US009496720B2

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

(10) **Patent No.: US 9,496,720 B2**
(45) **Date of Patent: *Nov. 15, 2016**

(54) **SYSTEM FOR AUTOMATICALLY GATHERING BATTERY INFORMATION**

(75) Inventors: **Stephen J. McShane**, Oak Brook, IL (US);
(Continued)

(73) Assignee: **Midtronics, Inc.**, Willowbrook, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 165 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/357,306**

(22) Filed: **Jan. 24, 2012**

(65) **Prior Publication Data**

US 2012/0182132 A1 Jul. 19, 2012

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/416,457, filed on Apr. 1, 2009, now Pat. No. 8,344,685, which is
(Continued)

(51) **Int. Cl.**
H04Q 5/22 (2006.01)
H02J 7/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02J 7/0009*** (2013.01); ***H01M 10/486*** (2013.01); ***H01M 10/488*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G06K 7/0008; H01M 10/486; G01R 31/3627
(Continued)

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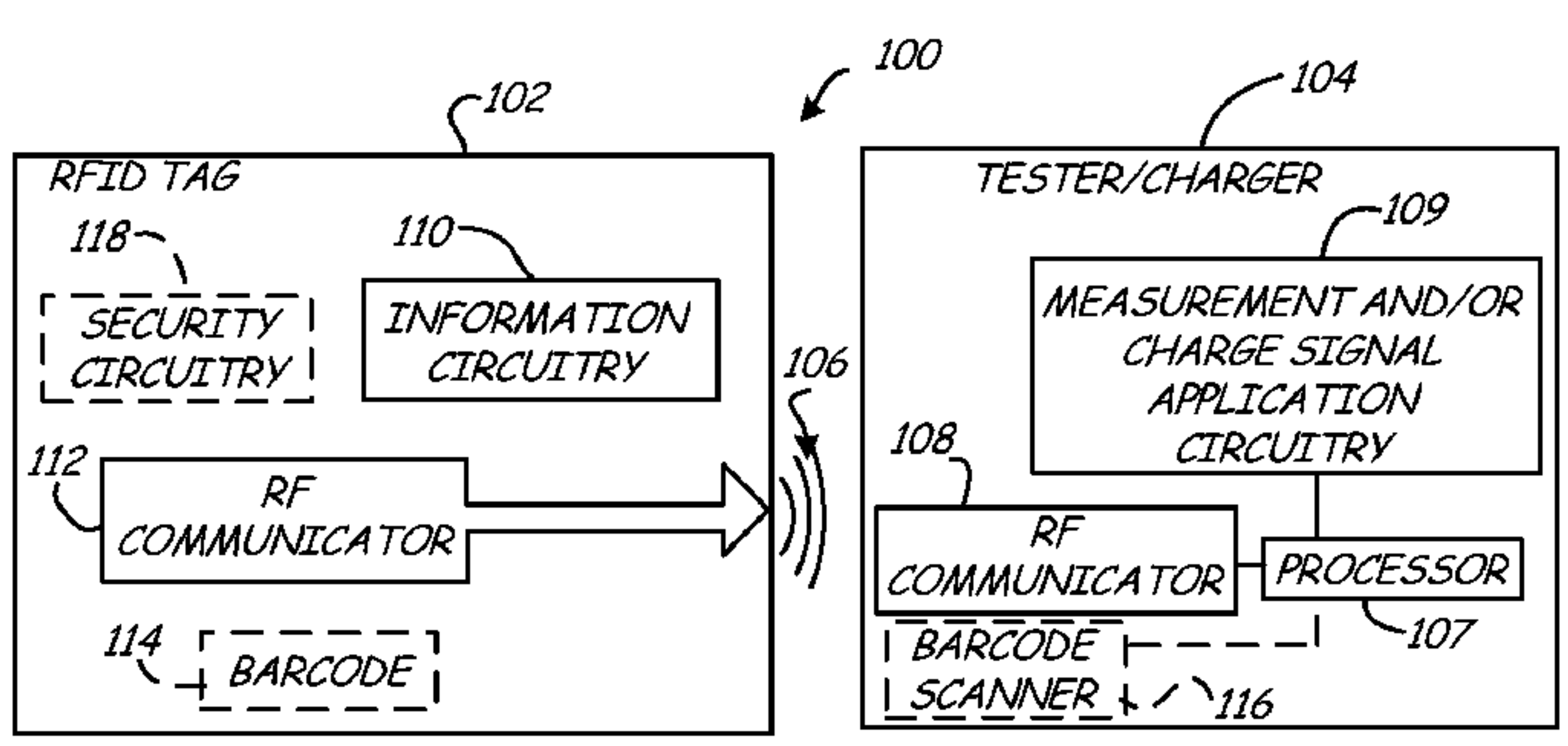
Primary Examiner — Verna Brown
(74) *Attorney, Agent, or Firm* — Westman, Champlin & Koehler, P.A.

(57) **ABSTRACT**

A method and apparatus is provided in which a radio frequency identification (RIFD) tag is associated with the storage battery and is used in conjunction with a battery test, battery charger, or other battery maintenance. A cable configured to be affixed to the storage battery. The cable is configured to store information and wirelessly communicate the information to a battery tester. A battery maintenance device configured to couple to the battery and to perform battery maintenance on the battery through the cable. The battery maintenance device includes wireless communication circuitry configured to communicate with a memory of the cable.

27 Claims, 10 Drawing Sheets



(75) Inventors: **Todd J. Stukenberg**, Indian Head Park, IL (US); **Kevin I. Bertness**, Batavia, IL (US); **John S. Philbrook**, Crown Point, IN (US)

Related U.S. Application Data

a continuation-in-part of application No. 11/207,419, filed on Aug. 19, 2005, now abandoned, application No. 13/357,306, which is a continuation-in-part of application No. 12/416,453, filed on Apr. 1, 2009, now Pat. No. 8,436,619, application No. 13/357,306, which is a continuation-in-part of application No. 12/416,445, filed on Apr. 1, 2009, now Pat. No. 8,442,877.

(60) Provisional application No. 60/603,078, filed on Aug. 20, 2004.

(51) **Int. Cl.**
H01M 10/48 (2006.01)
G01R 31/36 (2006.01)
H01M 2/02 (2006.01)

(52) **U.S. Cl.**
CPC *G01R 31/3627* (2013.01); *G01R 31/3655* (2013.01); *H01M 2/0267* (2013.01); *H02J 2007/0098* (2013.01)

(58) **Field of Classification Search**
USPC 340/10.51, 539.1
See application file for complete search history.

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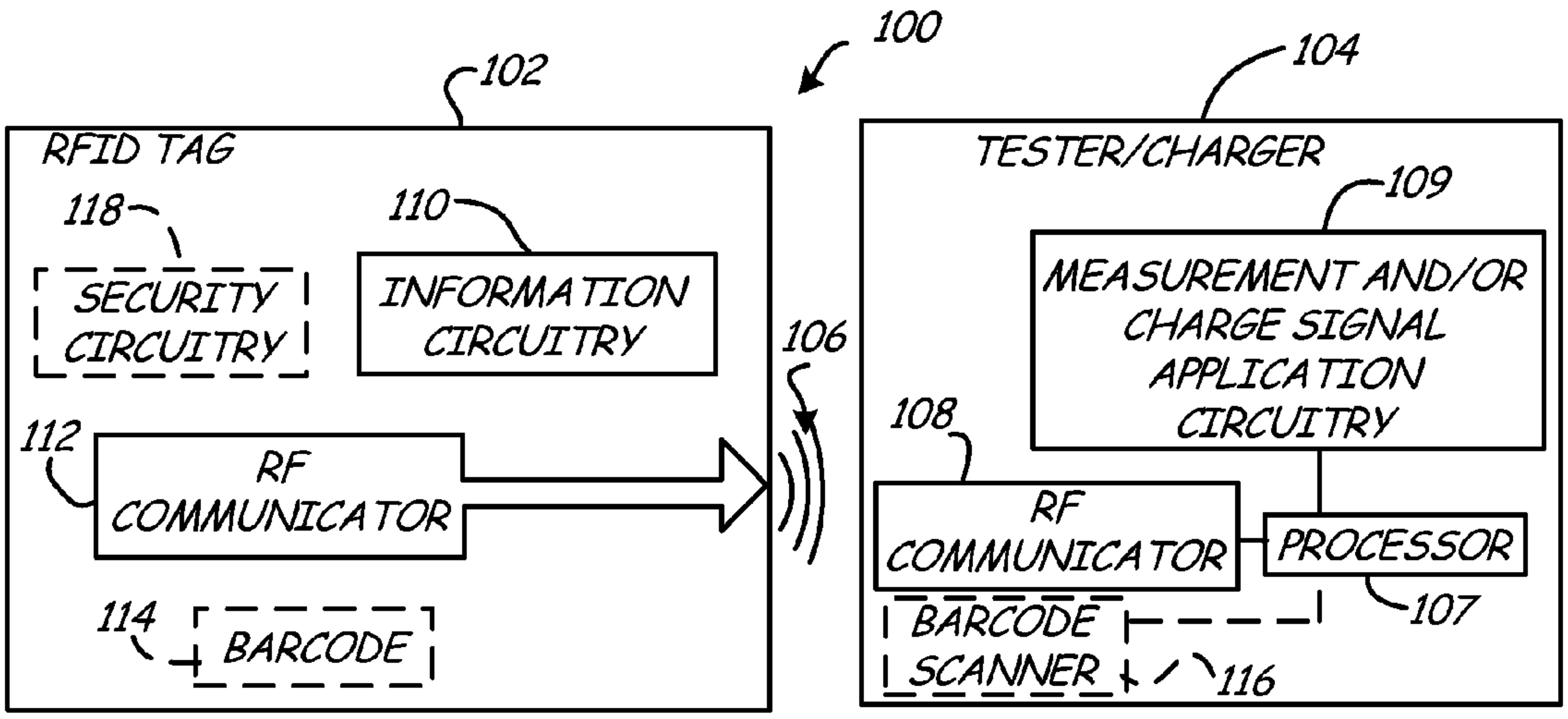

100
102
RFID TAG
118
SECURITY CIRCUITRY
110
INFORMATION CIRCUITRY
112
RF COMMUNICATOR
114
BARCODE
106
104
TESTER/CHARGER
109
MEASUREMENT AND/OR CHARGE SIGNAL APPLICATION CIRCUITRY
108
RF COMMUNICATOR
PROCESSOR
107
BARCODE SCANNER
116

