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(54) **BATTERY MONITORING SYSTEM**

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G01R 19/165 (2006.01)
G01R 31/36 (2019.01)
G01R 31/3835 (2019.01)

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CPC ... ***G01R 19/16542*** (2013.01); ***G01R 31/3648*** (2013.01); ***G01R 31/3835*** (2019.01)

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CPC G01R 31/3606; G01R 19/16542; G01R 31/3658; G01R 31/025; G01R 31/362; G01R 31/3624
See application file for complete search history.

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(57) **ABSTRACT**

Provided is a battery monitoring system that has a high level of safety even under a state in which characteristics of a reference voltage circuit are deteriorated. The battery monitoring system has a configuration in which: a reference voltage of a first battery monitoring IC is monitored by a second battery monitoring IC; and the second battery monitoring IC outputs, when detecting that the reference voltage reaches a value falling outside a predetermined range, a signal indicating an abnormality of the reference voltage to the first battery monitoring IC, and the first battery monitoring IC stops monitoring of a battery when the signal indicating the abnormality of the reference voltage is input to the first battery monitoring IC.

4 Claims, 3 Drawing Sheets

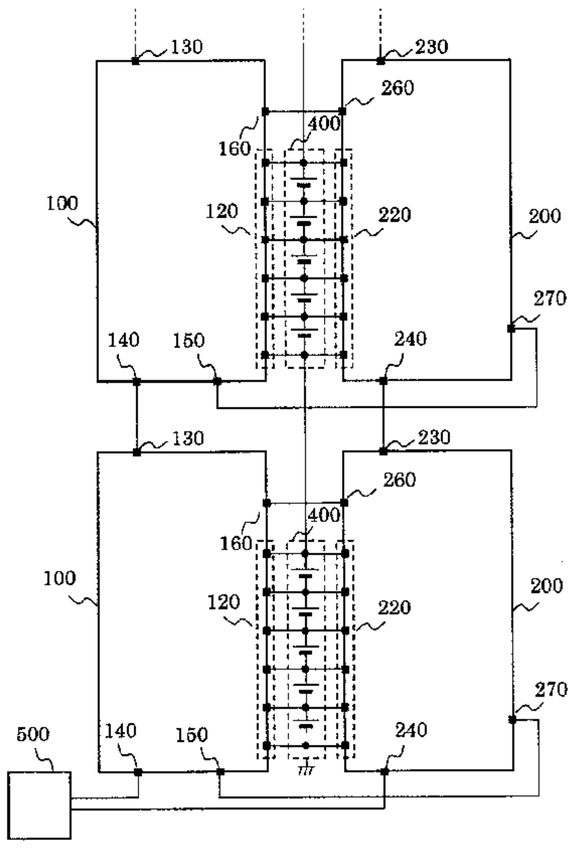

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FIG. 1

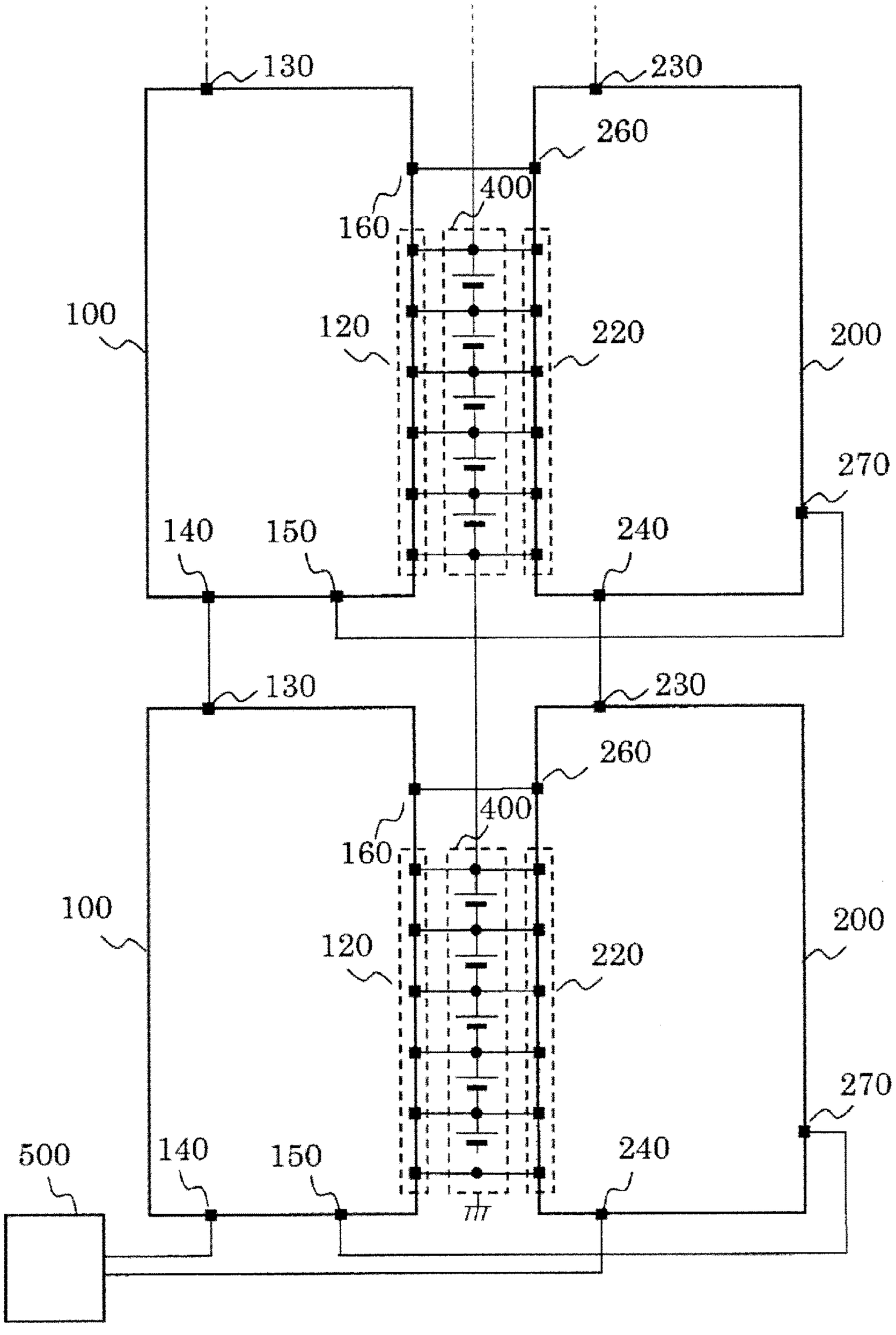

130
230
260
400
160
100
120
220
200
270
140
150
240
130
230
260
400
160
100
120
220
200
270
500
140
150
240

