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Vehicular power supply system

Abstract

A vehicular power supply system includes a sensor unit that detects a battery state of a storage battery and a control unit that performs instruction to perform energization and interruption thereof between the storage battery and the electrical load based on the battery state. The sensor unit includes a detection unit that detects the battery state of the storage battery, a switch drive unit that performs drive control of a switch unit provided between the storage battery and the electrical load, and a control unit that controls the switch drive unit. The control unit switches between the energization and interruption thereof between the storage battery and the electrical load. If determining an abnormality, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state and switches between the energization and interruption thereof based on the determination.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION
(1) The present application is based on and claims the benefit of priority from earlier Japanese Patent Application No. 2021-136438 filed on Aug. 24, 2021, the description of which is incorporated herein by reference.
BACKGROUND
Technical Field
(2) The present disclosure relates to a vehicular power supply system.
Related Art
(3) Power supply systems have been known which include a sensor unit that detects a state (voltage, current, ground fault, and the like) of a storage battery, and an ECU that receives a detection result from the sensor unit and controls, based on the received detection result, on/off operation of a relay switch that switches between energization and interruption of energization between the storage battery and an electrical load (including a generator such as a rotary electric machine).
SUMMARY
(4) According to an aspect of the present disclosure, a vehicular power supply system is provided which includes a sensor unit that detects a battery state of a storage battery that is capable of supplying electrical power to an electrical load, and a control unit that receives the battery state from the sensor unit via a communication path and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state.
(5) The sensor unit includes: a detection unit that detects the battery state of the storage battery; a switch drive unit that performs drive control of a switch unit provided between the storage battery and the electrical load; and a control unit that controls the switch drive unit. The control unit controls the switch drive unit based on the instruction from the control unit to switch between the energization and interruption of the energization between the storage battery and the electrical load.
(6) If determining an abnormality in the control unit or the communication path, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state detected by the detection unit and controls the switch drive unit based on the determination to switch between the energization and interruption of the energization between the storage battery and the electrical load.
(7) The detection unit includes a first current detection unit that detects a first current value at a first point on an electrical path between the storage battery and the electrical load and a second current detection unit that detects a second current value at a second point different from the first point on the electrical path.
(8) If the first current value is a first threshold value or greater and the second current value is a second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.
(9) If the number of times the first current value is the first threshold value or more is a predetermined first number of times or more and if the number of times the second current value is the second threshold value or more is a second number of times, which is different from the first number of times, or more, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) In the accompanying drawings:
(2) FIG. **1** is a diagram illustrating a configuration of a vehicular power supply system;
(3) FIG. **2** is a diagram illustrating configurations of a control unit and a sensor unit;
(4) FIG. **3** is a flowchart of a switch control process;
(5) FIG. **4** is a diagram illustrating configurations of a control unit and a sensor unit according to a second embodiment;
(6) FIG. **5** is a flowchart of a switch drive process;
(7) FIG. **6** is a diagram illustrating configurations of a control unit and a sensor unit according to a third embodiment;
(8) FIG. **7** is a flowchart of a switch drive instruction process;
(9) FIG. **8** is a diagram illustrating a configuration of a sensor unit according to a fourth embodiment;
(10) FIG. **9** is a timing chart illustrating input-output timings of signals according to the fourth embodiment;
(11) FIG. **10** is a timing chart illustrating input-output timings of signals according to a modification of the fourth embodiment;
(12) FIG. **11** is a diagram illustrating a configuration of a sensor unit according to a fifth embodiment;
(13) FIG. **12** is a diagram illustrating a configuration of a sensor unit according to a modification of the fifth embodiment; and
(14) FIG. **13** is a diagram illustrating a configuration of a vehicular power supply system according to a sixth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(15) Power supply systems have been known which include a sensor unit that detects a state (voltage, current, ground fault, and the like) of a storage battery, and an ECU that receives a detection result from the sensor unit and controls, based on the received detection result, on/off operation of a relay switch that switches between energization and interruption of energization between the storage battery and an electrical load (including a generator such as a rotary electric machine) (e.g., JP 2021-16247 A).
(16) Incidentally, in a case of a power supply system disclosed in JP 2021-16247 A, if communication between the sensor unit and the ECU breaks down, in order to prevent overdischarge and overcharge of the storage battery, the relay switch is typically turned off to interrupt energization between the storage battery and the electrical load, thereby ensuring safety.
(17) However, as in an electrical vehicle, when a rotary electric machine is used as a traction unit, a problem is caused that if power supply from the storage battery is stopped, the electrical vehicle immediately stops.
(18) In view of the above problem, the present disclosure has an object of providing a vehicular power supply system that can supply electrical power from a storage battery for a certain time even when communication is broken.
(19) Hereinafter, embodiments in which a vehicular power supply system is applied to a vehicle (e.g., an electrical vehicle) will be described with reference to the drawings. It is noted that, in the following embodiments, the same or equivalent portions are given the same reference numerals in the drawings, and descriptions of the portions given the same reference numerals are incorporated by reference.

First Embodiment

(20) As illustrated in FIG. **1**, a vehicular power supply system **100** includes an assembled battery **10**, sensor units **20** that detect a battery state of the assembled battery **10**, and a control unit **30** that is connected to the sensor units **20** and acquires the battery state from the sensor units **20** to

perform various types of control based on the battery state.

(21) The assembled battery **10** has a voltage across terminals of, for example, 100V or higher and is configured by connecting a plurality of battery modules **11** in series. Each of the battery modules **11** is configured by connecting a plurality of battery cells **12** in series. As the battery cell **12**, for example, a lithium-ion storage cell or a nickel-hydrogen storage cell may be used. In the present embodiment, the battery module **11** corresponds to a storage battery.

(22) The assembled battery **10** is connected to an electrical load **13** via an electrical path and supplies electrical power to the electrical load **13**. It is noted that the electrical load **13** includes a rotary electric machine. The assembled battery **10** supplies electrical power for driving the rotary electric machine. In addition, the assembled battery **10** may be charged by the rotary electric machine.

(23) Electrical paths L**1**, L**2** connecting the assembled battery **10** and the electrical load **13** are provided with a system main relay SMR. In addition, the electrical load **13** is connected with a capacitor C**1** in parallel.