FIG. 1

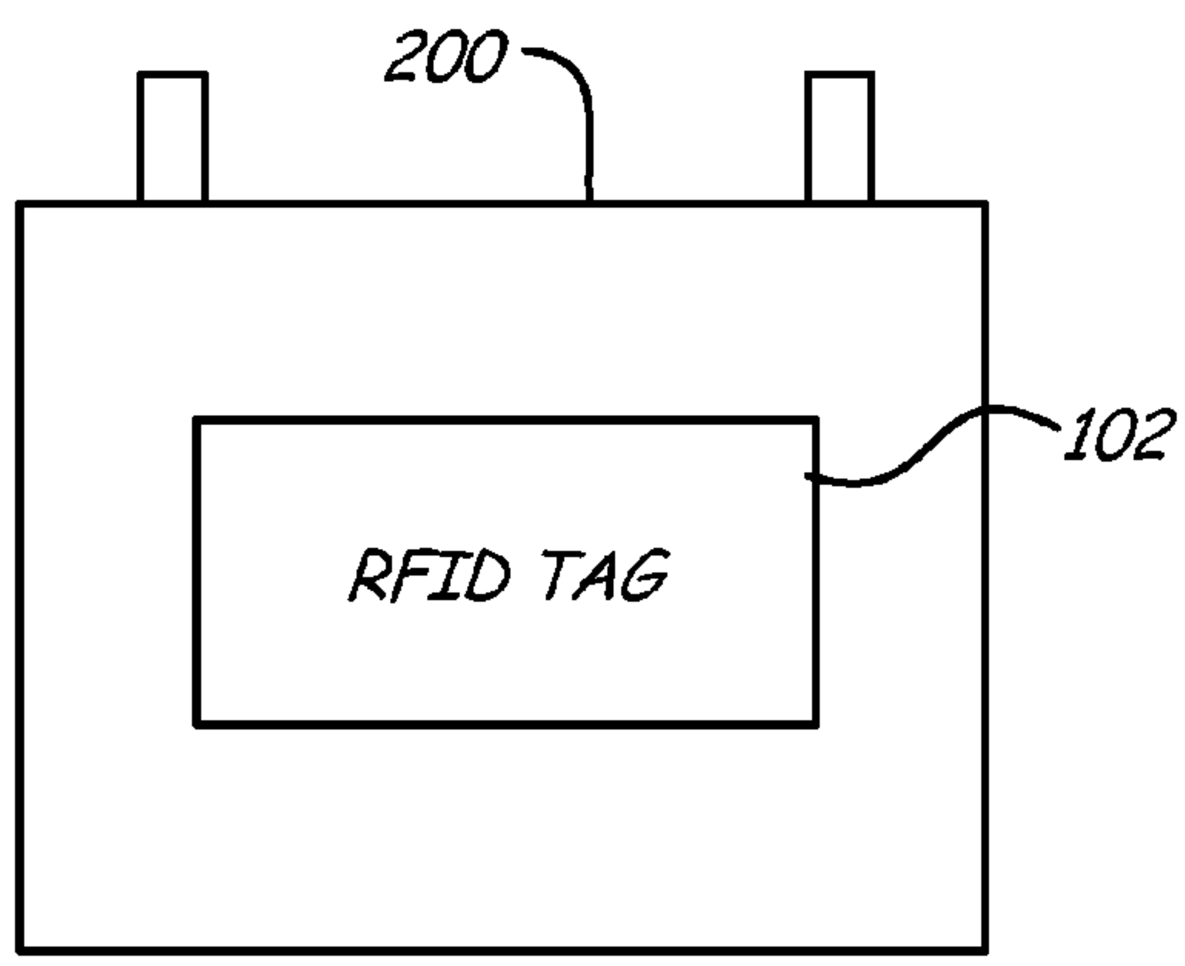
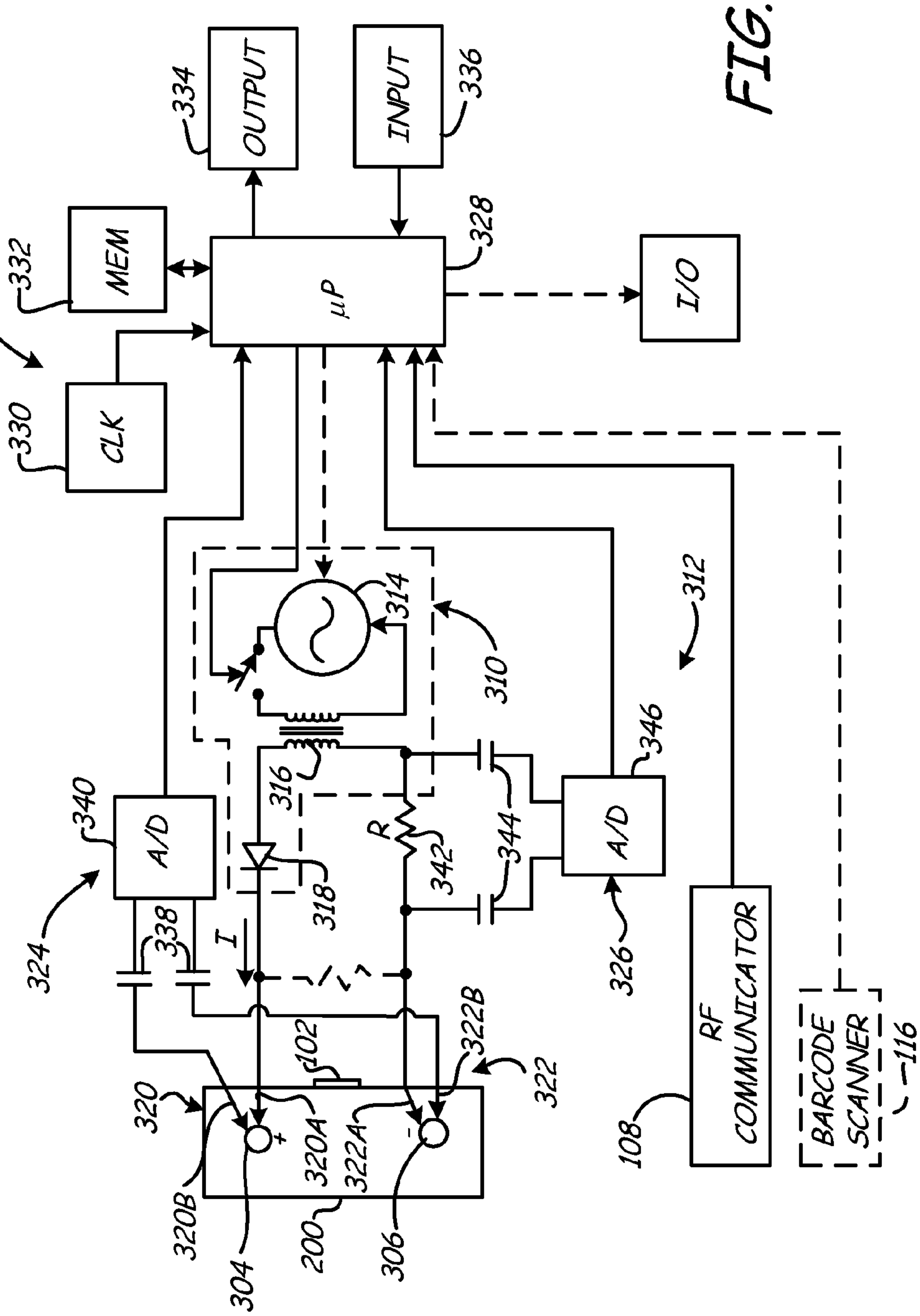

200
RFID TAG
102

FIG. 2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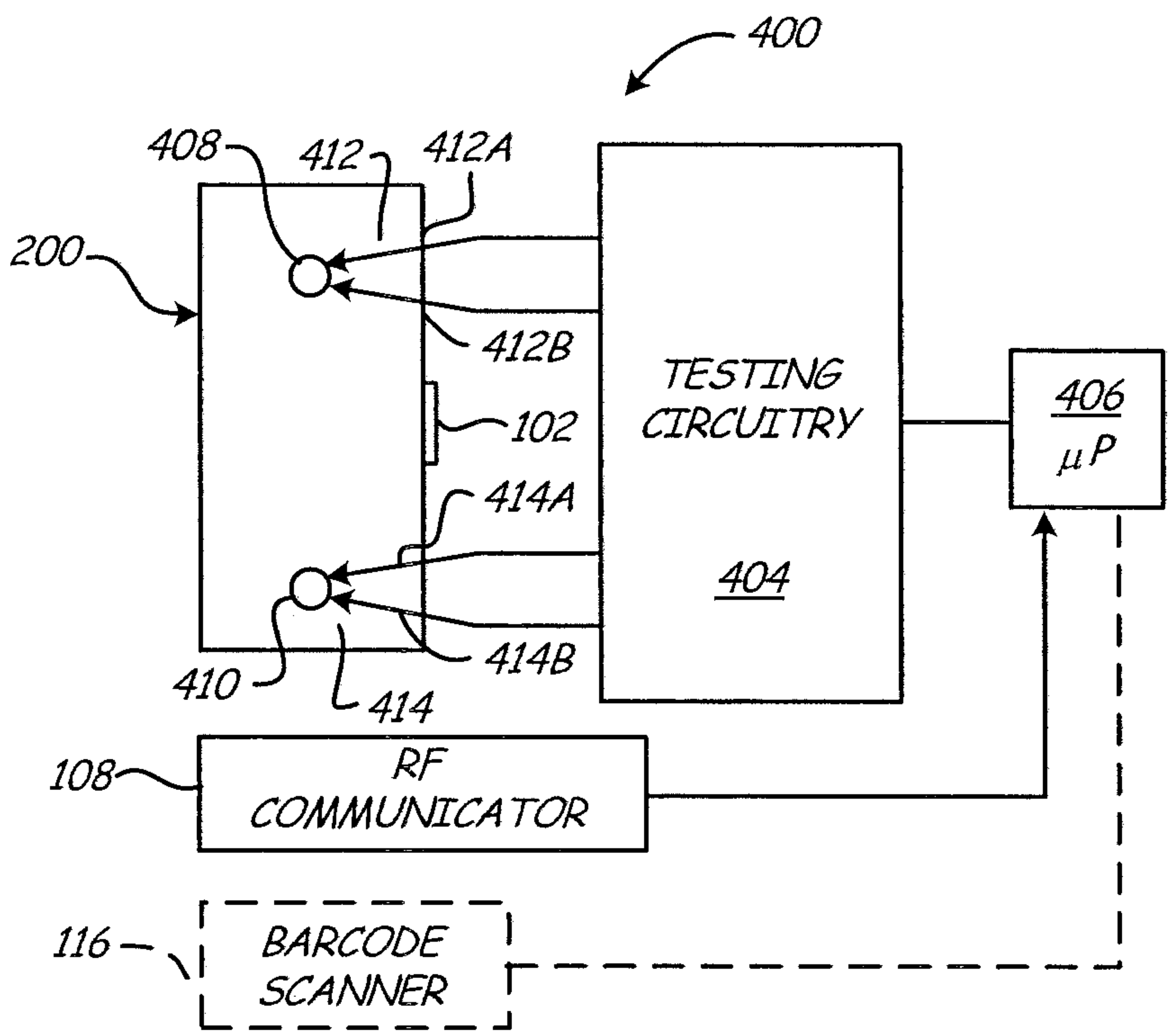
MEM
332
CLK
330
μP
328
OUTPUT
334
INPUT
336
I/O
314
310
312
316
318
R
342
344
A/D
346
A/D
340
324
338
I
326
RF COMMUNICATOR
108
BARCODE SCANNER
116
102
322B
322
320
+
-
320A
322A
320B
304
200
306

FIG. 3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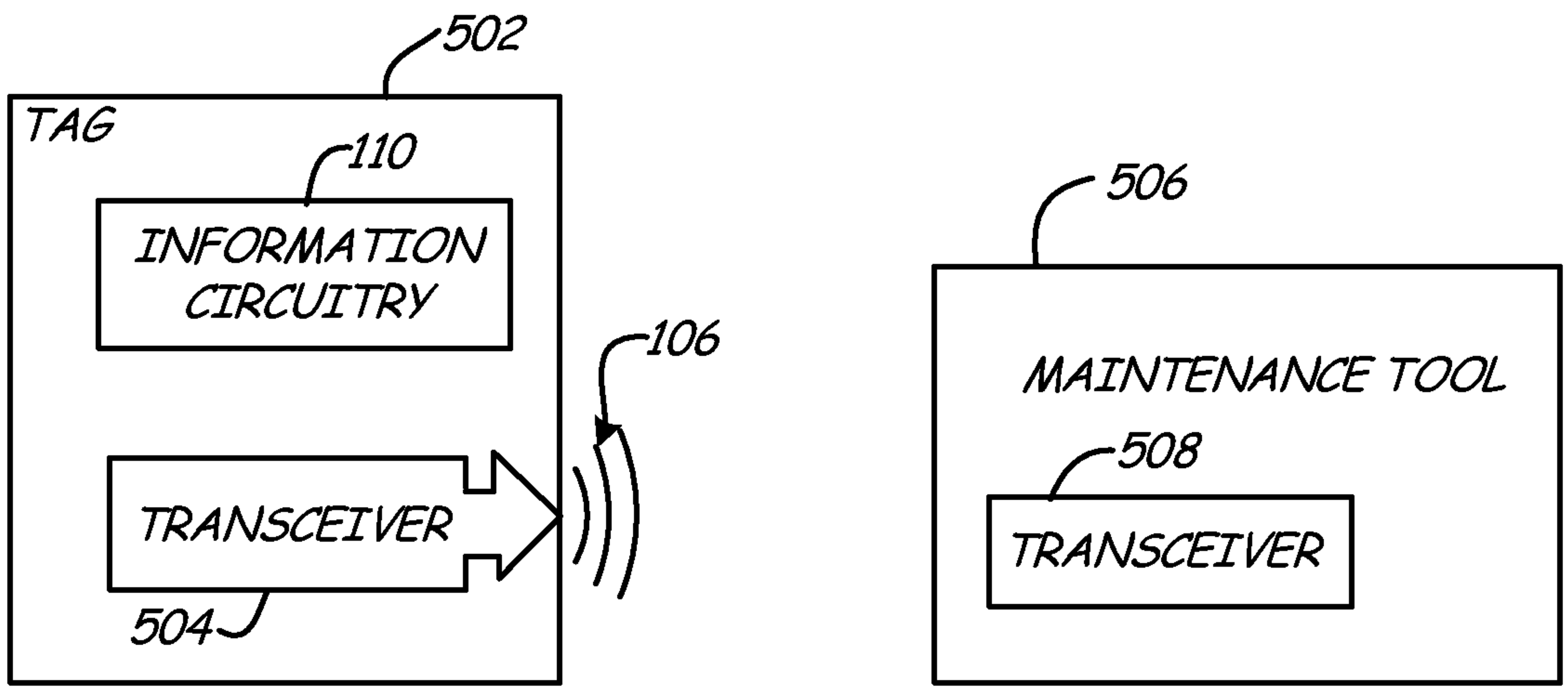
408
412
412A
200
412B
TESTING
CIRCUITRY
404
406
μP
102
414A
414B
410
414
108
RF
COMMUNICATOR
116
BARCODE
SCANNER

FIG. 4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TAG
110
INFORMATION CIRCUITRY
106
TRANSCEIVER
504
506
MAINTENANCE TOOL
508
TRANSCEIVER