FIG. 2

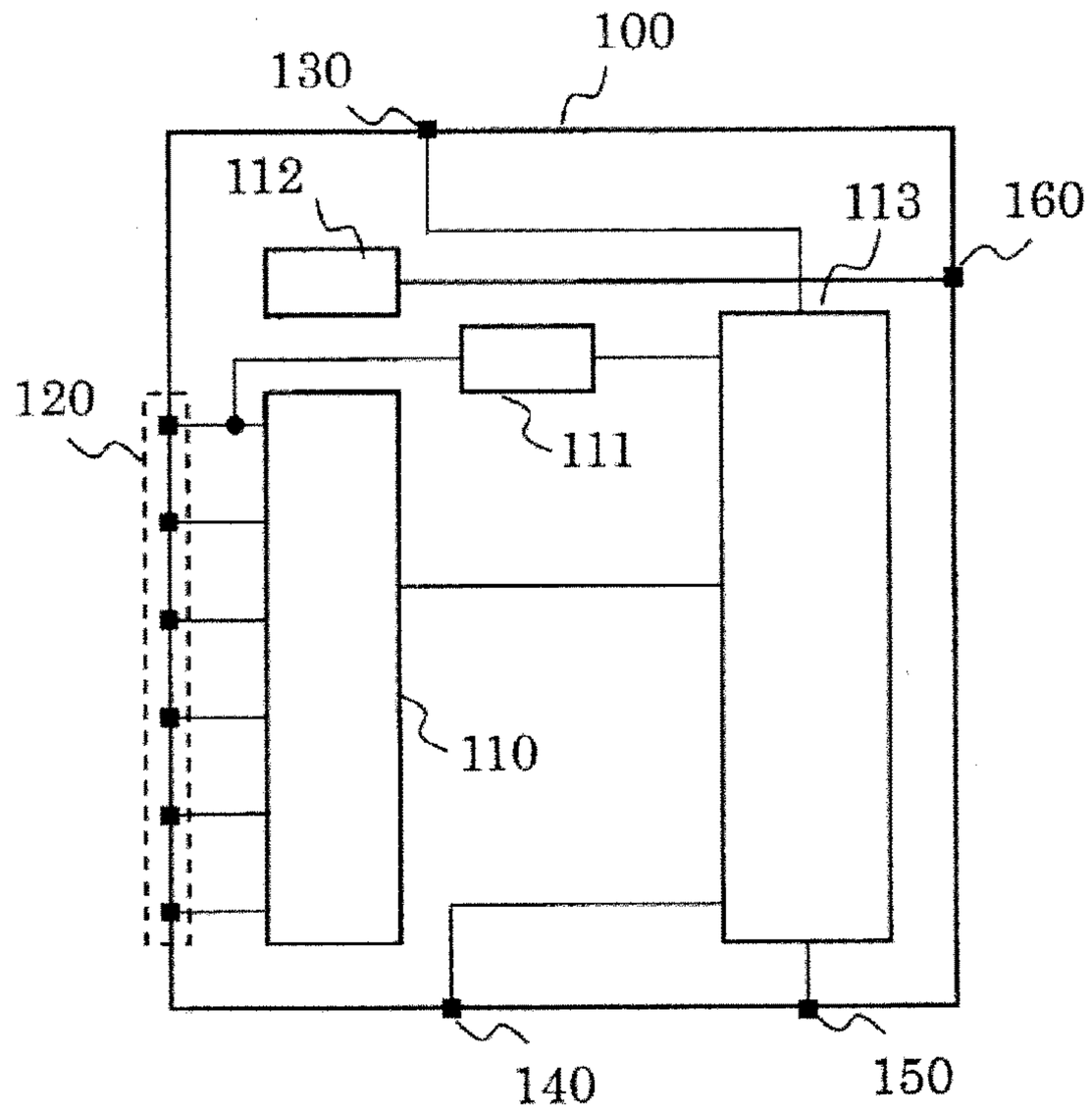

100
130
112