(24) The sensor units **20** are provided to the respective battery modules **11** and detect (monitor) battery states of the respective battery modules **11**. The battery states may include voltage, current, SOC, SOH, internal impedance, battery temperature, and the like. In the description of the present embodiment, voltage and current are detected as the battery states of the battery modules **11**. It is noted that the sensor units **20** may be provided not to the respective battery modules **11** but to respective groups of a plurality of battery cells **12**. Alternatively, the sensor units **20** may be provided to the respective battery cells **12** or the respective assembled batteries **10**. In addition, the sensor unit **20** may detect a battery state of each of the battery cells **12** or a battery state of the assembled battery **10**.

(25) Based on FIG. **2**, the sensor unit **20** will be described in detail. The sensor unit **20** includes a current detection unit **21** that detects a current of the battery module **11**, which is a detection target, and a voltage detection unit **22** that detects a voltage of the battery module **11**, which is a detection target. In addition, on an electrical path connecting the battery module **11**, which is a detection target, and the electrical load **13** (or on an electrical path connecting the battery modules **11** in series), a switch **23***a* is provided which is a switch unit that switches between energization and interruption of energization between the battery module **11**, which is a detection target, and the electrical load **13**. The sensor unit **20** includes a switch drive unit **23** that performs on/off-control of the switch **23***a*. The switch **23***a* is, for example, a relay switch. The switch **23***a* may be implemented by a pyro fuse.

(26) In addition, the sensor unit **20** includes a control unit **24** that performs various types of control. The control unit **24** is configured by, for example, a microcomputer including a CPU, a memory, and the like. The control unit **24** is connected to the current detection unit **21**, the voltage detection unit **22**, and the switch drive unit **23**. In addition, the control unit **24** is connected with an MCU **31** of the control unit **30** via a communication path L**38**, communication IFs **25**, **35**, and insulated elements **26**, **36**, and receives instructions from the control unit **30** and performs various processes based on the instructions. For example, if being instructed to detect battery states of the battery module **11**, which is a detection target, by the control unit **30**, the control unit **24** receives battery states (current and voltage) from the current detection unit **21** and the voltage detection unit **22** and outputs the received battery states to the control unit **30**.

(27) In addition, if being instructed to interrupt energization of the battery module **11**, which is a detection target, by the control unit **30**, the control unit **24** instructs the switch drive unit **23** to interrupt energization with the switch **23***a*. If receiving the instruction to interrupt energization from the control unit **24**, the switch drive unit **23** turns off the switch **23***a* to interrupt energization of the battery module **11**.

(28) Next, the control unit **30** will be described. The control unit **30** includes an MCU (Micro Controller Unit) **31**. The MCU **31** is a type of microcomputer including a CPU, a memory, and the

like. The MCU **31** receives a request (accelerator position or the like) from the vehicle and performs an instruction to supply electrical power from the assembled battery **10** to the electrical load **13** based on the request from the vehicle and the battery states. Specifically, the MCU **31** performs on-control of the system main relay SMR. In addition, when the electrical load **13** includes a rotary electric machine and the like, the MCU **31** may perform on-control of the system main relay SMR and control charging the assembled battery **10**.

(29) In addition, if any abnormality has occurred in the assembled battery **10** or the like, the MCU **31** interrupts energization from the assembled battery **10** to the electrical load **13**. Specifically, the MCU **31** performs off-control of the system main relay SMR and performs an instruction to perform off-control of the switch **23***a*.

(30) In addition, the control unit **30** is connected with an auxiliary power supply **32**. Electrical power supplied from the auxiliary power supply **32** is supplied to a power supply generation unit **33** provided in the control unit **30**. The power supply generation unit **33** converts the electrical power supplied from the auxiliary power supply **32** to drive electrical power for the control unit **30** and supplies the drive electrical power to elements configuring the control unit **30** such as the MCU **31**.

(31) As described above, the MCU **31** of the control unit **30** is configured so as to switch between energization and interruption of energization between the assembled battery **10** (including the battery modules **11**) and the electrical load. Hence, if communication with the sensor unit **20** is broken due to some problem, thereby being not capable of acquiring battery states from the sensor unit **20**, the MCU **31** cannot perform energization and interruption of energization. Similarly, if an abnormality is caused in the MCU **31**, energization and interruption of energization cannot be performed.

(32) If an abnormality is caused in the communication path L**38** or the MCU **31**, it is desirable to interrupt energization between the assembled battery **10** and the electrical load **13** considering safety. However, in a case of an electrical vehicle, if energization is interrupted between the assembled battery **10** and the electrical load **13**, power supply to the rotary electric machine serving as a traction unit (vehicle drive source) included in the electrical load **13** is also interrupted. In this case, the vehicle immediately stops. Hence, the vehicle may stop in such a manner as to obstruct the path of another vehicle on the road, which is a problem.

(33) Meanwhile, even when an abnormality is caused in the communication path L**38** or the MCU **31**, no abnormality may be caused in the assembled battery **10**, the electrical load **13**, and the electrical paths L**1**, L**2** therebetween. Hence, if there is no abnormality in the assembled battery **10** or the like, it is preferable to supply electrical power to the electrical load **13** for a certain time to allow the vehicle to move in such a degree as not to cause obstruction. Thus, in the present embodiment, the sensor unit **20** is configured as described below to allow the assembled battery **10** to supply electrical power for a certain time even when communication with the control unit **30** is broken.

(34) Hereinafter, the configuration of the sensor unit **20**, specifically, a switch control process performed by the control unit **24** will be described based on FIG. **3**. The switch control process is performed by the control unit **24** at predetermined intervals.

(35) The control unit **24** determines whether the communication path L**38** and the MCU **31** are normal (step S**101**). Specifically, the control unit **24** detects a disconnection of the communication path L**38** (including an abnormality of elements provided to the communication path L**38**) and an abnormality of the MCU **31**. The disconnection of the communication path L**38** can be detected by various methods such as using a voltage of the communication path L**38**, using a disconnection detection circuit, or the like. Similarly, an abnormality of the MCU **31** can be detected by various methods, for example, when there is no response from the MCU **31**. These abnormality determination methods may be well-known methods.