FIG. 5

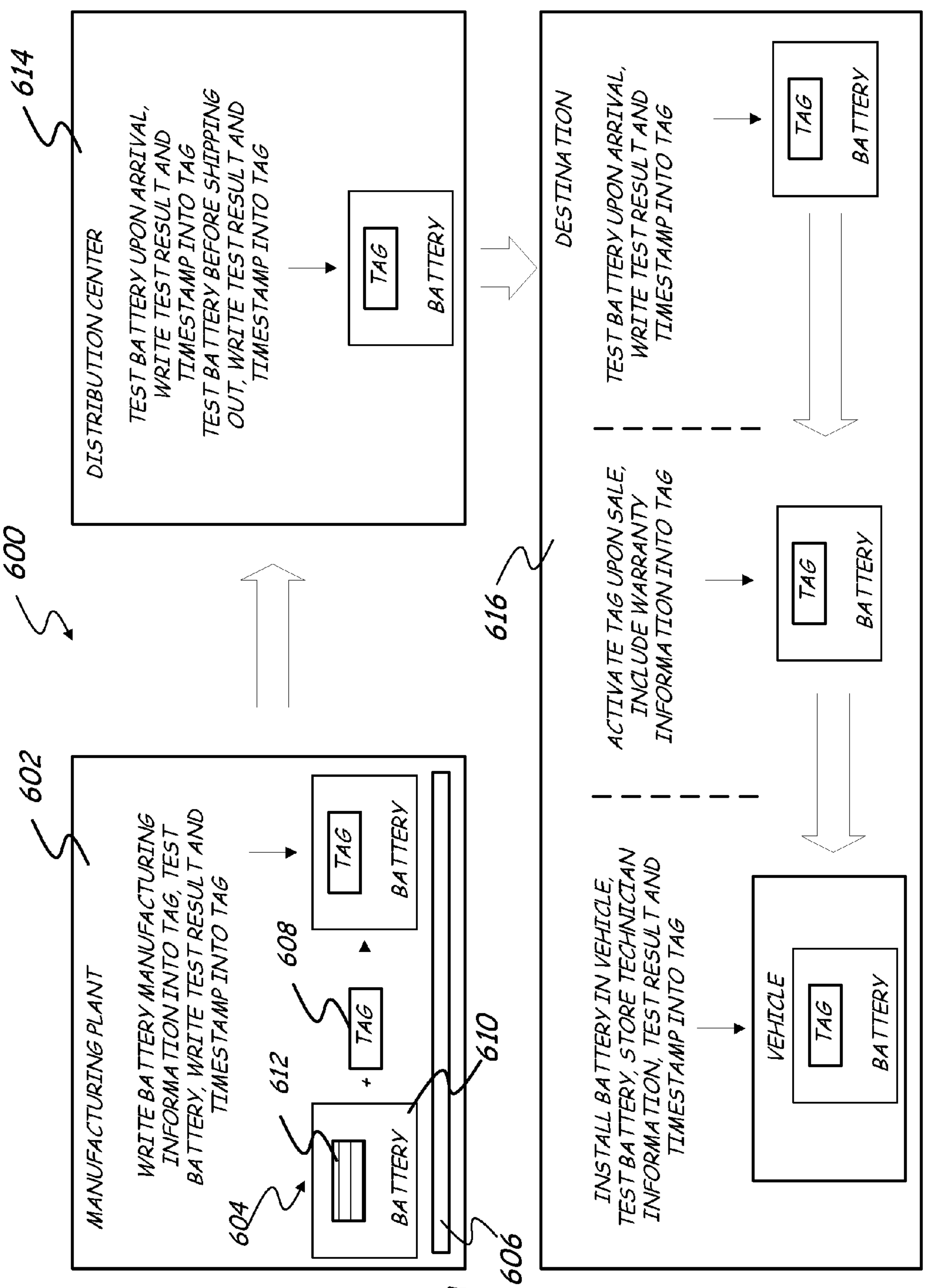
600
602
MANUFACTURING PLANT
WRITE BATTERY MANUFACTURING INFORMATION INTO TAG, TEST BATTERY, WRITE TEST RESULT AND TIMESTAMP INTO TAG
604
612
608
610
606
TAG
BATTERY
614
DISTRIBUTION CENTER
TEST BATTERY UPON ARRIVAL, WRITE TEST RESULT AND TIMESTAMP INTO TAG
TEST BATTERY BEFORE SHIPPING OUT, WRITE TEST RESULT AND TIMESTAMP INTO TAG
616
DESTINATION
TEST BATTERY UPON ARRIVAL, WRITE TEST RESULT AND TIMESTAMP INTO TAG
ACTIVATE TAG UPON SALE, INCLUDE WARRANTY INFORMATION INTO TAG
INSTALL BATTERY IN VEHICLE, TEST BATTERY, STORE TECHNICIAN INFORMATION, TEST RESULT AND TIMESTAMP INTO TAG
VEHICLE

FIG. 6A

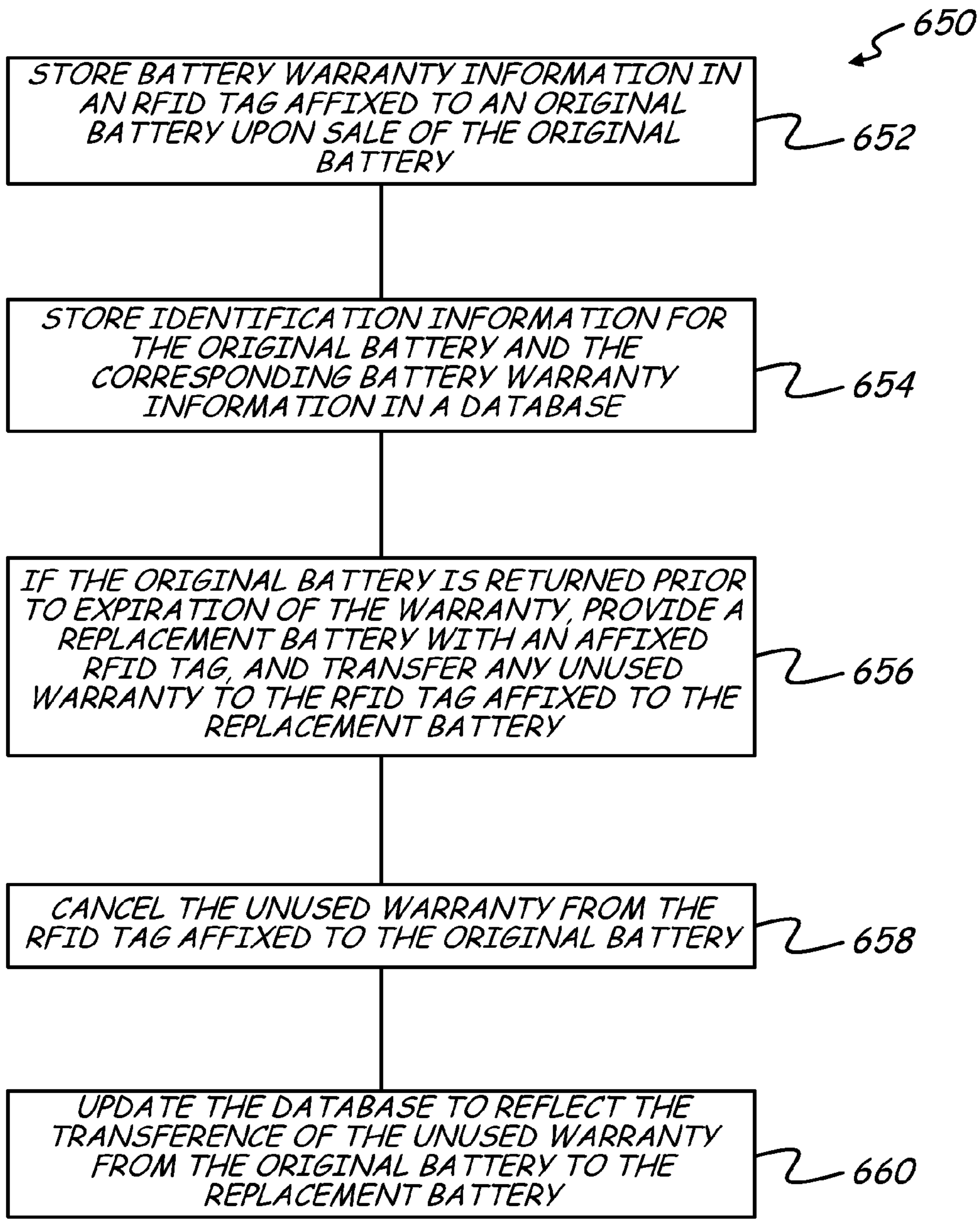
650
STORE BATTERY WARRANTY INFORMATION IN AN RFID TAG AFFIXED TO AN ORIGINAL BATTERY UPON SALE OF THE ORIGINAL BATTERY
652
STORE IDENTIFICATION INFORMATION FOR THE ORIGINAL BATTERY AND THE CORRESPONDING BATTERY WARRANTY INFORMATION IN A DATABASE
654
IF THE ORIGINAL BATTERY IS RETURNED PRIOR TO EXPIRATION OF THE WARRANTY, PROVIDE A REPLACEMENT BATTERY WITH AN AFFIXED RFID TAG, AND TRANSFER ANY UNUSED WARRANTY TO THE RFID TAG AFFIXED TO THE REPLACEMENT BATTERY
656
CANCEL THE UNUSED WARRANTY FROM THE RFID TAG AFFIXED TO THE ORIGINAL BATTERY
658
UPDATE THE DATABASE TO REFLECT THE TRANSFERENCE OF THE UNUSED WARRANTY FROM THE ORIGINAL BATTERY TO THE REPLACEMENT BATTERY
660

FIG. 6B

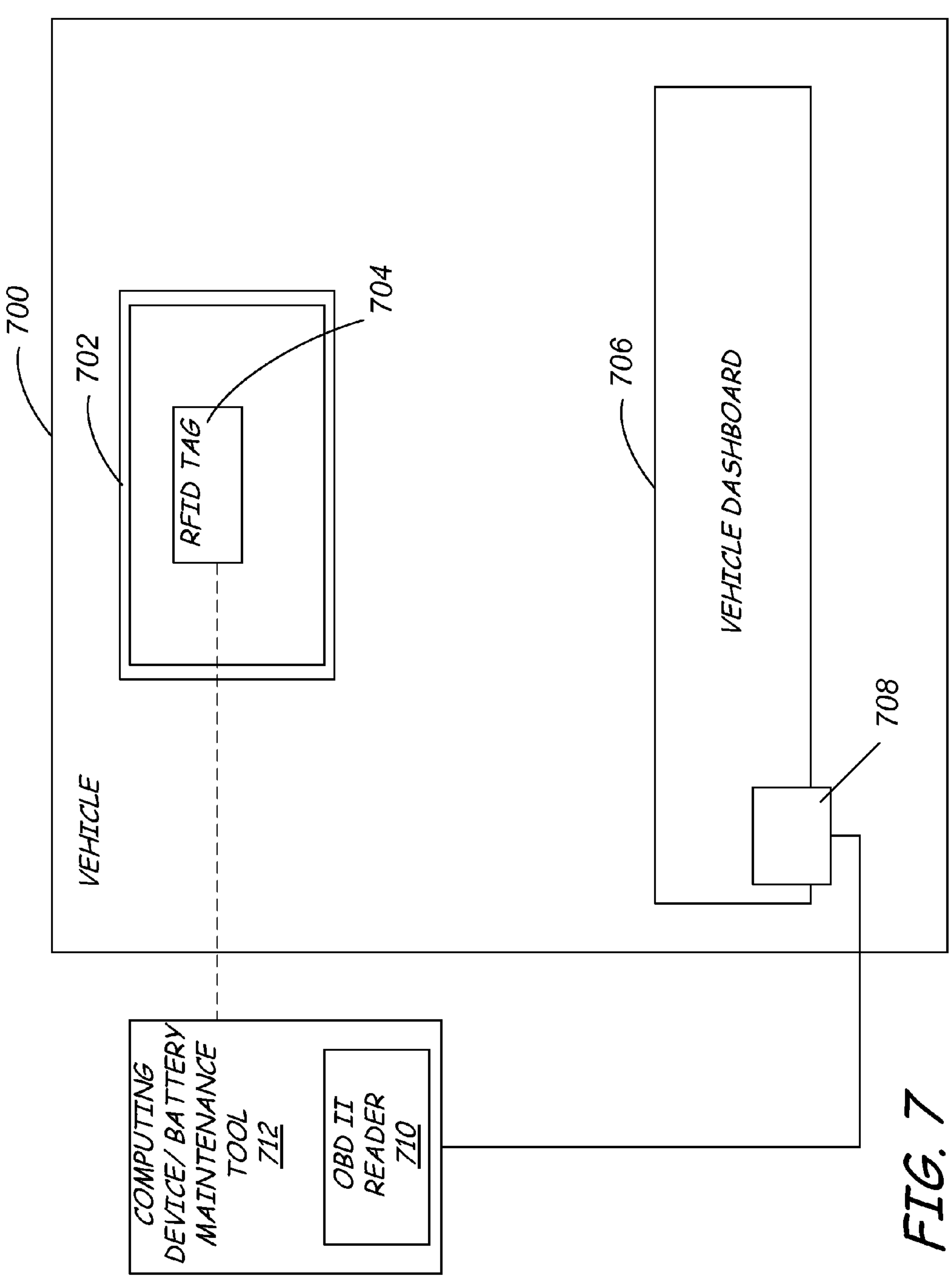
700
702
704
RFID TAG
706
VEHICLE DASHBOARD
708
VEHICLE
COMPUTING DEVICE/ BATTERY MAINTENANCE TOOL 712
OBD II READER 710