113
160
120
111
110
140
150

FIG. 3

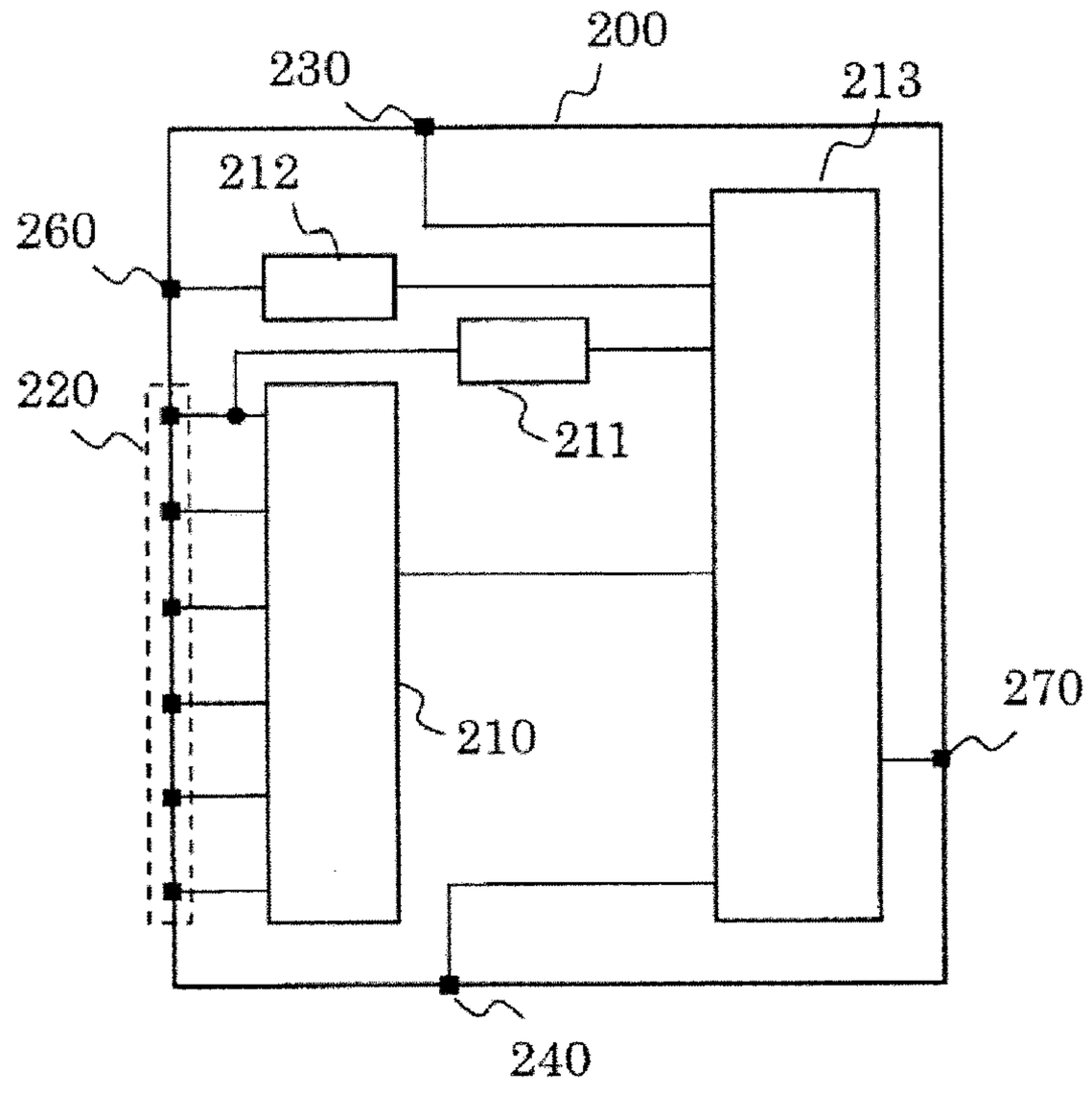