(36) If the determination result in step S**101** is affirmative (if the communication path L**38** and the

MCU **31** are normal), the control unit **24** receives a switch control signal from the control unit **30** and controls on/off operation of the switch **23***a* based on the received switch control signal (step S**102**).
(37) It is noted that the MCU **31** of the control unit **30** acquires switch control information concerning on/off operation of the switch **23***a* such as a vehicle request, a battery state, and the like, and outputs the switch control signal for performing an instruction to perform the on/off operation of the switch **23***a*.
(38) In contrast, if the determination result in step S**101** is negative (if the communication path L**38** or the MCU **31** is abnormal), the control unit **24** acquires battery states (current and voltage) from the current detection unit **21** and the voltage detection unit **22** (step S**103**). Then, the control unit **24** determines whether the battery module **11**, which is a detection target, is normal based on the acquired battery states (step S**104**). Specifically, the control unit **24** determines whether the received current and voltage are respectively within predetermined normal value ranges. It is noted that, in the present embodiment, although it is determined whether the battery module **11** is normal based on current and voltage, the determination may be based on any one of current and voltage. Alternatively, a value other than current and voltage may be received and combined therewith to make the determination, or may make the determination based on the value other than current and voltage.
(39) If the determination result in step S**104** is affirmative (if the received current and voltage are within the normal value ranges), the control unit **24** performs energization maintenance control that makes the switch drive unit **23** maintain an on state (energization state) of the switch **23***a* (step S**105**). Then, after a predetermined time period has elapsed, the control unit **24** performs processing of step S**103** again.
(40) In contrast, if the determination result in step S**104** is negative (if the received current and voltage are not within the normal value ranges), the control unit **24** performs energization interruption control for the switch drive unit **23** so that the switch **23***a* becomes an off state (energization interruption state) (step S**106**). Specifically, the control unit **24** instructs the switch drive unit **23** to perform energization interruption with the switch **23***a*. On receiving the instruction for energization interruption from the control unit **24**, the switch drive unit **23** turns off the switch **23***a* to interrupt energization of the battery module **11**.
(41) The configuration of the present embodiment provides the following significant effects.
(42) If an abnormality is caused in the control unit **30** or the communication path L**38**, the control unit **24** acquires battery states from the current detection unit **21** and the voltage detection unit **22** and determines whether to maintain energization between the battery module **11** and the electrical load **13** based on the acquired battery states. If determining to interrupt energization between the battery module **11** and the electrical load **13**, the control unit **24** instructs the switch drive unit **23** to interrupt energization based on the determination. The switch drive unit **23** performs off-control of the switch **23***a* based on the instruction for the energization interruption. Hence, if an abnormality is caused in the control unit **30** or the communication path L**38**, power supply from the battery module **11** is stopped, and the vehicle can be prevented from being immediately stopped.
(43) If an abnormality is caused in the control unit **30** or the communication path L**38**, the control unit **24** acquires battery states every time a predetermined time period elapses and determines whether to maintain energization based on the battery states. Hence, after it is determined to maintain energization, if an abnormality is caused in the battery module **11**, energization interruption can be performed to protect the battery module **11** and the like.
Modifications of First Embodiment
(44) In the above first embodiment, after it is determined to maintain energization, if a predetermined saving time has elapsed, the control unit **24** may perform energization interruption. The saving time is preferably a time period (e.g. about five minutes) during which the own vehicle can be moved to the side of the road at which no obstruction to travel of other vehicles is caused.

Hence, the battery module **11** and the like can be protected more reliably. In the above first embodiment, a power supply generation unit, which is supplied with electrical power from the battery module **11** and generates drive electrical power for the sensor unit **20**, may be provided to the sensor unit **20**. Hence, even if a power line between the sensor unit **20** and control unit **30** is broken, the sensor unit **20** can be driven.

Second Embodiment

(45) The configuration of the above first embodiment may be modified as the following second embodiment. Hereinafter, in the second embodiment, part different from the configurations described in the above embodiments will be mainly described. In addition, in the second embodiment, as a basic configuration, the vehicular power supply system **100** of the first embodiment will be exemplified.

(46) Configurations of the control unit **30** and the sensor unit **20** according to the second embodiment will be described with reference to FIG. **4**. First, the configuration of the control unit **30** will be described. The MCU **31** of the control unit **30** acquires switch control information concerning on/off operation of the switch **23***a* such as a vehicle request, battery states, and the like. Then, the MCU **31** determines whether to turn on or off the switch **23***a* based on the switch control information and outputs a switch control signal for instructing the sensor unit **20** to perform on/off operation of the switch **23***a*. For example, if the assembled battery **10** and the like are normal, the MCU **31** outputs a switch control signal for performing instruction to perform on operation of the switch **23***a*. In contrast, if an abnormality is caused in the assembled battery **10** or the like, the MCU **31** outputs a switch control signal for performing instruction to perform off operation of the switch **23***a*.

(47) In addition, if the control unit **30** and the communication path L**38** are normal, the MCU **31** outputs a notification signal for making a notification that the control unit **30** and the communication path L**38** are normal every time a certain time period T**1** has elapsed. The certain time period T**1** may be any time period, for example, 5 minutes.

(48) Next, the sensor unit **20** will be described. As illustrated in FIG. **4**, the sensor units **20** in the second embodiment does not include the control unit **24**. Hence, if it is instructed to detect battery states of battery module **11**, which is a detection target, by the control unit **30**, the current detection unit **21** and the voltage detection unit **22** of the second embodiment directly receive the instruction. In addition, the current detection unit **21** and the voltage detection unit **22** have a configuration in which if being instructed to detect battery states, the current detection unit **21** and the voltage detection unit **22** detect battery states (current and voltage) and output the obtained battery states to the control unit **30**. Alternatively, the current detection unit **21** and the voltage detection unit **22** may have a configuration in which the current detection unit **21** and the voltage detection unit **22** detect battery states (current and voltage) at predetermined intervals and output the obtained battery states to the control unit **30**.

(49) In addition, the switch drive unit **23** has a configuration in which if receiving a switch control signal from the control unit **30**, the switch drive unit **23** changes on/off states of the switch **23***a* based on the switch control signal. That is, the switch drive unit **23** performs drive control of the switch **23***a*.

(50) In addition, the switch drive unit **23** includes a drive latch function and has a configuration in which when receiving a notification signal from the control unit **30** until the certain time period T**1** elapses, the switch drive unit **23** maintains an on state of the switch **23***a*. In contrast, the switch drive unit **23** has a configuration in which when receiving no notification signal from the control unit **30** until the certain time period T**1** elapses, the switch drive unit **23** changes the switch **23***a* to an off state. Hereinafter, a switch drive process for implementing this function will be described based on FIG. **5**. The switch drive process is performed by the switch drive unit **23** at predetermined intervals.