FIG. 7

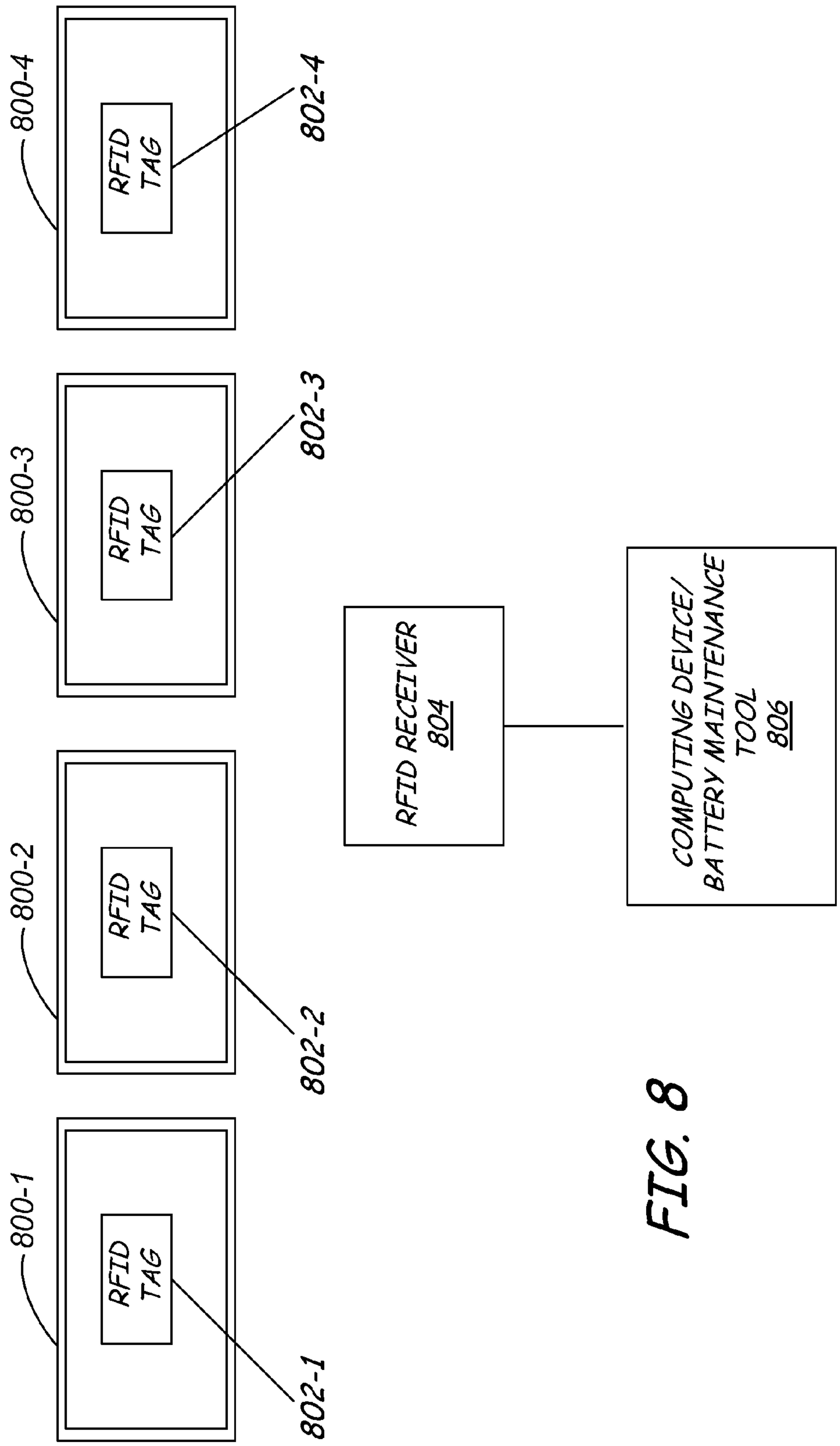
800-1
RFID TAG
802-1
800-2
RFID TAG
802-2
800-3
RFID TAG
802-3
800-4
RFID TAG
802-4
RFID RECEIVER 804
COMPUTING DEVICE/ BATTERY MAINTENANCE TOOL 806

FIG. 8

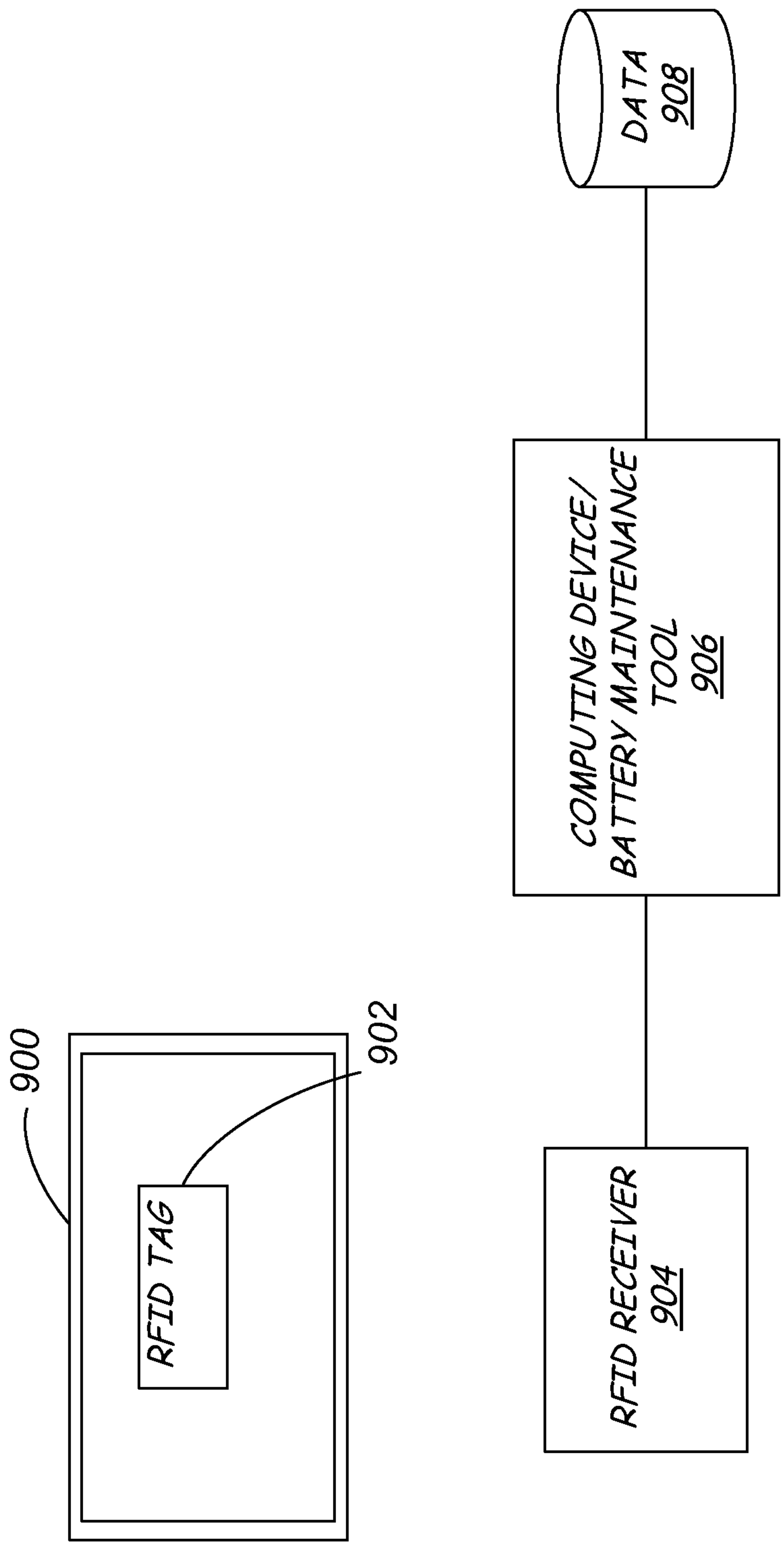
DATA 908
COMPUTING DEVICE/ BATTERY MAINTENANCE TOOL 906
RFID RECEIVER 904
RFID TAG
900
902

FIG. 9

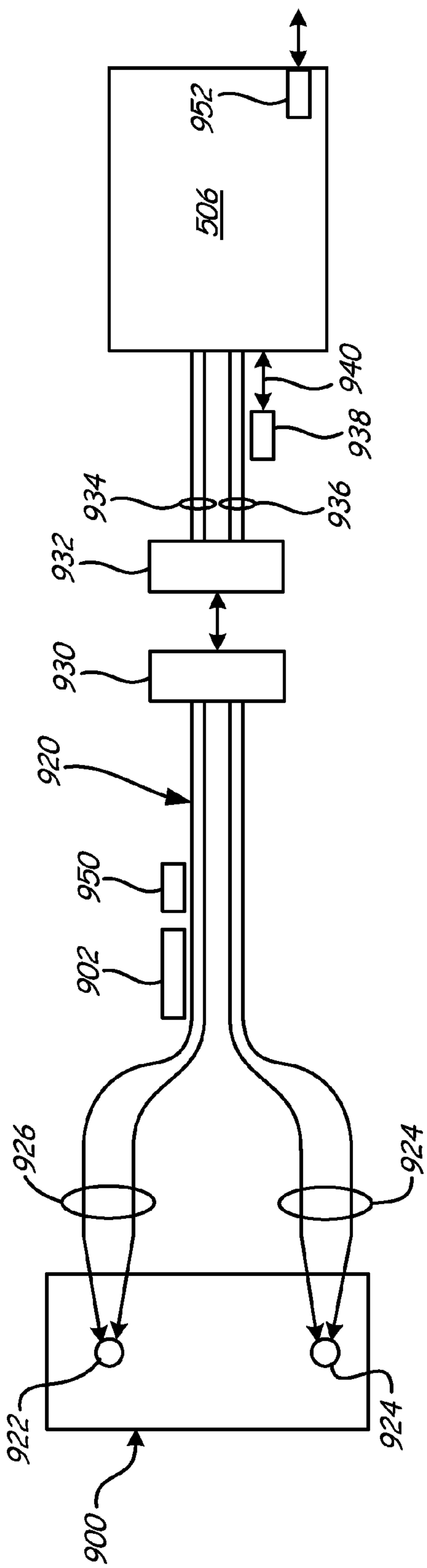

FIG. 10

SYSTEM FOR AUTOMATICALLY GATHERING BATTERY INFORMATION

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a Continuation-in-Part and claims priority of U.S. Ser. No. 12/416,457, filed Apr. 1, 2009, which is a Continuation-In-Part of and claims priority of U.S. patent application Ser. No. 11/207,419, filed Aug. 19, 2005, which is based on and claims the benefit of U.S. provisional patent application Ser. No. 60/603,078, filed Aug. 20, 2004; the present application is also a Continuation-in-Part and claims priority of U.S. Ser. No. 12/416,453, filed Apr. 1, 2009, which is a Continuation-In-Part of and claims priority of U.S. patent application Ser. No. 11/207,419, filed Aug. 19, 2005, which is based on and claims the benefit of U.S. provisional patent application Ser. No. 60/603,078, filed Aug. 20, 2004; the present invention is also a Continuation-in-Part and claims priority of U.S. Ser. No. 12/416,445, filed Apr. 1, 2009, which is a Continuation-In-Part of and claims priority of U.S. patent application Ser. No. 11/207,419, filed Aug. 19, 2005, which is based on and claims the benefit of U.S. provisional patent application Ser. No. 60/603,078, filed Aug. 20, 2004, the contents of which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

The present invention relates to storage batteries. More specifically, the present invention relates to a system for automatically gathering battery information for use during battery testing/charging.

Storage batteries, such as lead acid storage batteries, are used in a variety of applications such as automotive vehicles and stand by power sources. Typically, storage batteries consist of a plurality of individual storage cells which are electrically connected in series. Each cell can have a voltage potential of about 2.1 volts, for example. By connecting the cells in series, the voltages of individual cells are added in a cumulative manner. For example, in a typical automotive battery, six storage cells are used to provide a total voltage of 12.6 volts. The individual cells are held in a housing and the entire assembly is commonly referred to as the "battery."

It is frequently desirable to ascertain the condition of a storage battery. Various testing techniques have been developed over the long history of storage batteries. For example, one technique involves the use of a hygrometer in which the specific gravity of the acid mixture in the battery is measured. Electrical testing has also been used to provide less invasive battery testing techniques. A very simple electrical test is to simply measure the voltage across the battery. If the voltage is below a certain threshold, the battery is determined to be bad. Another technique for testing a battery is referred to as a load test. In the load test, the battery is discharged using a known load. As the battery is discharged, the voltage across the battery is monitored and used to determine the condition of the battery. More recently, techniques have been pioneered by Dr. Keith S. Champlin and Midtronics, Inc. of Willowbrook, Ill. for testing storage batteries by measuring a dynamic parameter of the battery such as the dynamic conductance of the battery. This technique is described in a number of United States patents and United States patent applications, for example U.S. Pat. No. 3,873,911, issued Mar. 25, 1975, to Champlin; U.S. Pat. No. 3,909,708, issued Sep. 30, 1975, to Champlin; U.S. Pat. No. 4,816,768, issued Mar. 28, 1989, to Champlin; U.S. Pat. No.