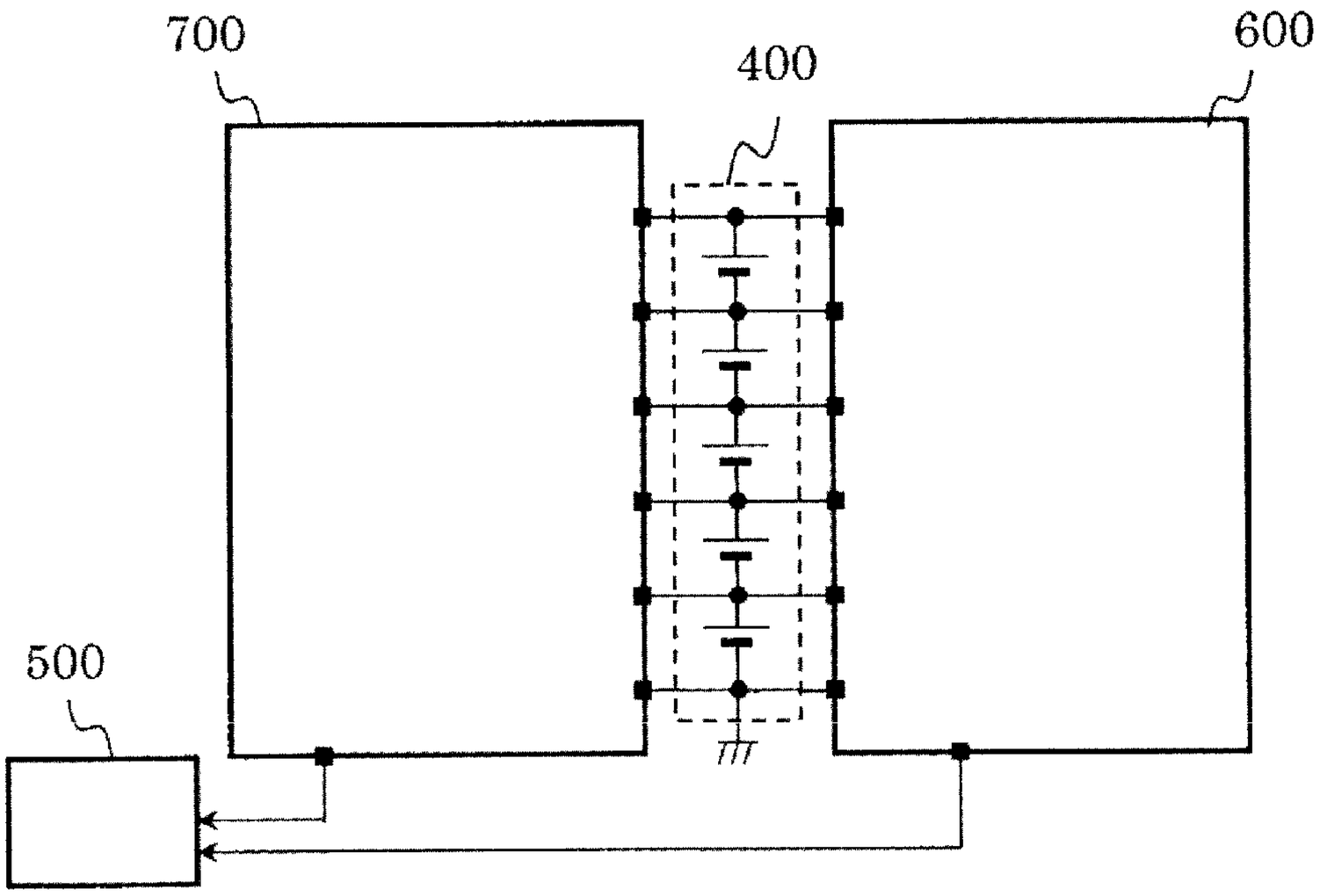