(51) The switch drive unit **23** determines whether a notification signal is received from the control

unit **30** within the certain time period T**1** (step S**201**). If the determination result is affirmative, the switch drive unit **23** determines that the communication path, the MCU **31**, or the like is normal (step S**202**). Then, the control unit **24** maintains an on state of the switch **23***a* (step S**203**).
(52) In contrast, if the determination result in step S**201** is negative, the switch drive unit **23** determines that an abnormality is caused in the communication path L**38**, the MCU **31**, or the like (step S**204**). Then, the switch drive unit **23** maintains an on state of the switch **23***a* until a predetermined allowable time Ton elapses (step s**205**). The allowable time To is a time period (e.g. about five minutes) during which the own vehicle can be moved to the side of the road at which no obstruction to travel of other vehicles is caused, and is preferably as short as possible. After the allowable time Ton has elapsed, the switch drive unit **23** changes the switch **23***a* to an off state to interrupt energization of the battery module **11** (step s**206**).
(53) Effects of the Second Embodiment Will be Described.
(54) If receiving a notification signal from the control unit **30** until the certain time period T**1** has elapsed, the switch drive unit **23** determines that the communication path L**38** and the like are normal and maintains an on state of the switch **23***a*. In contrast, if receiving no notification signal from the control unit **30** until the certain time period T**1** has elapsed, the switch drive unit **23** determines that an abnormality has occurred and changes the switch **23***a* to an off state. Thus, without the control unit **24** determining an abnormality, the simple mechanism can maintain energization for a while and thereafter interrupt the energization.
Modifications of Second Embodiment
(55) In the above second embodiment, the switch drive unit **23** determines whether to maintain an on state of the switch **23***a* based on the battery states detected by the current detection unit **21** and the voltage detection unit **22**.
Third Embodiment
(56) The configuration of the above first embodiment may be modified as the following third embodiment. Hereinafter, in the third embodiment, part different from the configurations described in the above embodiments will be mainly described. In addition, in the third embodiment, as a basic configuration, the vehicular power supply system **100** of the first embodiment will be exemplified.
(57) The sensor unit **20** according to the third embodiment will be described. As illustrated in FIG. **6**, the sensor unit **20** according to the third embodiment does not include the control unit **24**. Hence, the current detection unit **21** and the voltage detection unit **22** according to the third embodiment has a configuration in which if being instructed to detect battery states of the battery module **11**, which is a detection target, by the control unit **30** (or at predetermined intervals), the current detection unit **21** and the voltage detection unit **22** detect battery states (current and voltage) and output the obtained battery states to the control unit **30**. Alternatively, the current detection unit **21** and the voltage detection unit **22** may have a configuration in which the current detection unit **21** and the voltage detection unit **22** detect battery states (current and voltage) at predetermined intervals and output the obtained battery states to the control unit **30**.
(58) In addition, as in the second embodiment, the MCU **31** is configured to output a switch control signal. The switch drive unit **23** has a configuration in which if receiving a switch control signal from the control unit **30**, the switch drive unit **23** changes on/off states of the switch **23***a* based on the switch control signal.
(59) In addition, the switch drive unit **23** is connected to a sensor side power supply generation unit **29** provided to the sensor unit **20**, and the sensor side power supply generation unit **29** supplies drive electrical power. The sensor side power supply generation unit **29** is connected with the power supply generation unit **33** of the control unit **30**, and the power supply generation unit **33** supplies electrical power. A power supply switch **37** is provided between the power supply generation unit **33** and the sensor side power supply generation unit **29** and is configured to be turned on and off by the MCU **31**. That is, the switch drive unit **23** is configured to maintain an on

state of the switch **23***a* using electrical power supplied from the power supply generation unit **33** as drive electrical power. Hence, if the power supply switch **37** is changed to an off state, and supply of drive electrical power from control unit **30** is interrupted, the on state of the switch **23***a* cannot be maintained, and the switch **23***a* is changed to an off state.

(60) The configuration of the control unit **30** according to the third embodiment will be described. The MCU **31** of the control unit **30** performs a switch drive instruction process illustrated in FIG. **7** at predetermined intervals. The MCU **31** determines whether the communication path L**38** and the sensor unit **20** are normal (step S**301**). Specifically, the MCU **31** detects a disconnection of the communication path L**38** (including an abnormality of elements provided to the communication path L**38**) and an abnormality of the sensor unit **20**. The method of detecting a disconnection of the communication path L**38** is similar to that of the first embodiment. An abnormality of the sensor unit **20** can be detected by various methods, for example, when there is no response from the sensor unit **20**, or when an abnormality signal is received from the sensor unit **20**. These abnormality determination methods may be well-known methods.

(61) If the determination result is affirmative, that is, if it is normal, the MCU **31** outputs a switch control signal based on battery states or the like (step S**302**). Then, the MCU **31** terminates the switch drive instruction process.

(62) In contrast, if the determination result of step S**301** is negative, that is, if an abnormality has occurred in the communication path L**38** or the sensor unit **20**, it is determined whether to maintain on state of the switch **23***a* based on the most recently acquired latest battery state (step S**303**).

(63) If the determination result of step S**303** is affirmative, the MCU **31** maintains electrical power supply to the sensor unit **20** for the predetermined allowable time Ton (step S**304**). Hence, since drive electrical power is continuously supplied to the switch drive unit **23**, the on state of the switch **23***a* is maintained. It is noted that, in step S**304**, the MCU **31** may notify an external device such as a host ECU of occurrence of an abnormality. The allowable time Ton is similar to that in the second embodiment.

(64) Then, after the allowable time Ton has elapsed, the MCU **31** stops supplying drive electrical power to the sensor unit **20** (step S**305**). Hence, since the switch drive unit **23** cannot maintain the on state of the switch **23***a*, the switch **23***a* is changed to an off state. As a result, the energization between the battery module **11** and the electrical load **13** is interrupted.

(65) In addition, if the determination result of step S**303** is affirmative, the MCU **31** proceeds to step S**305** to stop supplying drive electrical power to the sensor unit **20**. Hence, as described above, the energization between the battery module **11** and the electrical load **13** is interrupted.

(66) Effects of the third embodiment will be described.

(67) If an abnormality has occurred in the communication path L**38** or the sensor unit **20**, the MCU **31** stops supplying drive electrical power to the sensor unit **20** after the allowable time Ton has elapsed, and causes the switch **23***a* to change to an off state. Thus, without the control unit **24** determining an abnormality, the simple mechanism can maintain energization for a while and thereafter interrupt the energization.