4,825,170, issued Apr. 25, 1989, to Champlin; U.S. Pat. No. 4,881,038, issued Nov. 14, 1989, to Champlin; U.S. Pat. No. 4,912,416, issued Mar. 27, 1990, to Champlin; U.S. Pat. No. 5,140,269, issued Aug. 18, 1992, to Champlin; U.S. Pat. No. 5,343,380, issued Aug. 30, 1994; U.S. Pat. No. 5,572,136, issued Nov. 5, 1996; U.S. Pat. No. 5,574,355, issued Nov. 12, 1996; U.S. Pat. No. 5,583,416, issued Dec. 10, 1996; U.S. Pat. No. 5,585,728, issued Dec. 17, 1996; U.S. Pat. No. 5,589,757, issued Dec. 31, 1996; U.S. Pat. No. 5,592,093, issued Jan. 7, 1997; U.S. Pat. No. 5,598,098, issued Jan. 28, 1997; U.S. Pat. No. 5,656,920, issued Aug. 12, 1997; U.S. Pat. No. 5,757,192, issued May 26, 1998; U.S. Pat. No. 5,821,756, issued Oct. 13, 1998; U.S. Pat. No. 5,831,435, issued Nov. 3, 1998; U.S. Pat. No. 5,871,858, issued Feb. 16, 1999; U.S. Pat. No. 5,914,605, issued Jun. 22, 1999; U.S. Pat. No. 5,945,829, issued Aug. 31, 1999; U.S. Pat. No. 6,002,238, issued Dec. 14, 1999; U.S. Pat. No. 6,037,751, issued Mar. 14, 2000; U.S. Pat. No. 6,037,777, issued Mar. 14, 2000; U.S. Pat. No. 6,051,976, issued Apr. 18, 2000; U.S. Pat. No. 6,081,098, issued Jun. 27, 2000; U.S. Pat. No. 6,091,245, issued Jul. 18, 2000; U.S. Pat. No. 6,104,167, issued Aug. 15, 2000; U.S. Pat. No. 6,137,269, issued Oct. 24, 2000; U.S. Pat. No. 6,163,156, issued Dec. 19, 2000; U.S. Pat. No. 6,172,483, issued Jan. 9, 2001; U.S. Pat. No. 6,172,505, issued Jan. 9, 2001; U.S. Pat. No. 6,222,369, issued Apr. 24, 2001; U.S. Pat. No. 6,225,808, issued May 1, 2001; U.S. Pat. No. 6,249,124, issued Jun. 19, 2001; U.S. Pat. No. 6,259,254, issued Jul. 10, 2001; U.S. Pat. No. 6,262,563, issued Jul. 17, 2001; U.S. Pat. No. 6,294,896, issued Sep. 25, 2001; U.S. Pat. No. 6,294,897, issued Sep. 25, 2001; U.S. Pat. No. 6,304,087, issued Oct. 16, 2001; U.S. Pat. No. 6,310,481, issued Oct. 30, 2001; U.S. Pat. No. 6,313,607, issued Nov. 6, 2001; U.S. Pat. No. 6,313,608, issued Nov. 6, 2001; U.S. Pat. No. 6,316,914, issued Nov. 13, 2001; U.S. Pat. No. 6,323,650, issued Nov. 27, 2001; U.S. Pat. No. 6,329,793, issued Dec. 11, 2001; U.S. Pat. No. 6,331,762, issued Dec. 18, 2001; U.S. Pat. No. 6,332,113, issued Dec. 18, 2001; U.S. Pat. No. 6,351,102, issued Feb. 26, 2002; U.S. Pat. No. 6,359,441, issued Mar. 19, 2002; U.S. Pat. No. 6,363,303, issued Mar. 26, 2002; U.S. Pat. No. 6,377,031, issued Apr. 23, 2002; U.S. Pat. No. 6,392,414, issued May 21, 2002; U.S. Pat. No. 6,417,669, issued Jul. 9, 2002; U.S. Pat. No. 6,424,158, issued Jul. 23, 2002; U.S. Pat. No. 6,441,585, issued Aug. 17, 2002; U.S. Pat. No. 6,437,957, issued Aug. 20, 2002; U.S. Pat. No. 6,445,158, issued Sep. 3, 2002; U.S. Pat. No. 6,456,045; U.S. Pat. No. 6,466,025, issued Oct. 15, 2002; U.S. Pat. No. 6,465,908, issued Oct. 15, 2002; U.S. Pat. No. 6,466,026, issued Oct. 15, 2002; U.S. Pat. No. 6,469,511, issued Nov. 22, 2002; U.S. Pat. No. 6,495,990, issued Dec. 17, 2002; U.S. Pat. No. 6,497,209, issued Dec. 24, 2002; U.S. Pat. No. 6,507,196, issued Jan. 14, 2003; U.S. Pat. No. 6,534,993; issued Mar. 18, 2003; U.S. Pat. No. 6,544,078, issued Apr. 8, 2003; U.S. Pat. No. 6,556,019, issued Apr. 29, 2003; U.S. Pat. No. 6,566,883, issued May 20, 2003; U.S. Pat. No. 6,586,941, issued Jul. 1, 2003; U.S. Pat. No. 6,597,150, issued Jul. 22, 2003; U.S. Pat. No. 6,621,272, issued Sep. 16, 2003; U.S. Pat. No. 6,623,314, issued Sep. 23, 2003; U.S. Pat. No. 6,633,165, issued Oct. 14, 2003; U.S. Pat. No. 6,635,974, issued Oct. 21, 2003; U.S. Pat. No. 6,707,303, issued Mar. 16, 2004; U.S. Pat. No. 6,737,831, issued May 18, 2004; U.S. Pat. No. 6,744,149, issued Jun. 1, 2004; U.S. Pat. No. 6,759,849, issued Jul. 6, 2004; U.S. Pat. No. 6,781,382, issued Aug. 24, 2004; U.S. Pat. No. 6,788,025, filed Sep. 7, 2004; U.S. Pat. No. 6,795,782, issued Sep. 21, 2004; U.S. Pat. No. 6,805,090, filed Oct. 19, 2004; U.S. Pat. No. 6,806,716, filed Oct. 19, 2004; U.S. Pat. No. 6,850,037, filed

Feb. 1, 2005; U.S. Pat. No. 6,850,037, issued Feb. 1, 2005; U.S. Pat. No. 6,871,151, issued Mar. 22, 2005; U.S. Pat. No. 6,885,195, issued Apr. 26, 2005; U.S. Pat. No. 6,888,468, issued May 3, 2005; U.S. Pat. No. 6,891,378, issued May 10, 2005; U.S. Pat. No. 6,906,522, issued Jun. 14, 2005; U.S. Pat. No. 6,906,523, issued Jun. 14, 2005; U.S. Pat. No. 6,909,287, issued Jun. 21, 2005; U.S. Pat. No. 6,914,413, issued Jul. 5, 2005; U.S. Pat. No. 6,913,483, issued Jul. 5, 2005; U.S. Pat. No. 6,930,485, issued Aug. 16, 2005; U.S. Pat. No. 6,933,727, issued Aug. 23, 200; U.S. Pat. No. 6,941,234, filed Sep. 6, 2005; U.S. Pat. No. 6,967,484, issued Nov. 22, 2005; U.S. Pat. No. 6,998,847, issued Feb. 14, 2006; U.S. Pat. No. 7,003,410, issued Feb. 21, 2006; U.S. Pat. No. 7,003,411, issued Feb. 21, 2006; U.S. Pat. No. 7,012,433, issued Mar. 14, 2006; U.S. Pat. No. 7,015,674, issued Mar. 21, 2006; U.S. Pat. No. 7,034,541, issued Apr. 25, 2006; U.S. Pat. No. 7,039,533, issued May 2, 2006; U.S. Pat. No. 7,058,525, issued Jun. 6, 2006; U.S. Pat. No. 7,081,755, issued Jul. 25, 2006; U.S. Pat. No. 7,106,070, issued Sep. 12, 2006; U.S. Pat. No. 7,116,109, issued Oct. 3, 2006; U.S. Pat. No. 7,119,686, issued Oct. 10, 2006; and U.S. Pat. No. 7,126,341, issued Oct. 24, 2006; U.S. Pat. No. 7,154,276, issued Dec. 26, 2006; U.S. Pat. No. 7,198,510, issued Apr. 3, 2007; U.S. Pat. No. 7,363,175, issued Apr. 22, 2008; U.S. Pat. No. 7,208,914, issued Apr. 24, 2007; U.S. Pat. No. 7,246,015, issued Jul. 17, 2007; U.S. Pat. No. 7,295,936, issued Nov. 13, 2007; U.S. Pat. No. 7,319,304, issued Jan. 15, 2008; U.S. Pat. No. 7,363,175, issued Apr. 22, 2008; U.S. Pat. No. 7,398,176, issued Jul. 8, 2008; U.S. Pat. No. 7,408,358, issued Aug. 5, 2008; U.S. Pat. No. 7,425,833, issued Sep. 16, 2008; U.S. Pat. No. 7,446,536, issued Nov. 4, 2008; U.S. Pat. No. 7,479,763, issued Jan. 20, 2009; U.S. Pat. No. 7,498,767, issued Mar. 3, 2009; U.S. Pat. No. 7,501,795, issued Mar. 10, 2009; U.S. Pat. No. 7,505, 856, issued Mar. 17, 2009; U.S. Pat. No. 7,545,146, issued Jun. 9, 2009; U.S. Pat. No. 7,557,586, issued Jul. 7, 2009; U.S. Pat. No. 7,595,643, issued Sep. 29, 2009; U.S. Pat. No. 7,598,699, issued Oct. 6, 2009; U.S. Pat. No. 7,598,744, issued Oct. 6, 2009; U.S. Pat. No. 7,598,743, issued Oct. 6, 2009; U.S. Pat. No. 7,619,417, issued Nov. 17, 2009; U.S. Pat. No. 7,642,786, issued Jan. 5, 2010; U.S. Pat. No. 7,642,787, issued Jan. 5, 2010; U.S. Pat. No. 7,656,162, issued Feb. 2, 2010; U.S. Pat. No. 7,688,074, issued Mar. 30, 2010; U.S. Pat. No. 7,705,602, issued Apr. 27, 2010; U.S. Pat. No. 7,706,992, issued Apr. 27, 2010; U.S. Pat. No. 7,710,119, issued May 4, 2010; U.S. Pat. No. 7,723,993, issued May 25, 2010; U.S. Pat. No. 7,728,597, issued Jun. 1, 2010; U.S. Pat. No. 7,772,850, issued Aug. 10, 2010; U.S. Pat. No. 7,774,151, issued Aug. 10, 2010; U.S. Pat. No. 7,777,612, issued Aug. 17, 2010; U.S. Pat. No. 7,791,348, issued Sep. 7, 2010; U.S. Pat. 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No. 10/109,734, filed Mar. 28, 2002, entitled APPARATUS AND METHOD FOR COUNTERACTING SELF DISCHARGE IN A STORAGE BATTERY; U.S. Ser. No. 10/112,998, filed Mar. 29, 2002, entitled BATTERY TESTER WITH BATTERY REPLACEMENT OUTPUT; U.S. Ser. No. 10/263,473, filed Oct. 2, 2002, entitled ELECTRONIC BATTERY TESTER WITH RELATIVE TEST OUTPUT; U.S. Ser. No. 10/310,385, filed Dec. 5, 2002, entitled BATTERY TEST MODULE; U.S. Ser. No. 09/653,963, filed Sep. 1, 2000, entitled SYSTEM AND METHOD FOR CONTROLLING POWER GENERATION AND STORAGE; U.S. Ser. No. 10/174, 110, filed Jun. 18, 2002, entitled DAYTIME RUNNING LIGHT CONTROL USING AN INTELLIGENT POWER MANAGEMENT SYSTEM; U.S. Ser. No. 10/258,441, filed Apr. 9, 2003, entitled CURRENT MEASURING CIRCUIT SUITED FOR BATTERIES; U.S. Ser. No. 10/681,666, filed Oct. 8, 2003, entitled ELECTRONIC BATTERY TESTER WITH PROBE LIGHT; U.S. Ser. No. 10/791,141, filed Mar. 2, 2004, entitled METHOD AND APPARATUS FOR AUDITING A BATTERY TEST; U.S. Ser. No. 10/867,385, filed Jun. 14, 2004, entitled ENERGY MANAGEMENT SYSTEM FOR AUTOMOTIVE VEHICLE; U.S. Ser. No. 10/958,812, filed Oct. 5, 2004, entitled SCAN TOOL FOR ELECTRONIC BATTERY TESTER; U.S. Ser. No. 60/587, 232, filed Dec. 14, 2004, entitled CELLTRON ULTRA, U.S. Ser. No. 60/653,537, filed Feb. 16, 2005, entitled CUSTOMER MANAGED WARRANTY CODE; U.S. Ser. No. 60/665,070, filed Mar. 24, 2005, entitled OHMMETER PROTECTION CIRCUIT; U.S. Ser. No. 60,694,199, filed Jun. 27, 2005, entitled GEL BATTERY CONDUCTANCE COMPENSATION; U.S. Ser. No. 60/705,389, filed Aug. 4, 2005, entitled PORTABLE TOOL THEFT PREVENTION SYSTEM, U.S. Ser. No. 11/207,419, filed Aug. 19, 2005, entitled SYSTEM FOR AUTOMATICALLY GATHERING BATTERY INFORMATION FOR USE DURING BATTERY TESTER/CHARGING, U.S. Ser. No. 60/712,322, filed Aug. 29, 2005, entitled AUTOMOTIVE VEHICLE ELECTRICAL SYSTEM DIAGNOSTIC DEVICE, U.S. Ser. No. 60/713,168, filed Aug. 31, 2005, entitled LOAD TESTER SIMULATION WITH DISCHARGE COMPENSATION, U.S. Ser. No. 60/731,881, filed Oct. 31, 2005, entitled PLUG-IN FEATURES FOR BATTERY TESTERS; U.S. Ser. No. 60/731,887, filed Oct. 31, 2005, entitled AUTOMOTIVE VEHICLE ELECTRICAL SYSTEM DIAGNOSTIC DEVICE; U.S. Ser. No. 11/304,004, filed Dec. 14, 2005, entitled BATTERY TESTER THAT CALCULATES ITS OWN REFERENCE VALUES; U.S. Ser. No. 60/751,853, filed Dec. 20, 2005, entitled BATTERY MONITORING SYSTEM; U.S. Ser. No. 11/304,004, filed Dec. 14, 2005, entitled BATTERY TESTER WITH CALCULATES ITS OWN REFERENCE VALUES; U.S. Ser. No. 60/751,853, filed Dec. 20, 2005, entitled BATTERY MONITORING SYSTEM; U.S. Ser. No. 11/356,443, filed Feb. 16, 2006, entitled ELECTRONIC BATTERY TESTER WITH NETWORK COMMUNICATION; U.S. Ser. No. 11/519,481, filed Sep. 12, 2006, entitled BROAD-BAND LOW-CONDUCTANCE CABLES FOR MAKING KELVIN CONNECTIONS TO ELECTROCHEMICAL CELLS AND BATTERIES; U.S. Ser. No. 60/847,064, filed Sep. 25, 2006, entitled STATIONARY BATTERY MONITORING ALGORITHMS; U.S. Ser. No. 11/641,594, filed Dec. 19, 2006, entitled METHOD AND APPARATUS FOR MEASURING A PARAMETER OF A VEHICLE ELECTRONIC SYSTEM; U.S. Ser. No. 60/950,182, filed Jul. 17, 2007, entitled BATTERY TESTER FOR HYBRID VEHICLE;