200
230
213
212
260
220
211
210
270
240

FIG. 4
PRIOR ART



BATTERY MONITORING SYSTEM

RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2015-134785 filed on Jul. 3, 2015, the entire content of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a battery monitoring system configured to monitor a voltage of a battery.

FIG. **4** is a configuration diagram of a related-art battery monitoring system. The related-art battery monitoring system includes a combination of a primary battery monitoring IC **700** and a secondary battery monitoring IC **600**. The primary battery monitoring IC **700** is configured to monitor a voltage, a charge/discharge current, an ambient temperature, and the like of a battery block **400**, to thereby detect an abnormality, e.g., an overvoltage state of the battery block **400**. The secondary battery monitoring IC **600** has the almost same function as the primary battery monitoring IC **700**, and is thus similarly configured to monitor the battery. The related-art battery monitoring system is configured to output detection signals to a host controller **500** from those battery monitoring ICs. The primary battery monitoring IC **700** and the secondary battery monitoring IC **600** each include a reference voltage circuit, and are configured to monitor a voltage and the like of the battery block **400** based on respective reference voltages.

2. Description of the Related Art

When the primary battery monitoring IC **700** cannot normally operate anymore due to troubles and other causes, the secondary battery monitoring IC **600** continues the monitoring operation, thereby enabling the safety of the battery monitoring system to be maintained.

However, there is a problem in that, even when the primary battery monitoring IC **700** or the secondary battery monitoring IC **600** is damaged during its operation, and then the characteristics of the reference voltage circuit are deteriorated, monitoring of the battery may be continued based on a deteriorated reference voltage.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above-mentioned problem, and has an object to provide a battery monitoring system with improved safety.

In order to solve the related-art problem, a battery monitoring system according to one embodiment of the present invention has the following configuration. The battery monitoring system includes: a first battery monitoring IC; and a second battery monitoring IC, the second battery monitoring IC being configured to: monitor a reference voltage of the first battery monitoring IC; and output, when the second battery monitoring IC detects that the reference voltage reaches a value falling outside a predetermined range, a signal indicating an abnormality of the reference voltage to the first battery monitoring IC, the first battery monitoring IC being configured to stop monitoring of the battery when the first battery monitoring IC inputs the signal indicating the abnormality of the reference voltage from the second battery monitoring IC.