Modifications of Third Embodiment

(68) The above third embodiment may be combined with the above first embodiment or the above second embodiment. Thus, even if an abnormality is caused in any of the control unit **30** and the sensor unit **20**, the vehicle can be prevented from being immediately stopped. In the above third embodiment, if an abnormality has been caused in the communication path L**38** or the like, it is determined whether to maintain on state of the switch **23***a* based on the latest battery state. However, without the determination, the on state may be maintained until the allowable time Ton elapses.

Fourth Embodiment

(69) The configuration of the above first embodiment may be modified as the following fourth embodiment. Hereinafter, in the third embodiment, part different from the configurations described

in the above embodiments will be mainly described. In addition, in the fourth embodiment, as a basic configuration, the vehicular power supply system **100** of the first embodiment will be exemplified.
(70) As illustrated in FIG. **8**, the sensor unit **20** according to the fourth embodiment includes a plurality of (two in the present embodiment) current detection unit **21**. It is noted that, unlike the first embodiment, the voltage detection unit **22** may be included or not be included.
(71) The two current detection units **21** detect currents at different positions. In the fourth embodiment, a first current detection unit **21***a* and a second current detection unit **21***b* are included. The first current detection unit **21***a* detects a current (first current value) at a first position P**1** in the vicinity of the battery module **11** on the electrical path, which is a detection target, of the sensor unit **20**. The second current detection unit **21***b* is farther from the battery module **11** than the first current detection unit **21***a* and detects a current (second current value) at a second position P**2** in the vicinity of the switch **23***a* on the electrical path.
(72) The first current detection unit **21***a* detects a current at the first position P**1**. If the value of the current is a predetermined first threshold value or greater, the first current detection unit **21***a* outputs a first detection signal indicating this. The second current detection unit **21***b* detects a current at the second position P**2**. If the value of the current is a predetermined second threshold value or greater, the second current detection unit **21***b* outputs a second detection signal indicating this. In the second embodiment, the first threshold value and the second threshold value are set to the same value Th.
(73) The first current detection unit **21***a* and the second current detection unit **21***b* are configures to be connected to an AND circuit AND**1** to which the first detection signal and the second detection signal are input. As illustrated in FIG. **9**, if receiving the first detection signal and the second detection signal, the AND circuit AND**1** outputs an overcurrent detection signal.
(74) A switch drive unit **231** in the fourth embodiment is configured to be connected to the AND circuit AND**1** and can receive the overcurrent detection signal. The switch drive unit **231** is configured to, on receiving the overcurrent detection signal from the AND circuit AND**1**, change the switch **23***a* from an on state to an off state.
(75) Effects of the Fourth Embodiment Will be Described.
(76) Since it is detected whether overcurrents are generated at different two positions (first position P**1** and second position P**2**), noise resistance increases, whereby erroneous detection can be prevented.
Modifications of Fourth Embodiment
(77) In the above fourth embodiment, the first threshold value and the second threshold value are the same value. However, as illustrated in FIG. **10**, the first threshold value and the second threshold value may be different values Th**1** and Th**2**. Thus, even if noise is generated, malfunctions can be prevented. In the fourth embodiment, the first current detection unit **21***a* and the second current detection unit **21***b* may differ in a sampling rate or an internal error count number of times. For example, the first current detection unit **21***a* may be configured to output the first detection signal if the number of times that the first threshold value is exceeded (first number of times) is a first internal error count number of times or more. The second current detection unit **21***b* may be configured to output the second detection signal if the number of times that the second threshold value is exceeded (second number of times) is a second internal error count number of times or more. In addition, the first current detection unit **21***a* may be configured to output the first detection signal if the time period during which the first threshold value is exceeded is a first time period or longer. The second current detection unit **21***b* may be configured to output the second detection signal if the time period during which the second threshold value is exceeded is a second time period or longer. Thus, when an overcurrent is generated only for an extremely short time due to influence of noise or the like, erroneous detection can be prevented. In the fourth embodiment, the first current detection unit **21***a* may be a Hall sensor type or a shunt resistance type. Similarly,

the second current detection unit **21***b* may be a Hall sensor type or a shunt resistance type. Thus, the first current detection unit **21***a* and the second current detection unit **21***b* can be appropriately changed according to required specifications. The above fourth embodiment and the modifications thereof may be appropriately combined with the above second embodiment or the above third embodiment.

Five Embodiment

(78) The configuration of the above fourth embodiment may be modified as the following fifth embodiment. Hereinafter, in the fifth embodiment, part different from the configurations described in the above embodiments will be mainly described. In addition, in the fifth embodiment, as a basic configuration, the vehicular power supply system **100** of the fourth embodiment will be exemplified.

(79) As illustrated in FIG. **11**, in the fifth embodiment, a discharge circuit **51** for quickly discharging charge of the capacitor C**1** is provided between the battery module **11** and the electrical load **13**. The discharge circuit **51** is connected with the capacitor C**1**, the battery module **11**, and the electrical load **13** in parallel. The discharge circuit **51** is configured of a series connection of a resistor R**10** and a switch **23***b*. The switch **23***b* is normally set so as to be an off state (energization interruption state).

(80) The sensor unit **20** of the fifth embodiment includes, as in the fourth embodiment, the first current detection unit **21***a*, the second current detection unit **21***b*, the AND circuit AND**1**, and the switch drive unit **231**. The sensor units **20** of the fifth embodiment includes, in addition to the above configuration, a second switch drive unit **232**. It is noted, in the fifth embodiment, the switch drive unit **231** is referred to as a first switch drive unit **231** as a matter of convenience.

(81) The second switch drive unit **232** is connected to an output terminal of the AND circuit AND**1** via a delay circuit D**1**. As illustrated in FIG. **11**, if the first detection signal and the second detection signal are input to the AND circuit AND**1**, and the AND circuit AND**1** outputs an overcurrent detection signal, the overcurrent detection signal is input to the second switch drive unit **232** by the delay circuit D**1** later than to the switch drive unit **231** by predetermined time.

(82) On receiving the overcurrent detection signal, the second switch drive unit **232** changes the switch **23***b* to an on state. Hence, the switch **23***b* becomes an on state after the predetermined time elapses from when the first switch drive unit **231** changes the switch **23***a* to an off state. Thus, charge of the capacitor C**1** is discharged by the discharge circuit **51**.

(83) Effects of the Fifth Embodiment Will be Described.

(84) After the predetermined time has elapsed from when energization of the battery module **11** is interrupted, the second switch drive unit **232** changes the switch **23***b* to an on state to cause the discharge circuit **51** to discharge charge of the capacitor C**1**. Thus, the charge of the capacitor C**1** can be quickly discharged.

