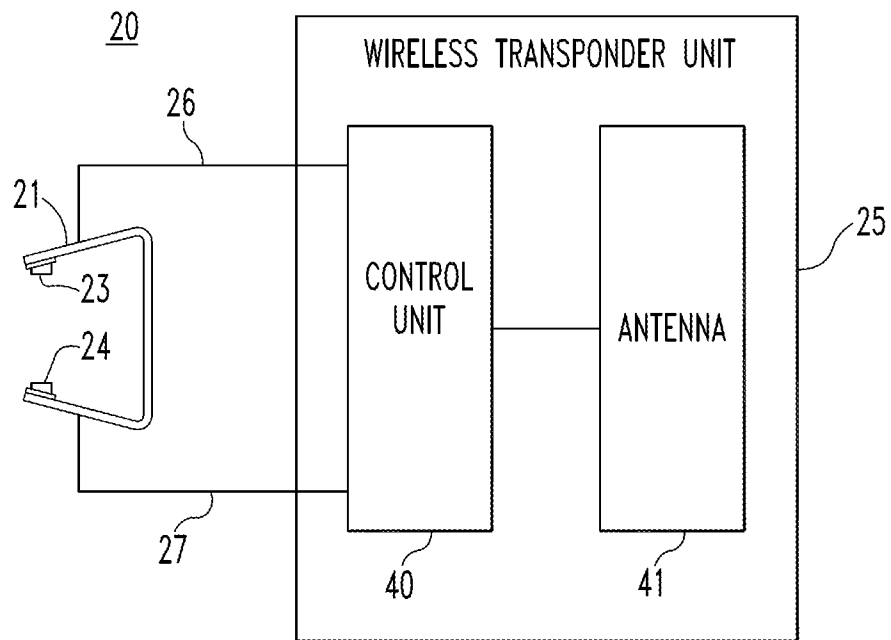


FIG. 3

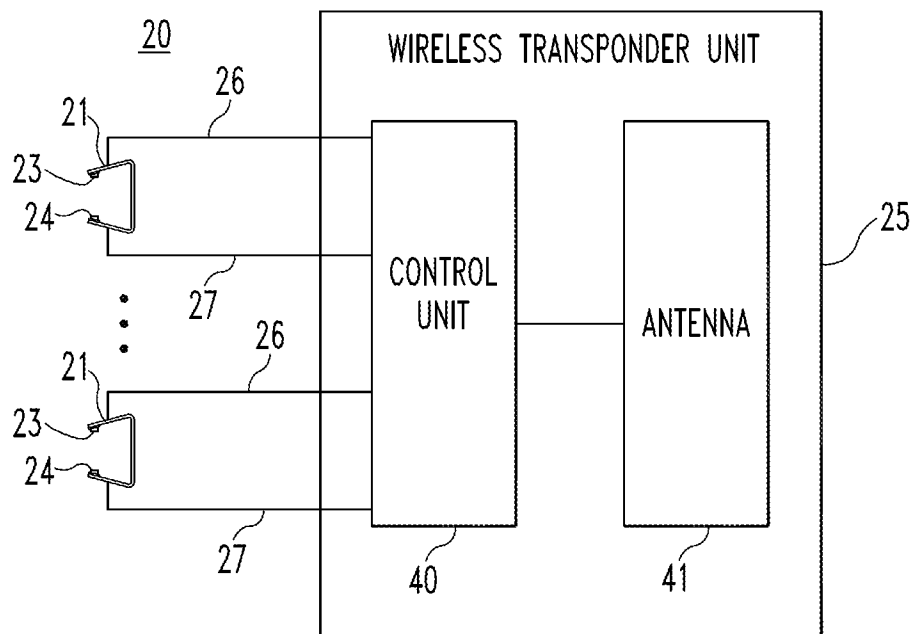


FIG. 4

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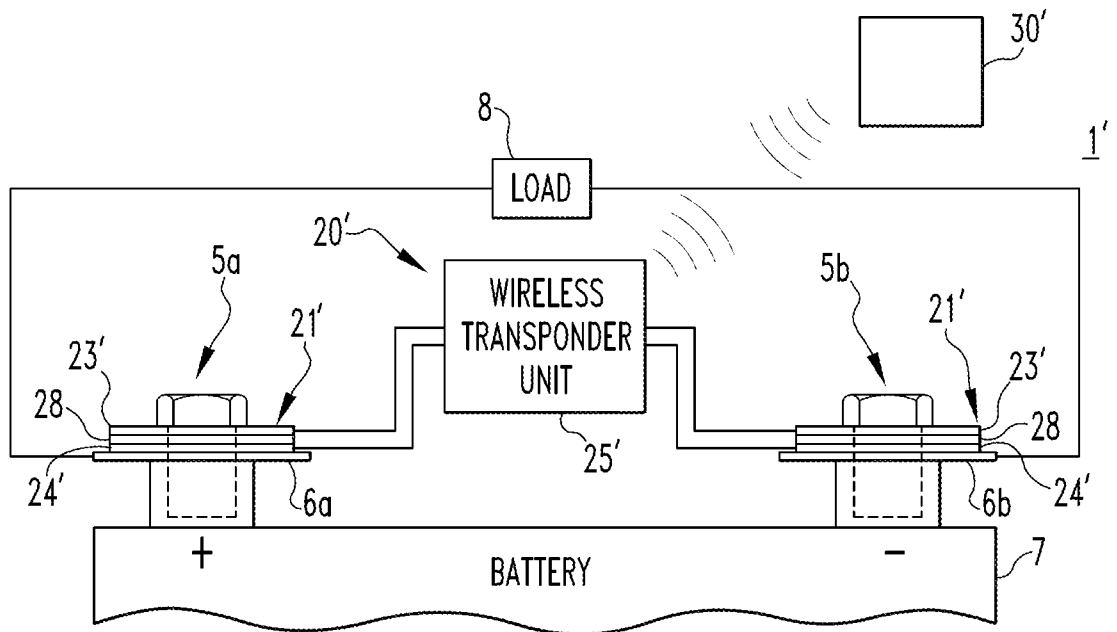


FIG. 5

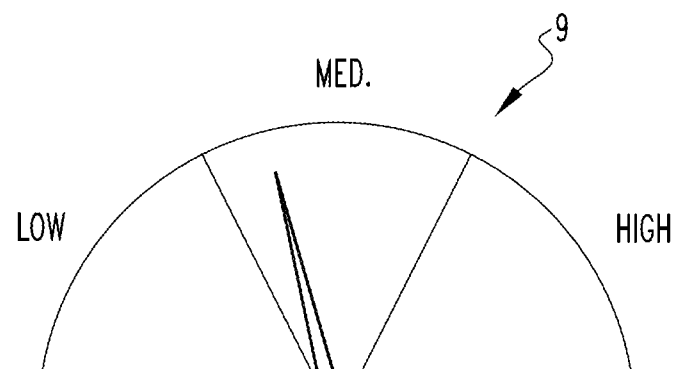


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/056701

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01R31/02 G01R31/04 G06K19/077
ADD. G01R1/067

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01R G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	paragraphs [0033], [0045]; figures 1,6 -----	8
Y	US 2010/010758 A1 (KINAHAN WILLIAM P [US]) 14 January 2010 (2010-01-14) paragraphs [0010], [0014], [0017]; figures 1,3 -----	8
X	US 2009/212938 A1 (SWAIM JASON A [US] ET AL) 27 August 2009 (2009-08-27) paragraphs [0006], [0009], [0021], [0022]; figures 4-8 -----	1
A	GB 2 465 590 A (LEDGARD PAUL [GB]) 26 May 2010 (2010-05-26) abstract; figures 1,2 ----- -/--	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

22 November 2013

Date of mailing of the international search report

02/12/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Iwansson, Kaj

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/056701

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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