The battery monitoring system according to the present invention is configured to detect an abnormality of the reference voltage, and hence the safety of the battery monitoring system can be further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a configuration diagram of a battery monitoring system according to an embodiment of the present invention.

FIG. **2** is a block diagram of a first battery monitoring IC according to this embodiment.

FIG. **3** is a block diagram of a second battery monitoring IC according to this embodiment.

FIG. **4** is a configuration diagram of a related-art battery monitoring system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, a battery monitoring system according to an embodiment of the present invention is described with reference to the drawings.

FIG. **1** is a configuration diagram of the battery monitoring system of this embodiment.

The battery monitoring system of this embodiment includes first battery monitoring ICs **100**, second battery monitoring ICs **200**, and battery blocks **400**. The battery monitoring system of this embodiment is configured to monitor the battery blocks **400** with the vertically stacked first battery monitoring ICs **100** and the vertically stacked second battery monitoring ICs **200**, and output detection signals from the respective ICs located in the lowest stage to a host controller **500**.

FIG. **2** is a block diagram of the first battery monitoring IC according to this embodiment.

The first battery monitoring IC **100** includes a battery voltage monitoring circuit **110**, a battery block voltage monitoring circuit **111**, a reference voltage circuit **112**, a logic circuit **113**, a battery voltage monitoring terminal **120**, an input terminal **130**, an output terminal **140**, an input terminal **150**, and a reference voltage output terminal **160**.

FIG. **3** is a block diagram of the second battery monitoring IC according to this embodiment.

The second battery monitoring IC **200** includes a battery voltage monitoring circuit **210**, a battery block voltage monitoring circuit **211**, an external reference voltage monitoring circuit **212**, a logic circuit **213**, a battery voltage monitoring terminal **220**, an input terminal **230**, an output terminal **240**, a reference voltage input terminal **260**, and an output terminal **270**. Further, the second battery monitoring IC **200** also includes a reference voltage circuit (not shown).

The battery voltage monitoring terminals **120** and **220** are connected to the battery block **400**. The input terminal **130** of the first battery monitoring IC **100** is connected to the output terminal **140** of the first battery monitoring IC **100** located upstream thereof. The output terminal **140** of the first battery monitoring IC **100** is connected to the input terminal **130** of the first battery monitoring IC **100** located downstream thereof or the host controller **500**. The input terminal **150** of the first battery monitoring IC **100** is connected to the output terminal **270** of the second battery monitoring IC **200**. The reference voltage output terminal **160** of the first battery monitoring IC **100** is connected to the reference voltage input terminal **260** of the second battery monitoring IC **200**. The input terminal **230** of the second battery monitoring IC **200** is connected to the output terminal **240** of the second battery monitoring IC **200** located upstream thereof. The

output terminal **240** of the second battery monitoring IC **200** is connected to the input terminal **230** of the second battery monitoring IC **200** located downstream thereof or the host controller **500**.

Internal connections of the first battery monitoring IC **100** are described.

The reference voltage circuit **112** configured to generate a reference voltage to be used in internal circuits is connected to the reference voltage output terminal **160**. The battery voltage monitoring circuit **110** and the battery block voltage monitoring circuit **111** are connected to the battery voltage monitoring terminal **120**, and have output terminals connected to the logic circuit **113**. The logic circuit **113** is connected to the input terminal **130**, the output terminal **140**, and the input terminal **150**.

Internal connections of the second battery monitoring IC **200** are described.

The battery voltage monitoring circuit **210** and the battery block voltage monitoring circuit **211** are connected to the battery voltage monitoring terminal **220**, and have output terminals connected to the logic circuit **213**. The external reference voltage monitoring circuit **212** is connected to the reference voltage input terminal **260**, and has an output terminal connected to the logic circuit **213**. The logic circuit **213** is connected to the input terminal **230**, the output terminal **240**, and the output terminal **270**.