Modifications of Fifth Embodiment

(85) In the above fifth embodiment, the second switch drive unit **232** is configured to turn on the switch **23***b* after the predetermined time has elapsed from when energization of the battery module **11** is interrupted. As another example, as illustrated in FIG. **12**, a connection determination circuit **52** may be included which determines that the switch **23***a* has been changed to an off state. In addition, the second switch drive unit **232** may be configured to change the switch **23***b* to an on state if it is determined by the connection determination circuit **52** that the switch **23***a* has been changed to an off state. The above fifth embodiment and the modifications thereof may be appropriately combined with the above second embodiment or the above third embodiment.

Sixth Embodiment

(86) The configuration of the above fifth embodiment may be modified as the following sixth embodiment. Hereinafter, in the fifth embodiment, part different from the configurations described in the above embodiments will be mainly described. In addition, in the sixth embodiment, as a basic configuration, the vehicular power supply system **100** of the fifth embodiment will be

exemplified.
(87) As illustrated in FIG. **13**, the assembled battery **10** in the sixth embodiment is configured by a first battery module **61** and a second battery module **62**. In addition, the first battery module **61** and the second battery module **62** are configured to be able to be changed between a serial connection and a parallel connection.
(88) Specifically, the first battery module **61** and the second battery module **62** are connected in series via a switch F**1**. A first connection changing switch S**1** is connected to the first battery module **61** in parallel. The first connection changing switch S**1** has one end connected to a positive electrode side electrical path L**1** and the other end connected between the switch F**1** and the second battery module **62**. Similarly, a second connection changing switch S**2** is connected to the second battery module **62** in parallel. The second connection changing switch S**2** has one end connected to a negative electrode side electrical path L**2** and the other end connected between the switch F**1** and the first battery module **61**.
(89) When the first battery module **61** and the second battery module **62** are connected in series, the first connection changing switch S**1** and the second connection changing switch S**2** are changed to off states. When the first battery module **61** and the second battery module **62** are connected in parallel, the first connection changing switch S**1** and the second connection changing switch S**2** are changed to on states.
(90) The first connection changing switch S**1** and the second connection changing switch S**2** may be subjected to on/off-control by the control unit **30** or the sensor unit **20** or may be subjected to on/off-control by the host ECU or the like. It is noted that when electrical power is supplied from the assembled battery **10** to the electrical load **13**, the first battery module **61** and the second battery module **62** are connected in series. In contrast, when electrical power is supplied from the rotary electric machine included in the electrical load **13** to the assembled battery **10** (i.e., when the assembled battery **10** is charged), the first battery module **61** and the second battery module **62** are connected in parallel.
(91) In addition, in the sixth embodiment, the sensor unit **20** is provided with a low-voltage substrate **63** whose drive electrical power has a low voltage and a high-voltage substrate **64** whose drive electrical power is higher than that of the low-voltage substrate **63**. The low-voltage substrate **63** is provided with the first current detection unit **21***a*. The high-voltage substrate **64** is provided with the second current detection unit **21***b*.
(92) In the sixth embodiment, the first current detection unit **21***a* detects a current flowing through a first point P**11** located on the negative electrode terminal side of the first battery module **61** with respect to a connection point of the second connection changing switch S**2** on the electrical path between the first battery module **61** and the second battery module **62**. The first point P**11** is a point at which a current from the first battery module **61** can be detected in any connection manner.
(93) In addition, in the sixth embodiment, the second current detection unit **21***b* detects a current flowing through a second point P**12** located on the positive electrode terminal side of the second battery module **62** with respect to a connection point of the first connection changing switch S**1** on the electrical path between the first battery module **61** and the second battery module **62**. The second point P**12** is a point at which a current from the second battery module **62** can be detected in any connection manner.
(94) In the sixth embodiment, the first current detection unit **21***a* and the second current detection unit **21***b* are connected to an abnormality determination circuit **53**. The abnormality determination circuit **53** is provided to the high-voltage substrate **64**. The abnormality determination circuit **53** is configured to receive connection information concerning whether the first battery module **61** and the second battery module **62** are connected in series.
(95) If the first battery module **61** and the second battery module **62** are connected in series, when receiving the first detection signal and the second detection signal, the abnormality determination circuit **53** outputs an overcurrent detection signal. In contrast, if the first battery module **61** and the

second battery module **62** are connected in parallel (not in series), when receiving any of the first detection signal and the second detection signal, the abnormality determination circuit **53** outputs an overcurrent detection signal.
(96) The sensor unit **20** of the sixth embodiment includes, as in the fifth embodiment, the first switch drive unit **231** and the second switch drive unit **232**.
(97) The first switch drive unit **231** in the sixth embodiment is connected to the abnormality determination circuit **53** and is configured to be able to receive the overcurrent detection signal. The first switch drive unit **231** is configures to, on receiving the overcurrent detection signal from the abnormality determination circuit **53**, change the switch **23***a* from an on state to an off state.
(98) The second switch drive unit **232** is connected to an output terminal of the abnormality determination circuit **53** via the delay circuit D**1**. As in the fifth embodiment, if the overcurrent detection signal is output from the abnormality determination circuit **53**, the overcurrent detection signal is input to the second switch drive unit **232** by the delay circuit D**1** later than to the first switch drive unit **231** by predetermined time.
(99) On receiving the overcurrent detection signal, the second switch drive unit **232** changes the switch **23***b* to an on state. Hence, the switch **23***b* becomes an on state after the predetermined time elapses from when the first switch drive unit **231** changes the switch **23***b* to an off state. Thus, charge of the capacitor C**1** is discharged by the discharge circuit **51**.
(100) The above sixth embodiment has, in addition to the effects of the above fifth embodiment, the following effects.
(101) when electrical power is supplied from the assembled battery **10** to the electrical load **13**, the first battery module **61** and the second battery module **62** are connected in series. In contrast, when electrical power is supplied from the rotary electric machine included in the electrical load **13** to the assembled battery **10** (i.e., when the assembled battery **10** is charged), the first battery module **61** and the second battery module **62** are connected in parallel. Hence, the charging voltage can be lowered, while the electrical power supplied to the electrical load **13** becomes a high voltage. Thus, the configuration for increasing the charging voltage supplied from the rotary electric machine can be omitted or simplified.
(102) If the first battery module **61** and the second battery module **62** are connected in series, when receiving the first detection signal and the second detection signal, the abnormality determination circuit **53** outputs an overcurrent detection signal. In contrast, if the first battery module **61** and the second battery module **62** are connected in parallel, when receiving any of the first detection signal and the second detection signal, the abnormality determination circuit **53** outputs an overcurrent detection signal. Hence, depending on the connection manner, overcurrent can be appropriately detected. It is noted that when charged is performed, since energization is interrupted between the electrical load **13** other than the rotary electric machine and the assembled battery **10**. Hence, it is expected that noise to the assembled battery **10** decreases. Thus, when the first battery module **61** and the second battery module **62** are connected in parallel, an overcurrent can be detected appropriately.
Modifications of Sixth Embodiment
(103) The above embodiment may be configured to output an overcurrent detection signal in any communication state when the first detection signal and the second detection signal are output. The above sixth embodiment and the modifications thereof may be appropriately combined with the above second embodiment or the above third embodiment. In the above sixth embodiment, the sensor unit **20** is provided with the low-voltage substrate **63** and the high-voltage substrate **64** separately. However, the low-voltage substrate **63** and the high-voltage substrate **64** may not be separated. In the above sixth embodiment, the first battery module **61** and the second battery module **62** may be configured to be connected in parallel when an abnormality has occurred. In addition, the first battery module **61** and the second battery module **62** may be configured to be connected in series if it is determined that no overcurrent has been generated. In the above sixth