U.S. Ser. No. 60/973,879, filed Sep. 20, 2007, entitled ELECTRONIC BATTERY TESTER FOR TESTING STATIONARY BATTERIES; U.S. Ser. No. 60/992,798, filed Dec. 6, 2007, entitled STORAGE BATTERY AND BATTERY TESTER; U.S. Ser. No. 61/061,848, filed Jun. 16, 2008, entitled KELVIN CLAMP FOR ELECTRONICALLY COUPLING TO A BATTERY CONTACT; U.S. Ser. No. 12/168,264, filed Jul. 7, 2008, entitled BATTERY TESTERS WITH SECONDARY FUNCTIONALITY; U.S. Ser. No. 12/174,894, filed Jul. 17, 2008, entitled BATTERY TESTER FOR ELECTRIC VEHICLE; U.S. Ser. No. 12/204,141, filed Sep. 4, 2008, entitled ELECTRONIC BATTERY TESTER OR CHARGER WITH DATABUS CONNECTION; U.S. Ser. No. 12/328,022, filed Dec. 4, 2008, entitled STORAGE BATTERY AND BATTERY TESTER; U.S. Ser. No. 12/416,457, filed Apr. 1, 2009, entitled SYSTEM FOR AUTOMATICALLY GATHERING BATTERY INFORMATION; U.S. Ser. No. 12/416,453, filed Apr. 1, 2009, entitled INTEGRATED TAG READER AND ENVIRONMENT SENSOR; U.S. Ser. No. 12/416,445, filed Apr. 1, 2009, entitled SIMPLIFICATION OF INVENTORY MANAGEMENT; U.S. Ser. No. 12/498,642, filed Jul. 7, 2009, entitled ELECTRONIC BATTERY TESTER; U.S. Ser. No. 12/697,485, filed Feb. 1, 2010, entitled ELECTRONIC BATTERY TESTER; U.S. Ser. No. 12/712,456, filed Feb. 25, 2010, entitled METHOD AND APPARATUS FOR DETECTING CELL DETERIORATION IN AN ELECTROCHEMICAL CELL OR BATTERY; U.S. Ser. No. 61/311,485, filed Mar. 8, 2010, entitled BATTERY TESTER WITH DATABUS FOR COMMUNICATING WITH VEHICLE ELECTRICAL SYSTEM; U.S. Ser. No. 61/313,893, filed Mar. 15, 2010, entitled USE OF BATTERY MANUFACTURE/SELL DATE IN DIAGNOSIS AND RECOVERY OF DISCHARGED BATTERIES; U.S. Ser. No. 12/758,407, filed Apr. 12, 2010, entitled ELECTRONIC BATTERY TESTER WITH NETWORK COMMUNICATION; U.S. Ser. No. 12/765,323, filed Apr. 22, 2010, entitled AUTOMOTIVE VEHICLE ELECTRICAL SYSTEM DIAGNOSTIC DEVICE; U.S. Ser. No. 12/769,911, filed Apr. 29, 2010, entitled STATIONARY BATTERY TESTER; U.S. Ser. No. 61/330,497, filed May 3, 2010, entitled MAGIC WAND WITH ADVANCED HARNESS DETECTION; U.S. Ser. No. 61/348,901, filed May 27, 2010, entitled ELECTRONIC BATTERY TESTER; U.S. Ser. No. 61/351,017, filed Jun. 3, 2010, entitled IMPROVED ELECTRIC VEHICLE AND HYBRID ELECTRIC VEHICLE BATTERY MODULE BALANCER; U.S. Ser. No. 12/818,290, filed Jun. 18, 2010, entitled BATTERY MAINTENANCE DEVICE WITH THERMAL BUFFER; U.S. Ser. No. 61/373,045, filed Aug. 12, 2010, entitled ELECTRONIC BATTERY TESTER FOR TESTING STATIONERY STORAGE BATTERY; U.S. Ser. No. 12/888,689, filed Sep. 23, 2010, entitled BATTERY TESTER FOR ELECTRIC VEHICLE; U.S. Ser. No. 12/894,951, filed Sep. 30, 2010, entitled BATTERY PACK MAINTENANCE FOR ELECTRIC VEHICLES; U.S. Ser. No. 61/411,162, filed Nov. 8, 2010, entitled ELECTRONIC BATTERY TESTER; U.S. Ser. No. 13/037,641, filed Mar. 1, 2011, entitled MONITOR FOR FRONT TERMINAL BATTERIES; U.S. Ser. No. 13/037,641, filed Mar. 1, 2011, entitled MONITOR FOR FRONT TERMINAL BATTERIES; U.S. Ser. No. 13/048,365, filed Mar. 15, 2011, entitled ELECTRONIC BATTERY TESTER WITH BATTERY AGE UNIT; U.S. Ser. No. 13/098,661, filed May 2, 2011, entitled METHOD AND APPARATUS FOR MEASURING A PARAMETER OF A VEHICLE ELECTRICAL SYSTEM; U.S. Ser. No. 13/113,272, filed May 23, 2011, entitled ELECTRONIC STORAGE BATTERY DIAGNOSTIC SYSTEM; U.S. Ser. No. 13/152,711, filed Jun. 3, 2011, entitled BATTERY PACK MAINTENANCE FOR ELECTRIC VEHICLE; U.S. Ser. No. 13/205,949, filed Aug. 9, 2011, entitled ELECTRONIC BATTERY TESTER FOR TESTING STORAGE BATTERY; U.S. Ser. No. 13/205,904, filed Aug. 9, 2011, entitled IN-VEHICLE BATTERY MONITOR; U.S. Ser. No. 13/270,828, filed Oct. 11, 2011, entitled SYSTEM FOR AUTOMATICALLY GATHERING BATTERY INFORMATION; U.S. Ser. No. 13/276,639, filed Oct. 19, 2011, entitled METHOD AND APPARATUS FOR MEASURING A PARAMETER OF A VEHICLE ELECTRICAL SYSTEM; U.S. Ser. No. 61/558,088, filed Nov. 10, 2011, entitled BATTERY PACK TESTER; which are incorporated herein by reference in their entirety.

In general, most prior art battery testers/chargers require tester/charger users to enter information related to the battery (such as battery type, battery group size, battery Cold Cranking Amp (CCA) rating, etc.) via a user input such as a keypad. Reliance on user entry of battery information may result in incorrect information being entered, which in turn can result in inaccurate battery test results or improper charging of the battery. Further, the results for the battery test are typically simply displayed to an operator or, in some more advance configurations, transmitted to another location, for example over a communication link.

SUMMARY OF THE INVENTION

A method and apparatus is provided in which a radio frequency identification (RIFD) tag is associated with the storage battery and is used in conjunction with a battery test, battery charger, or other battery maintenance. A cable configured to be affixed to the storage battery. The cable is configured to store information and communicate the information to a battery tester.

A battery maintenance device configured to couple to the battery and to perform battery maintenance on the battery through the cable. The battery maintenance device includes communication circuitry configured to communicate with a memory of the cable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified block diagram showing components of a battery testing/charging system in accordance with an embodiment of the present invention.

FIG. **2** is a side plan view of a storage battery including a RFID tag in accordance with an embodiment of the present invention.

FIG. **3** is a simplified block diagram of an example battery charging system that is capable of receiving information from the RFID tag.

FIG. **4** is a simplified block diagram of an example battery tester that is capable of receiving information from the RFID tag.

FIG. **5** is a simplified block diagram of a battery maintenance system in accordance with an embodiment of the present invention.

FIG. **6**A is a simplified block diagram illustrating the use of information in an RFID tag affixed to a battery at different stages in the life of the battery.

FIG. **6**B is a flowchart showing steps of a warranty management method in accordance with one embodiment.

FIG. **7** is a simplified block diagram showing a vehicle having a battery with an affixed RFID tag in accordance with one embodiment.

FIG. **8** is a simplified block diagram showing multiple batteries with each of the batteries including an RFID label with balancing information.

FIG. **9** simplified block diagram showing a method for fraud prevention when RFID tags are used to store battery related information.

FIG. **10** is a simplified block diagram showing a cable affixed to a battery in which the cable includes a RFID tag.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Storage batteries are used in many applications including both automotive vehicles as well as stationary implementations such as for use as a backup power supply, etc. It is frequently desirable to perform tests on the batteries so that they're performance capabilities may be evaluated. In order to be able to perform a test on the battery or other battery maintenance, a battery maintenance device must be coupled to the battery through electrical connections. This connection can be a source of errors and inconsistencies in the test measurements. For example, an unskilled operator may improperly connect the cable to the posts of the battery. This will result in, for example, an error in the battery test measurement. Similarly, even if a skilled operator properly connects the cable to the battery a previously obtained inaccurate test result will affect the ability to observe trending in the test measurements. Further, there are various parameters which can be associated with a battery. It would be beneficial to associate those parameters with the battery. In one aspect, the present invention provides a cable which can be permanently, or semi-permanently, affixed to a battery and coupled to the terminals of the battery. This ensures consistent test results and eliminates errors caused by improper connections of the cables to the battery. Further, in one aspect the present invention includes a memory which is associated with the battery. This memory can be carried in the cable and, in one configuration, can contain information which is wirelessly communicated to a battery maintenance device. This communication can be both from the memory to the device as well as from the device to the memory. This allows parameters related to the battery, such as a battery rating, to be stored and associated with the battery. Further still, test results can be stored in the cable memory whereby trends in the measurements can be observed and used to determine the condition of the battery as well as predict its ultimate failure. These techniques are useful in both storage batteries used in, for example, automotive vehicles as well as storage batteries used in stationary configurations and this is reflected in the following discussion.

FIG. **1** is a simplified block diagram of a battery testing/charging system **100** in accordance with an embodiment of the present invention. System **100** includes a radio frequency identification (RFID) tag **102**, which can be affixed to a battery (such as **200** (FIG. **2**)). RFID tag **102** is configured to transmit stored battery information in the form of RF signals **106**. System **100** also includes a battery tester/charger **104** having an embedded/integrated radio frequency (RF) communicator **108**, which is configured to receive the transmitted battery information from RF tag **102** when battery tester/charger **104** is proximate RF tag **102**. Further, in some configurations, RF communicator **108** is configured to transmit information RF communicator **112** in RFID tag **100**. This information can be, for example, stored in information circuitry **110**. The battery information, which is automatically received by RF communicator **108**, is utilized by processor **107** and measurement and/or charge signal application circuitry **109** to test/charge the battery (such as **200** (FIG. **2**)). Thus, system **100** overcomes problems with prior art testers/chargers that, in general, require a tester/charger user to enter battery information with the help of a keypad, for example, during a testing/charging process. Of course, for battery information transfer to occur from RFID tag **102** to tester/charger **104**, tester/charger **104** should be within a perimeter defined by RF signal **106**. The perimeter is selected based upon a type of application and environment for which system **100** is required. Also, a memory size and encoding scheme for RFID tag **102** can be different for different applications. In general, system **100** allows for battery charging/testing with minimal or no user intervention, thereby substantially eliminating any inaccuracies associated with manual entry of battery information.

As can be seen in FIG. **1**, RFID tag **102** includes, as it primary components, a battery information storage circuit **110** and a RF communicator **112**. In embodiments of the present invention, battery information storage circuit **110** is configured to store certain basic information regarding the battery. This information includes battery type, battery group size, cold cranking amp (CCA) rating, battery manufacture date (which could later be used for warranty processing), battery cost, etc. In addition to utilizing RFID tag **102** to store the above-noted battery information, RFID tag **102** can also be used to store tracking information, such as a battery serial number, which is useful during the manufacture of the battery, for example. Further, RFID tag **102** could also store previous test results from factory or later tests that could aid in helping to determine battery condition. Previous test information can also be used to show a customer past and present test results. Battery information and other tracking information can be conveniently encoded and RFID tags **102** can be printed on demand using a suitable printer that includes RFID tag printer/encoder programs. In some embodiments, additional information, such as the date of sale of the battery, can be subsequently encoded into RFID tag **102**. In embodiments of the present invention, tag or label **102** includes a coating to dissipate static electricity that may corrupt information stored in the tag. As a battery (such a **200**) is often used in a harsh and constrained environment, suitable additional protective layers may be used for coating RFID tag **102**.

In some embodiments of the present invention, tag **102** also includes bar-coded battery information **114** in addition to the RFID encoded battery information. In some embodiments, the bar-coded battery information may be a copy of the RFID encoded information. In other embodiments, the bar-coded information may be different from the RFID encoded information. Of course, in such embodiments, battery tester/charger **104** includes a barcode reader **116** in addition to RF communicator **108**. Tags/labels with the barcode and RFID battery information can be printed from a single printer that includes the necessary label printer/encoder programs. It should be noted that it is possible to produce bar code tags that can contain previous test information that could be useful in providing previous test result information, which could be used in combination with RFID tags, or stand alone information. Production of bar code tags that contain battery test information is described in U.S. Pat. No. 6,051,976, entitled "METHOD AND APPARATUS FOR AUDITING A BATTERY TEST," which is incorporated herein by reference.

In addition to helping automate the battery testing/charging process, battery information stored in RFID tag **102** has other uses such as to help determine whether or not a particular battery is too "old" to be sold. It should be noted that batteries may not be suitable for sale after the expiration of a certain period (16 months, for example). The age of the battery can easily be determined by reading the battery date of manufacture from RFID tag **102**. An RFID reader that can automatically detect, identify and accept battery information from all RFID tags in its reading field is especially suitable for a retailer to rapidly identify "old" batteries. Information, such as the date of sale of the battery, included in RFID tag **102**, can be used for automating warranty claims processing which is based on the battery age, date of sale, etc. Thus, RFID tag **102** is useful for battery production, storage, monitoring and tracking.