The external reference voltage monitoring circuit **212** of the second battery monitoring IC **200** is configured to monitor the reference voltage of the first battery monitoring IC **100**. The battery voltage monitoring circuits **110** and **210** are configured to monitor voltages of respective batteries of the battery block **400**. The battery block voltage monitoring circuits **111** and **211** are configured to monitor a total voltage of the battery block **400**. The logic circuit **113** of the first battery monitoring IC **100** is configured to output a signal indicating an abnormality to the output terminal **140** when receiving a signal indicating an abnormality, e.g., overvoltage, from the battery voltage monitoring circuit **110**, the battery block voltage monitoring circuit **111**, or the input terminal **130**. In addition, the logic circuit **113** is configured to stop monitoring of a voltage of the battery block **400** and continuously output a signal indicating normal to the output terminal **140** when the logic circuit **113** receives a signal indicating an abnormality of an external reference voltage from the input terminal **150**, for example. The logic circuit **213** of the second battery monitoring IC **200** is configured to output a signal indicating an abnormality to the output terminal **240** when receiving a signal indicating an abnormality, e.g., overvoltage, from the battery voltage monitoring circuit **210**, the battery block voltage monitoring circuit **211**, or the input terminal **230**. In addition, the logic circuit **213** is configured to output a signal indicating an abnormality to the output terminal **270** when receiving a signal indicating an abnormality of an external reference voltage from the external reference voltage monitoring circuit **212**.

Next, operation of the battery monitoring system of this embodiment is described.

The first battery monitoring IC **100** monitors, with reference to a reference voltage of the reference voltage circuit **112**, a voltage of each battery of the battery block **400** connected to the battery voltage monitoring terminal **120**. Then, when detecting an abnormality, e.g., overvoltage in any of the batteries included in the battery block **400**, the first battery monitoring IC **100** outputs a detection signal indicating an abnormality to the output terminal **140**. For example, when the first battery monitoring IC **100** that has detected an abnormality is connected in a second stage, a detection signal output to the output terminal **140** is input to the input terminal **130** of the first battery monitoring IC **100** connected in the subsequent stage. The first battery monitoring IC **100** that has received the detection signal at the input terminal **130** similarly outputs a detection signal to the output terminal **140**. Thus, a detection signal eventually reaches the first battery monitoring IC **100** connected in the lowest stage regardless of which battery block **400** of the plurality of battery blocks **400**, which are connected in series, a battery abnormality is detected in. Then, the battery monitoring system outputs the detection signal to the host controller **500**.

Basic operation of the second battery monitoring IC **200** is similar to that of the first battery monitoring IC **100**. Specifically, the second battery monitoring IC **200** monitors a voltage of each battery of the battery block **400**, and outputs a detection signal to the host controller **500** when detecting an abnormality. Thus, even if the detection function of the first battery monitoring IC **100** is lost, the detection function for the battery monitoring system can be maintained by the second battery monitoring IC **200**.

Now, a description is given of a case in which the first battery monitoring IC **100** normally functions and the reference voltage characteristics of the reference voltage circuit **112** are deteriorated.

In this state, the detection function of the first battery monitoring IC **100** is not lost, and hence the first battery monitoring IC **100** monitors a voltage of the battery block **400** based on an abnormal reference voltage. At this time, the external reference voltage monitoring circuit **212** of the second battery monitoring IC **200** detects the deterioration in reference voltage of the reference voltage circuit **112** of the first battery monitoring IC **100**. Then, the second battery monitoring IC **200** outputs a signal indicating an abnormality to the output terminal **270** when the reference voltage of the reference voltage circuit **112** reaches a value falling outside a predetermined range. For example, the second battery monitoring IC **200** that has detected an abnormality of the reference voltage is connected in the second stage, a signal output to the output terminal **270** is input to the input terminal **150** of the first battery monitoring IC **100** connected in the second stage.

When the logic circuit **113** of the first battery monitoring IC **100** receives, at the input terminal **150**, the signal indicating the abnormality output to the output terminal **270** of the second battery monitoring IC **200**, for example, the logic circuit **113** stops monitoring of the voltage of the battery block **400** and continuously outputs a signal indicating normal to the output terminal **140**. The first battery monitoring IC **100** operates in this way so as not to monitor a voltage of the battery block **400** based on an abnormal reference voltage. In short, the battery monitoring system does not perform erroneous detection.