embodiment, the first point P**11** may be changed to any point in any connection manner if a current from the first battery module **61** can be detected at the point. Similarly, the second point P**12** may be changed to any point in any connection manner if a current from the second battery module **62** can be detected at the point.
(104) Hereinafter, characteristic configurations extracted from the embodiments described above will be described.
(105) [Configuration 1]
(106) A vehicular power supply system (**100**) including a sensor unit (**20**) that detects a battery state of a storage battery (**11**) that is capable of supplying electrical power to an electrical load (**13**), and a control unit (**30**) that receives the battery state from the sensor unit via a communication path (L**38**) and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit (**21**) that detects the battery state of the storage battery; a switch drive unit (**23**) that performs drive control of a switch unit (**23***a*) provided between the storage battery and the electrical load; and a control unit (**24**) that controls the switch drive unit, the control unit controls the switch drive unit based on the instruction from the control unit to switch between the energization and interruption of the energization between the storage battery and the electrical load, and if determining an abnormality in the control unit or the communication path, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state detected by the detection unit and controls the switch drive unit based on the determination to switch between the energization and interruption of the energization between the storage battery and the electrical load.
[Configuration 2]A vehicular power supply system (**100**) including a sensor unit (**20**) that detects a battery state of a storage battery (**11**) that is capable of supplying electrical power to an electrical load (**13**), and a control unit (**30**) that receives the battery state from the sensor unit via a communication path (L**38**) and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit (**21**) that detects the battery state of the storage battery; and a switch drive unit (**23**) that performs drive control of a switch unit (**23***a*) provided between the storage battery and the electrical load based on the instruction of the control unit to switch between the energization and the interruption of the energization between the storage battery and the electrical load, the control unit is configured to, in a normal state, output a notification signal indicating the normal state every time a certain time period has elapsed, and if receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit maintains the energization between the storage battery and the electrical load, and if not receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load after a predetermined allowable time has elapsed.
[Configuration 3]
(107) The vehicular power supply system according to configuration 1 or 2, wherein the control unit includes a power supply generation unit (**33**) that converts electrical power supplied from an auxiliary power supply to generate drive electrical power, the power supply generation unit is configured to supply the drive electrical power to the switch drive unit, and if communication from the sensor unit is interrupted or if a notification of occurrence of an abnormality is received from the sensor unit, the control unit determines whether to maintain the energization between the storage battery and the electrical load for a predetermined time period based on the most recently received battery state and maintains or stops supply of the drive electrical power based on the determination.
[Configuration 4]

(108) The vehicular power supply system according to any one of configurations 1 to 3, wherein the detection unit includes a first current detection unit (**21***a*) that detects a first current value at a first point (P**1**) on an electrical path between the storage battery and the electrical load and a second current detection unit (**21***b*) that detects a second current value at a second point (P**2**) different from the first point on the electrical path, and if the first current value is a first threshold value or greater and the second current value is a second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.
[Configuration 5]
(109) The vehicular power supply system according to configuration 4, wherein if the number of times the first current value is the first threshold value or more is a predetermined first number of times or more and if the number of times the second current value is the second threshold value or more is a second number of times, which is different from the first number of times, or more, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.
[Configuration 6]
(110) The vehicular power supply system according to configuration 4 or 5, wherein the storage battery is an assembled battery (**10**) configured by a first battery module (**61**) and a second battery module (**62**), the first battery module and the second battery module are configured to be capable of being changed between a series connection and a parallel connection, the first point is a point (P**11**) at which a current from the first battery module is capable of being detected in any connection manner, the second point is a point (P**12**) at which a current from the second battery module is capable of being detected in any connection manner, when the first battery module and the second battery module are connected in series, if the first current value is the first threshold value or greater and the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and when the first battery module and the second battery module are connected in parallel, if the first current value is the first threshold value or greater or the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and
[Configuration 7]
(111) The vehicular power supply system according to any one of configurations 1 to 6, further including a discharge circuit (**51**) that causes a capacitor connected to the electrical load in parallel to discharge charge after the energization is interrupted by the switch drive unit.
(112) The present disclosure has so far been described based on embodiments. However, the present disclosure should not be construed as being limited to these embodiments or the structures. The present disclosure should encompass various modifications, or modifications within the range of equivalence. In addition, various combinations and modes, as well as other combinations and modes, including those which include one or more additional elements, or those which include fewer elements should be construed as being within the scope and spirit of the present disclosure.
(113) A first means for solving the above problem is a vehicular power supply system (**100**) including a sensor unit (**20**) that detects a battery state of a storage battery (**11**) that is capable of supplying electrical power to an electrical load (**13**), and a control unit (**30**) that receives the battery state from the sensor unit via a communication path (L**38**) and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit (**21**) that detects the battery state of the storage battery; a switch drive unit (**23**) that performs drive control of a switch unit (**23***a*) provided between the storage battery and the electrical load; and a control unit (**24**) that controls the switch drive unit, the control unit controls the switch drive unit based on

the instruction from the control unit to switch between the energization and interruption of the energization between the storage battery and the electrical load, and if determining an abnormality in the control unit or the communication path, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state detected by the detection unit and controls the switch drive unit based on the determination to switch between the energization and interruption of the energization between the storage battery and the electrical load.