In some embodiments of the present invention, RFID tag **102** includes security circuitry **118**, which may be coupled to RF communicator **112** and may also include a receiver (not shown in FIG. **1**) which is capable of receiving signals from an external transmitter (not shown in FIG. **1**) that transmits security signals. Details regarding such a security system are included in U.S. Ser. No. 10/823,140, filed Apr. 13, 2004, entitled "THEFT PREVENTION DEVICE FOR AUTOMOTIVE VEHICLE SERVICE CENTERS," which is incorporated herein by reference. Details regarding components of battery tester/charger **104** are provided below in connection with FIGS. **3** and **4**.

FIG. **3** is a simplified block diagram of a battery charging system **300** in accordance with an embodiment of the present invention. System **300** is shown coupled to battery **200**. System **300** includes battery charger circuitry **310** and test circuitry **312**. Battery charger circuitry **310** generally includes an alternating current (AC) source **314**, a transformer **316** and a rectifier **318**. System **300** couples to battery **200** through electrical connection **320** which couples to the positive battery contact **304** and electrical connection **322** which couples to the negative battery contact **306**. In one preferred embodiment, a four point (or Kelvin) connection technique is used in which battery charge circuitry **310** couples to battery **300** through electrical connections **320**A and **322**A while battery testing circuitry **312** couples to battery **200** through electrical connections **320**B and **322**B.

Battery testing circuitry **312** includes voltage measurement circuitry **324** and current measurement circuitry **326** which provide outputs to microprocessor **328**. Microprocessor **328** also couples to a system clock **330** and memory **332** which is used to store information and programming instructions. In the embodiment of the invention shown in FIG. **3**, microprocessor **328** also couples to RF communicator **108**, user output circuitry **334**, user input circuitry **336** and barcode scanner **116**, which may be included in some embodiments.

Voltage measurement circuitry **324** includes capacitors **338** which couple analog to digital converter **340** to battery **200** thorough electrical connections **320**B and **322**B. Any type of coupling mechanism may be used for element **338** and capacitors are merely shown as one preferred embodiment. Further, the device may also couple to DC signals. Current measurement circuitry **326** includes a shunt resistor (R) **342** and coupling capacitors **344**. Shunt resistor **342** is coupled in series with battery charging circuitry **310**. Other current measurement techniques are within the scope of the invention including Hall-Effect sensors, magnetic or inductive coupling, etc. An analog to digital converter **346** is connected across shunt resistor **342** by capacitors **344** such that the voltage provided to analog to digital converter **346** is proportional to a current I flowing through battery **200** due to charging circuitry **310**. Analog to digital converter **346** provides a digitized output representative of this current to microprocessor **328**.

During operation, AC source **314** is coupled to battery **200** through transformer **316** and rectifier **318**. Rectifier **318** provides half wave rectification such that current I has a non-zero DC value. Of course, full wave rectification or other AC sources may also be used. Analog to digital converter **346** provides a digitized output to microprocessor **328** which is representative of current I flowing through battery **200**. Similarly, analog to digital converter **324** provides a digitized output representative of the voltage across the positive and negative terminals of battery **200**. Analog to digital converters **324** and **346** are capacitively coupled to battery **200** such that they measure the AC components of the charging signal.

Microprocessor **328** determines the conductance of battery **200** based upon the digitized current and voltage information provided by analog to digital converters **346** and **324**, respectively. Microprocessor **328** calculates the conductance of battery **200** as follows:

$$\text{Conductance} = G = \frac{I}{V} \qquad \text{Eq. 1}$$

where I is the AC charging current and V is the AC charging voltage across battery **200**. Note that in one preferred embodiment the Kelvin connections allow more accurate voltage determination because these connections do not carry substantial current to cause a resultant drop in the voltage measured.

The battery conductance is used to monitor charging of battery **200**. Specifically, it has been discovered that as a battery is charged the conductance of the battery rises which can be used as feedback to the charger. This rise in conductance can be monitored in microprocessor **328** to determine when the battery has been fully charged.

In accordance with the present invention, as described above, RF communicator **108** and/or barcode scanner **116** are included to substantially eliminate the need for user entry of the necessary battery information.

FIG. **4** is a simplified block diagram of a battery testing system **400** in accordance with an embodiment of the present invention. System **400** is shown coupled to battery **200**. System **400** includes battery testing circuitry **404** and microprocessor **406**. System **400** couples to battery contacts **408** and **410** through electrical connections **412** and **414**, respectively. In one preferred embodiment, a four point (or Kelvin) connection technique is used. Here, electrical connection **412** includes a first connection **412**A and second connection **412**B and connection **414** includes a first connection **414**A and a second connection **414**B. As in the case of battery charging system **300** (FIG. **3**), battery testing system **400** also includes RF communicator **108** and barcode scanner **116** to substantially eliminate the need for user entry of the necessary battery information. Battery tester **400** utilizes received battery information to determine a condition of storage battery **200**. A description of example components which can be employed to form battery testing circuitry **404** is set forth in U.S. Pat. No. 6,323,650, issued Nov. 27, 2001, and entitled "ELECTRONIC BATTERY TESTER," which is incorporated herein by reference.

The above-described invention can be employed in either portable or "bench" (non-portable) battery charging and testing systems, and other similar applications such as starter and alternator testing systems. Although the example embodiments described above relate to wireless communication (or transfer of battery information) using RF signals, other wireless communication techniques (for example, diffused infrared signals) that are known in the industry or are developed in the future may be employed without departing from the scope and spirit of the present invention. A general embodiment of a tag (which can be associated with a storage battery) that can wirelessly transmit information to, or receive information from, a battery maintenance tool (tester, charger, etc.) is shown in FIG. **5**. Tag **502** includes information circuitry **110** similar to that described in FIG. **1** and a transceiver **504** for communicating with maintenance tool **506**, which also includes a transceiver **508**. Different embodiments of tag **502** and maintenance tool **506** can use different wireless communication techniques. Transceivers **504** and **508** can be configured to send and/or receive information. The battery maintenance tool **506** can be any tool which is used to perform maintenance on a battery. Two examples include a battery tester and a battery charger.

There are several factors that relate to the manufacture, distribution, purchase and treatment of batteries, such as automotive batteries, that impact battery life. For example, when an battery such as automotive battery is purchased, the freshness of the new battery has an impact on the life of the battery because the longer the battery remains in storage without being recharged, the more damaging sulfation there may be on the plates within the battery. Also, consistent and accurate testing and recording of battery test results is important. Thus, in some embodiments, a RFID tag is used to store information about the battery and battery test results at different stages in the life a battery. FIG. **6**A illustrates an example of such an embodiment. As can be seen in block diagram **600** of FIG. **6**A, battery **604** is assembled on assembly line **606** at manufacturing plant **602**. At the end of the assembly of battery **604**, RFID tag **608** is affixed to battery housing **610**. In one embodiment, battery housing **610** includes a recessed portion **612** within which the RFID tag **608** is affixed. This prevents damage of the RFID tag **608** during transportation and storage of the battery **604**, for example. In general, at manufacturing plant **602**, battery manufacturing information is stored into RFID tag **608**. This can include manufacturing plant and assembly line identification information. In addition to the particular assembly line, the shift during which the battery was assembled can also be stored into the RFID tag **608**. Such detailed information related to the manufacture of the battery is useful for quality control audit purposes. Battery manufacturing information stored into RFID tag **608** also includes battery parameters and other battery information such as battery type (for example, flooded (wet), gelled, AGM (Absorbed Glass Mat, etc.), battery rating (for example, cold cranking ampere (CCA) rating), battery post configuration (top post or side post), etc. This battery-specific information facilitates the formation/coding of an algorithm that is tailored to the specific battery type, battery post configuration, etc. The algorithm can be stored into the RFID tag **608** and read and utilized by a battery tester each time the battery is tested, thereby making the type of battery test carried out on the battery consistent and substantially independent of any need for data entry by a battery tester user. After the above-described manufacturing information is loaded in to RFID tag **608** at the manufacturing plant, the battery is tested. As can be seen in FIG. **6**A, in manufacturing plant **602**, battery **604** is tested using information for RFID tag **608** and a timestamp for the test along with the battery test results are written into RFID Tag **608**.

Batteries such as **604** are shipped from a manufacturing plant such as **602** to a distribution center **614**. In some embodiments, upon arrival at the distribution center **614**, the battery **602** is tested and a timestamp for the test along with the battery test results are written into the RFID tag **608**. The battery storage location in the distribution center can also be stored in the RFID tag **608**. In some embodiments, prior to shipping the battery **604** to a destination **616**, a battery test is again performed at distribution center **614**. A timestamp for the test along with the battery test results are written into the RFID Tag **606**. Upon arrival at a destination such as a dealership, backup power station, etc., as illustrated at **616** in FIG. **6**A, battery manufacturing information is read from RFID tag **608**.

Using the information read from tag **608**, a battery test is conducted on battery **604** at the automobile destination **616**. A battery test result is obtained and the battery test result and a corresponding timestamp stored into the RFID tag **608**.

In some embodiments, a battery sale activation code is programmed into RFID tag **608** at the automotive destination **616**. The battery sale activation code is stored in a database. The database also stores information that indicates that the battery is currently for sale at the automotive destination **616**. When selling battery **604** to a customer, the battery sale activation code is read from the RFID tag and utilized to update the database to reflect that the battery has been sold. In general, the sale of battery **64** is proper only if the RFID tag **608** is properly activated. This prevents situations such as a person stealing battery **604** and then returning it to claim a refund, for example. Specifically, this security feature will show that the battery/RFID tag was not properly activated at the time of sale if a return of a stolen battery is attempted.

Selling the battery **604** to the customer may also involve storing battery warranty information and a date of sale of the battery into the RFID tag **608**. One embodiment of a warranty management method is described below in connection with FIG. **6**B.

FIG. **6**B is a flowchart **650** showing steps of a warranty management method in accordance with one embodiment. At step **652**, battery warranty information is stored in an RFID tag affixed to an original battery upon sale of the original battery. Also, at step **654**, identification information for the original battery and the corresponding battery warranty information are stored in a database. At step **656**, if the original battery is returned prior to expiration of the warranty, a replacement battery with an affixed RFID tag is provided to the customer, and any unused warranty is transferred to the RFID tag affixed to the replacement battery. At step **658**, the unused warranty is cancelled from the RFID tag affixed to the original battery. Further, at step **660**, the database is updated to reflect the transference of the unused warranty from the original battery to the replacement battery.

Referring back to FIG. **6**A, after entry of battery warranty information into RFID tag **608**, battery **604** is installed in a vehicle owned by the customer. Battery **604** is tested upon installation in the vehicle. As described earlier, testing of battery **604** involves reading the battery manufacturing information from the RFID tag **608**, conducting a battery test using the battery manufacturing information, and obtaining a battery test result. The battery test result and a corresponding timestamp is stored into the RFID tag **608**. In some embodiments, test technician information is also stored into the RFID tag **608**. Details about linking vehicle information with battery manufacturing information and battery warranty information in the RFID tag is described below in connection with FIG. **7**.

FIG. **7** is a simplified block diagram showing a vehicle **700** having a battery **702** with an affixed RFID tag **704** in accordance with one embodiment. Vehicle **700** has an on-board diagnostic II (OBDII) connection **706**. OBDII connections are known in the art and are used to couple to the OBDII databus (not shown) of modern vehicles. Although, in FIG. **7**, vehicle OBDII connection **708** is shown positioned in dashboard **706**, connection **708** can be positioned in any suitable location within vehicle **700**. The OBD databus, and therefore OBDII connection **708**, can be used to retrieve information related to various parameters, such as engine parameters, of the vehicle. Additionally, the OBDII connection **708** provides a connection to the vehicle battery **702**. In general, engine parameters, vehicle battery voltage and the vehicle identification number (VIN) can be obtained from the OBDII connection **708**. Thus, any suitable connector from a device separate from, or external to, vehicle **700** can be coupled to OBDII connection **708** to obtain the VIN, engine parameters, battery voltage, etc., of vehicle **700**. The devices used to obtain the OBDII information can include an OBDII reader **710**, which can be separate from, or a part of, a computing device or battery maintenance tool **712**. The VIN, engine parameters and battery voltage can be obtained from the OBDII connection **708** and can be programmed into memory of RFID tag **704** using battery maintenance tool **712** or any other suitable device at a vehicle dealership, for example. This, stored information can be read from RFID tag **704** prior to subsequent testing and can help in diagnosing and isolating battery, alternator and/or vehicle starter problems more rapidly and accurately. As indicated above, whether the VIN is obtained via OBDII connection **708**, entered manually into a computing device capable of storing the information if RFID tag **704**, or obtained using any other suitable method, a VIN stored in RFID tag **704** is useful to tie battery warranty to a specific vehicle. As noted above, the serial number of the battery and warranty information is also stored into the RFID tag.

In some embodiments, balancing information for multiple battery packs is stored into the RFID tag(s). FIG. **8** shows multiple batteries **800-1** through **800-4**, each including a corresponding one of RFID tags **802-1** through **802-4**. Battery balancing information in the RFID tags can be used in applications for heavy trucks or stationary power supplies, for example. In such applications, information stored in the RFID tags (**802-1**, **802-2**, **802-3** and **802-4**) can include cranking capacity, time in service, miles in service, geographical location, the results of prior battery tests, the number of charged, discharged cycles a battery has undergone, a total number of battery tests performed on the battery, the age of the battery, the battery rating, etc. Specifically, information from individual RFID tags (**802-1**, **802-2**, **802-3**, **802-4**) can be obtained using RFID receiver **804** and transferred to computing device/battery maintenance tool **806** that includes a memory and a processor that executes program code, which utilizes the information obtained from the individual RFID tags to automatically sort and match appropriate batteries for fleet maintenance, for example. In FIG. **8**, RFID receiver **804** is shown as a separate component coupled to computing device/battery maintenance tool **806**. However, in some embodiments, RFID receiver **804** is a part of, or integrated with, computing device/battery maintenance tool **806**.