As described above, according to the battery monitoring system of the present invention, the battery monitoring system does not perform erroneous detection even under a state in which the first battery monitoring IC **100** normally functions and in which the reference voltage characteristics are deteriorated. Thus, the safety of the battery monitoring system can be further improved.

The first battery monitoring IC **100** is configured to stop monitoring of a voltage of the battery block **400** when receiving a signal indicating an abnormality at the input terminal **150**, and a detection signal of the input terminal **130** may be output to the output terminal **140**.

Further, in this embodiment, although the second battery monitoring IC **200** is configured to monitor the reference

voltage of the first battery monitoring IC **100**, the first battery monitoring IC **100** may be configured to monitor the reference voltage of the second battery monitoring IC **200**, or the first and second battery monitoring ICs **100** and **200** may be configured to mutually monitor the respective reference voltages. The first and second battery monitoring ICs **100** and **200** that are configured to mutually monitor the respective reference voltages may further be configured to output, when abnormalities are detected in both the reference voltages, abnormality detection signals to the host controller **500**. With this, the safety of the battery monitoring system can be improved.

What is claimed is:

1. A battery monitoring system, comprising:

a battery;

a first battery monitoring circuit having a battery voltage monitoring terminal electrically connected to the battery; and

a second battery monitoring circuit having a battery voltage monitoring terminal electrically connected to the battery and electrically interconnected with the first battery monitoring circuit,

the second battery monitoring circuit configured to:

monitor a reference voltage of the first battery monitoring circuit; and

output a signal indicating an abnormality of the reference voltage to the first battery monitoring circuit when the second battery monitoring circuit detects that the reference voltage has a value outside a predetermined range,

wherein the first battery monitoring circuit is configured to stop monitoring the battery after the first battery monitoring circuit receives the signal indicating the abnormality of the reference voltage from the second battery monitoring circuit.

2. The battery monitoring system according to claim **1**, wherein the first battery monitoring circuit includes a reference voltage output terminal for outputting the reference voltage, and an input terminal for receiving the signal indicating the abnormality of the reference voltage, and

wherein the second battery monitoring circuit includes an external reference voltage input terminal for receiving the reference voltage, an external reference voltage monitoring circuit configured to detect the abnormality of the reference voltage, and an output terminal for outputting the signal indicating the abnormality of the reference voltage.

3. The battery monitoring system according to claim **1**, wherein the first battery monitoring circuit is configured to:

monitor a reference voltage of the second battery monitoring circuit; and

output a signal indicating an abnormality of the reference voltage to the second battery monitoring circuit when the first battery monitoring circuit detects that the reference voltage has a value outside a predetermined range, and

wherein the second battery monitoring circuit is configured to stop monitoring the battery when the second battery monitoring circuit receives the signal indicating the abnormality of the reference voltage from the first battery monitoring circuit.

4. The battery monitoring system according to claim **3**, wherein the first battery monitoring circuit includes:

a reference voltage output terminal that outputs the reference voltage;

an input terminal that receives a signal indicating the abnormality of the reference voltage of the first battery monitoring circuit;

an external reference voltage input terminal that receives the reference voltage of the second battery monitoring circuit;

an external reference voltage monitoring circuit configured to detect the abnormality of the reference voltage of the second battery monitoring circuit; and

an output terminal that outputs a signal indicating the abnormality of the reference voltage of the second battery monitoring circuit, and

wherein the second battery monitoring circuit includes:

a reference voltage output terminal that outputs the reference voltage;

an input terminal that receives a signal indicating the abnormality of the reference voltage of the second battery monitoring circuit;

an external reference voltage input terminal that receives the reference voltage of the first battery monitoring circuit;

an external reference voltage monitoring circuit configured to detect the abnormality of the reference voltage of the first battery monitoring circuit; and

an output terminal that outputs a signal indicating the abnormality of the reference voltage of the first battery monitoring circuit.

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