(114) Hence, even if an abnormality is caused in the control unit or the communication path and communication is broken, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state detected by the detection unit and performs drive control of the switch unit based on the determination. Hence, if no abnormality has been caused in the storage battery, electrical power can be supplied from the storage battery to the electrical load for a certain time.

(115) A second means for solving the above problem is a vehicular power supply system (**100**) including a sensor unit (**20**) that detects a battery state of a storage battery (**11**) that is capable of supplying electrical power to an electrical load (**13**), and a control unit (**30**) that receives the battery state from the sensor unit via a communication path (L**38**) and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit (**21**) that detects the battery state of the storage battery; and a switch drive unit (**23**) that performs drive control of a switch unit (**23***a*) provided between the storage battery and the electrical load based on the instruction of the control unit to switch between the energization and the interruption of the energization between the storage battery and the electrical load, the control unit is configured to, in a normal state, output a notification signal indicating the normal state every time a certain time period has elapsed, and if receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit maintains the energization between the storage battery and the electrical load, and if not receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load after a predetermined allowable time has elapsed.

(116) If an abnormality is caused in the control unit or the communication path and communication is broken, the notification signal is not input to the switch drive unit. Hence, if no notification signal is received every time the certain time period has elapsed, the switch drive unit determines that an abnormality has caused and performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load after the predetermined allowable time has elapsed. Hence, even if an abnormality is caused, electrical power can be supplied from the storage battery to the electrical load for a certain time.

Claims

1. A vehicular power supply system including a sensor unit that detects a battery state of a storage battery that is capable of supplying electrical power to an electrical load, and a control unit that receives the battery state from the sensor unit via a communication path and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit that detects the battery state of the storage battery; a switch drive unit that performs drive control of a switch unit provided between the storage battery and the electrical load; and a control unit that controls the switch drive unit, the control unit controls the switch drive unit based on the instruction from the control unit to switch between the energization and interruption of the energization between the storage battery and the electrical load, if determining an abnormality in

the control unit or the communication path, the control unit determines whether to maintain the energization between the storage battery and the electrical load based on the battery state detected by the detection unit and controls the switch drive unit based on the determination to switch between the energization and interruption of the energization between the storage battery and the electrical load, the detection unit includes a first current detection unit that detects a first current value at a first point on an electrical path between the storage battery and the electrical load and a second current detection unit that detects a second current value at a second point different from the first point on the electrical path, if the first current value is a first threshold value or greater and the second current value is a second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and if the number of times the first current value is the first threshold value or more is a predetermined first number of times or more and if the number of times the second current value is the second threshold value or more is a second number of times, which is different from the first number of times, or more, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.
2. The vehicular power supply system according to claim 1, wherein the storage battery is an assembled battery configured by a first battery module and a second battery module, the first battery module and the second battery module are configured to be capable of being changed between a series connection and a parallel connection, the first point is a point at which a current from the first battery module is capable of being detected in any connection manner, the second point is a point at which a current from the second battery module is capable of being detected in any connection manner, when the first battery module and the second battery module are connected in series, if the first current value is the first threshold value or greater and the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and when the first battery module and the second battery module are connected in parallel, if the first current value is the first threshold value or greater or the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.
3. The vehicular power supply system according to claim 1, wherein the control unit includes a power supply generation unit that converts electrical power supplied from an auxiliary power supply to generate drive electrical power, the power supply generation unit is configured to supply the drive electrical power to the switch drive unit, and if communication from the sensor unit is interrupted or if a notification of occurrence of an abnormality is received from the sensor unit, the control unit determines whether to maintain the energization between the storage battery and the electrical load for a predetermined time period based on the most recently received battery state and maintains or stops supply of the drive electrical power based on the determination.
4. The vehicular power supply system according to claim 1, further comprising a discharge circuit that causes a capacitor connected to the electrical load in parallel to discharge charge after the energization is interrupted by the switch drive unit.
5. A vehicular power supply system including a sensor unit that detects a battery state of a storage battery that is capable of supplying electrical power to an electrical load, and a control unit that receives the battery state from the sensor unit via a communication path and performs instruction to perform energization and interruption of the energization between the storage battery and the electrical load based on the received battery state, wherein the sensor unit includes: a detection unit that detects the battery state of the storage battery; and a switch drive unit that performs drive control of a switch unit provided between the storage battery and the electrical load based on the instruction of the control unit to switch between the energization and the interruption of the energization between the storage battery and the electrical load, the control unit is configured to, in a normal state, output a notification signal indicating the normal state every time a certain time

period has elapsed, if receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit maintains the energization between the storage battery and the electrical load, and if not receiving the notification signal from the control unit every time the certain time period has elapsed, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load after a predetermined allowable time has elapsed, the detection unit includes a first current detection unit that detects a first current value at a first point on an electrical path between the storage battery and the electrical load and a second current detection unit that detects a second current value at a second point different from the first point on the electrical path, if the first current value is a first threshold value or greater and the second current value is a second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and if the number of times the first current value is the first threshold value or more is a predetermined first number of times or more and if the number of times the second current value is the second threshold value or more is a second number of times, which is different from the first number of times, or more, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.

6. The vehicular power supply system according to claim 5, wherein the storage battery is an assembled battery configured by a first battery module and a second battery module, the first battery module and the second battery module are configured to be capable of being changed between a series connection and a parallel connection, the first point is a point at which a current from the first battery module is capable of being detected in any connection manner, the second point is a point at which a current from the second battery module is capable of being detected in any connection manner, when the first battery module and the second battery module are connected in series, if the first current value is the first threshold value or greater and the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load, and when the first battery module and the second battery module are connected in parallel, if the first current value is the first threshold value or greater or the second current value is the second threshold value or greater, the switch drive unit performs drive control of the switch unit to interrupt the energization between the storage battery and the electrical load.

7. The vehicular power supply system according to claim 5, wherein the control unit includes a power supply generation unit that converts electrical power supplied from an auxiliary power supply to generate drive electrical power, the power supply generation unit is configured to supply the drive electrical power to the switch drive unit, and if communication from the sensor unit is interrupted or if a notification of occurrence of an abnormality is received from the sensor unit, the control unit determines whether to maintain the energization between the storage battery and the electrical load for a predetermined time period based on the most recently received battery state and maintains or stops supply of the drive electrical power based on the determination.

8. The vehicular power supply system according to claim 5, further comprising a discharge circuit that causes a capacitor connected to the electrical load in parallel to discharge charge after the energization is interrupted by the switch drive unit.