As indicated above, in some embodiments, a battery purchase location identifier (store identification number or any other suitable equivalent) is stored into the RFID tag affixed to the battery. Also, as indicated above, storing the date of purchase of the battery into the RFID tag starts the warranty clock.

In some embodiments, a name or other identification information for a technician who tests the storage battery is stored into the RFID tag. This allows for automatic statistical checking of technician proficiency, for example, with the help of a computing device that employs the technician-related information in the RFID tag to determine technician proficiency.

As noted above, in some embodiments, battery test related information, such as battery test results are stored in an RFID tag affixed to the battery. Additionally, in some embodiments, battery trending information (for example, results of multiple tests over time) is stored into the RFID tag affixed to the battery. In such embodiments, battery degradation can be more accurately determined than by using a simple one point snapshot test. Also, data relating to a series of test steps can be stored into the RFID tag. For example, pre-charge test results and a corresponding time stamp and post-charge test results and a corresponding time stamp can be stored. This can be read by a battery maintenance tool and can be used, for example, to determine if enough time has elapsed to allow a proper battery charge.

As noted above, test results and test related data over multiple battery tests over time can be stored in the RFID tag affixed to the battery. The enables a battery maintenance tool having a memory and a processor to carry out a method for retrieving data from a previous test from the RFID tag and comparing the retrieved data to present test data. Also, prior test data from the RFID tag is, in some embodiments, utilized by the battery maintenance tool to determine a "slope" or rate of degradation of the battery to which the RFID tag is associated. Both pre and post load test results can be stored in the RFID tag, affixed to the battery, and utilized for computations by a battery maintenance tool. The stored battery test-related information, read from the RFID tag and utilized by a battery maintenance tool for battery analysis, could be from two completely different points in time and can be accumulated each time the battery is tested.

FIG. **9** simplified block diagram showing a method for fraud prevention when RFID tags are used to store battery related information. In essence, this method involves retrieving data stored in an RFID tag (such as **902**) affixed to a battery (such as **900**) and comparing the retrieved data with independent data at a remote database (such as **908**). In FIG. **9**, RFID receiver **904** is used to retrieve data from RFID tag **902** and computing device/battery maintenance tool **906** is used to compare the retrieved data with independent data retrieved from database **908**. Database **908** can be stored in memory of a remote computer, which communicates with computing device/battery maintenance tool **906** using wired or wireless communication. Database **908** can store a copy of warranty information stored in RFID tag **902** at the time of sale of battery **900** by a dealership, for example. Thus, at a later time, when the battery **900** is brought to the dealership, the above data comparisons can be used, for example, to determine whether warranty information stored in the RFID tag **902** has been altered subsequent to purchase to improperly gain additional warranty. In general, this data comparison technique is particularly useful for the purpose of fraud prevention and/or warranty verification.

As noted above, in some embodiments, the battery manufacturing date and the data of sale of the battery or the battery in-service date (date the battery was put in service) are stored into the RFID tag associated with the battery. In one embodiment, the battery manufacturing date from the RFID tag is used, by a battery maintenance tool or other computing device, to compare with the battery in-service date for tracking battery shelf life and supply chain stock rotation problems (i.e., improper first in, first out (FIFO) inventory control).

As noted earlier, in some embodiments, manufacturing plant or assembly line information is stored into the RFID tag associated to the battery. In addition to the particular assembly line, the shift during which the battery was assembled can also be stored in the RFID tag. Such detailed information related to the manufacture of the battery is useful for quality control audit purposes. Obtaining manufacturing related information from the RFID tags and processing of this information for quality control audit purposes is carried out by a suitable computing device having an RFID receiver, a processor and a memory with necessary programmed instructions.

FIG. **10** shows another example configuration of RFID tag **902** associated with a storage battery **900**. In the configuration of FIG. **10**, battery maintenance cable **920** is permanently or semi-permanently attached to terminals **922** and **924** of battery **900**. Cable **920** is illustrated as providing Kelvin connections **926** and **928** to terminals **922** and **924**, respectively. A battery maintenance device, for example maintenance tool **506** shown in FIG. **5**, can couple to cable **920** through, for example, plugs **930** and **932**. The Kelvin connection to the device **506** is continued from plug **932** through wiring **934**, **936**. An RFID communicator **938** is coupled to the cable and is configured to read and/or write information to RFID tag **902** from battery tester **506** through data bus **940**. Although the communication device **938** is shown as separate from tester **506** and associated with the cabling, the device **938** could also be located within battery tester **506**. When the battery maintenance device **506** is coupled to cable **920**, the device will be in sufficiently close proximity to RFID tag **902** to allow communication there between. This configuration allows existing batteries to be easily retrofit with an RFID tag **902** simply by coupling a cable **920** to the battery **900**. During operation, information regarding various battery tests can be stored in the memory of RFID tag **902**. This allows battery **506** tester to retrieve stored information for use in monitoring the storage battery **900**. For example, stored test results can be recovered and used to provide trending information about the battery. This can be used, for example, to predict a failure of the battery or a time at which the battery should be replaced.

As discussed previously, the connection between the battery and battery maintenance device can be a source of errors due to inconsistencies in the connection when performing battery tests. Technicians, with varying levels of training and experience, may encounter difficulties with the set up and use of the test equipment. With the present invention, the cabling can be permanently or semi-permanently coupled to the battery thereby eliminating the connection as a source of errors in measurements. Further, the RFID tag **902** can include information related to the battery **900**. This information can be read by the tester whereby the amount of information which must be manually entered into the tester is reduced or substantially eliminated. Such information includes reference values for various parameters of the battery, nominal voltage, information from prior tests, etc. This information can be stored in the memory of the RFID tag **902** during manufacture or installation of the battery, for example. This allows the manufacturer or installer to set these values based upon a particular battery, lot of batteries, particular use of the battery, etc. For example, a battery identifier such as a unique serial number may be associated with the battery, nominal battery voltage, the amp per hour rating of the battery, a conductance reference of the battery, the manufacturing date of the battery, the installation date of the battery, etc.

Additionally, information can be written into the memory of the RFID tag **902** following manufacture. This includes the installation date, as well as information about subsequent measurements. For example a time or date stamp can be stored, measured voltage, measured temperature, measured conductance, identification of the technician performing the test, etc. A temperature measurement can be obtained by using a temperature sensor contained within the battery tester **506**, or, for example in a temperature sensor **950** associated directly with a specific battery **900**. In one example configuration, the memory contains 80 registers for storing this information. Additional memory can be added simply by adding an additional RFID tag. The RFID tag **902** can be activated when it is in close proximity to the RFID tag reader/writer **938**. For example, an inductive connection can occur between the components. As discussed previously, the battery tester **506** can collect previous test measurements or other information from the memory and use this information for developing trends in the battery operation. This can be used to identify a battery which is rapidly failing, or predict an ultimate end of life of the battery, or use by a manufacturer to improve the manufacturing process. For example, input/output circuitry **952** which can be used to read back information from tester **506**. This can be, for example, USB connection whereby a PC or other device can be used to recover information read back from the RFID tag **902**. A manufacturer can use this information to determine how a particular battery is being used, identify failing batteries, improve the manufacturing process, etc. As a more specific example, any alarms or anomalies which are noted can be used to trigger an alert or e-mail which is transmitted.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. It should be noted that the barcode(s) (used in some embodiments of the tag) and the corresponding barcode scanner (used in some embodiments of the tester/charger) are optional and therefore the invention can operate only with the RFID encoded battery information in the tag and a corresponding RF receiver in the tester/charger. It should be noted that the above invention is suitable for use in battery testers, chargers or a combined battery tester and charger. Although the above description has been directed to battery maintenance devices such as battery testers and battery chargers, the present invention is applicable to any type of battery test device. Further, the RFID tags can be associated with a particular battery using any appropriate technique. The invention is not limited to the above examples of mounting the RFID tag to the battery or affixing a test cable to the battery. In one configuration, additional memory is provided by associating more than one RFID tag. For example, if an RFID tag is low on memory for storage of information, an additional RFID tag may be associated with the battery. Both tags can be used by the battery maintenance device and communicated therewith. For example, the RFID tags may include different addresses so that they may be communicated with individually. The RFID tags are configured to store battery information. Examples of battery information include information related to the rating of the battery, the result(s) of prior battery tests, temperature information, environment information, geographic information, information related to manufacturing such as manufacturing date or location, warranty information, information related to the person who performed the battery test or installed the battery, information related to anomalies regarding the battery, etc. In one configuration, the RFID tag may include information related to more than one battery. In another example configuration, the RFID tag may be configured to store notes or other information which is inputted by an operator. This information can be retrieved by an operator during a subsequent examination of the battery. For example, the information may indicate that an operator noted a manufacturing defect or observed a failure or impending failure in the external casing of the battery, notations regarding the location of the battery or condition of the site, etc. In one aspect, the RFID tag includes information such as an address which uniquely or semi-uniquely identifies the battery to which it is associated. Additionally, by storing parameters in the RFID tag, this reduces or eliminates errors that may occur when an operator inputs these parameters a battery maintenance device. The configuration also improves the efficiency of the testing because an operator can quickly plug the tester into the Kelvin connection of the battery. Further, because the operator does not need to input test parameters, this step is also eliminated from the testing.

What is claimed is:

1. A method comprising:

associating a radio frequency identification (RFID) tag with a storage battery;

storing battery information into the RFID tag;

wirelessly reading the battery information from the RFID tag;

testing the battery with an external electronic battery tester using the battery information by measuring a response of the storage battery to an applied signal and responsively obtaining a battery test result; and

wirelessly storing the battery test result into the RFID tag using an RF communicator in the electronic battery tester, including a plurality of battery test results obtained over time carried out on the battery as a basis for subsequent testing of the battery.

2. The method of claim **1** including the step of identifying trends in the battery test results based upon the battery information retrieved from the RFID tag.

3. The method of claim **1** wherein the testing is performed at a manufacturing plant.

4. The method of claim **1** wherein the testing is performed at a stationary location of the battery during normal operation of the battery.

5. The method of claim **1** and further comprising storing test technician information into the RFID tag.

6. The method of claim **1** and further comprising:

obtaining information related to the vehicle in which the battery is installed; and

storing the information related to the vehicle in the RFID tag.

7. The method of claim **1** wherein the battery information comprises battery temperature information.

8. The method of claim **1** including storing timestamp information in the RFID tag.

9. The method of claim **1** including identifying trends in battery test results.

10. The method of claim **1** wherein associating comprises attaching the RFID tag to the storage battery.

11. The method of claim **1** wherein associating comprises of attaching a cable which includes the RFID tag to the battery.

12. The method of claim **1** including adding an additional RFID tag to provide additional memory.

13. The method of claim **1** wherein the battery information comprises battery rating.

14. An apparatus comprising:

a radio frequency identification (RFID) configured to be associated with a storage battery, the RFID tag is configured to store and wirelessly transmit information related to the battery;

an external electronic battery tester configured to perform a battery test on the storage battery by measuring a response of the storage battery to an applied signal and responsively obtaining a battery test result, the electronic battery tester including:

a computing device comprising:

a computing device memory;

a processor; and

a receiver, which operates under the control of the processor, configured to receive the transmitted information related to the battery,

wherein the RFID tag is configured to store information received wirelessly, related to a plurality of battery test results obtained over time carried out on the battery, and as a basis for subsequent testing of the battery.

15. The apparatus of claim **14** and wherein the RFID tag is further configured to store information related to a vehicle in which the battery is used.

16. The apparatus of claim **14** and wherein the computing device comprises a battery tester.

17. The method of claim **16** including performing a battery test using the cable.

18. The apparatus of claim **16** and wherein the battery tester is configured to program test technician information into the RFID tag.

19. The apparatus of claim **16** and wherein the battery tester is configured to identify degradation of the storage battery based on the stored information related to the plurality of battery tests.

20. The apparatus of claim **14** and wherein the battery tester is further configured to determine a slope of degradation of the battery.

21. The apparatus of claim **14** including a cable configured to be affixed to the battery, the cable for use in performing a battery test on the battery.

22. The apparatus of claim **21** wherein the RFID tag is coupled to the cable.

23. The apparatus of claim **21** wherein the cable provides a Kelvin connection to the battery.

24. The apparatus of claim **21** including a temperature sensor configured to sense a temperature of the battery and wherein the RFID tag is configured to store battery temperature information.

25. The apparatus of claim **14** including a label affixed to the battery and wherein the RFID tag in included in the label.

26. The apparatus of claim **14** including an additional RFID tag to provide additional storage memory.

27. An apparatus comprising:

a radio frequency identification (RFID) tag configured to be associated with a storage battery, the RFID tag configured to store battery information related to a plurality of battery tests obtained over time carried out on the battery, to transmit the stored battery information wirelessly to a battery tester, to wirelessly receive battery test results based on battery tests performed in response to the stored and transmitted battery information, and to store the wirelessly received test results; and an external electronic battery tester configured to perform a battery test on the storage battery by measuring a response of the storage battery to an applied signal and responsively obtaining a battery test result comprising:

a computing device memory;

a processor; and

an RF communicator, which operates under the control of the processor, configured to receive the transmitted stored battery information, and to transmit battery test results to the RFID tag.

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