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(71) Applicant *(for all designated States except US)*: **PANASONIC CORPORATION** [JP/JP]; 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **FUKUO, Naoki** [JP/JP]; c/o Panasonic Corporation, 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP). **MUKAI, Tatsuya** [JP/JP]; c/o Panasonic Corporation, 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).

(74) Agent: **FIRST LAW P.C.**; Trust Tower, 275-7 Yang-jae-dong, Seochu-ku, Seoul 137-739 (KR).

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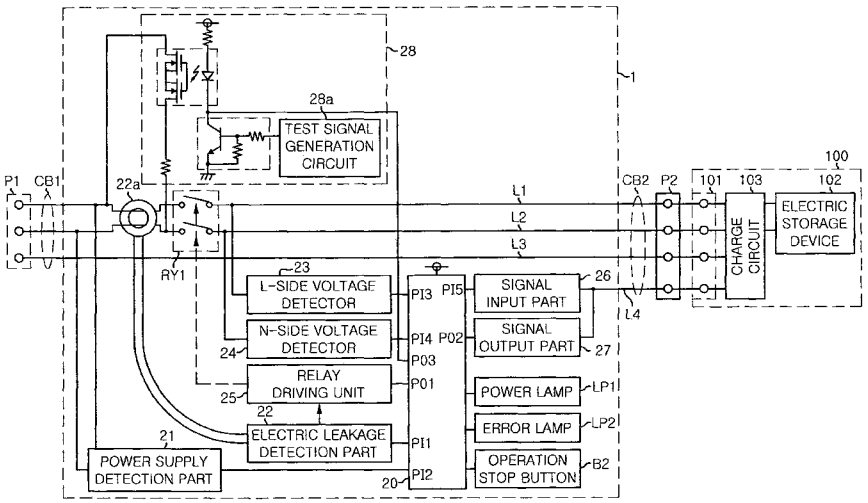
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(54) **Title**: POWER FEEDING CONTROL DEVICE

FIG. 1



(57) **Abstract**: A power feeding control device having a power supply path from an external power source to an electric storage device installed in the electric vehicle is provided. The power supply control device includes : a relay connected in the power supply path; an electric leakage detection part which detects an electric leakage in the power supply path and makes the relay opened; an electric leakage generation part that simulates the electric leakage in the power supply path; and a control part that controls opening and closing of the relay in response to a state notification signal inputted to the control part from the electric vehicle and controls the electric leakage generation part to simulate the electric leakage when power supply to the electric vehicle is stopped.

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POWER FEEDING CONTROL DEVICE

Field of the Invention

The present invention relates to a power feeding control device.

Background of the Invention

Conventionally, there is proposed a power feeding control device which controls power feeding from an external power source to an electric vehicle. The power feeding control device includes a power side plug connected to the external power source such as a commercial AC power source, and a vehicle side plug connected to an electric vehicle, the power side plug being connected to the vehicle side plug through a cable (see, e.g., Japanese Patent Application Publication No. 2009-240053).

In order to cope with a case when a high-voltage side of the power feeding control device is short-circuited to a vehicle body while a battery of the electric vehicle is charged, the power feeding control device includes a relay disposed in a power supply path for electrically connecting between both of the plugs, and an electric leakage detection circuit for detecting whether or not an electric leakage occurs. When the electric leakage detection circuit detects an electric leakage, the relay is opened to thereby shut off the power supply to the electric

vehicle.

In the conventional power feeding control device, in order to reliably shutting off the power supply to the electric vehicle when the electric leakage occurs, an electric leakage detection circuit is checked whenever an electric power is supplied to the electric vehicle. Specifically, when the power feeding control device is connected to the electric vehicle and receives a charge enable signal from the electric vehicle, the power feeding control device closes the relay and simulates a virtual electric leakage to check whether or not the leakage detection circuit operates normally.

When detecting an electric leakage, the leakage detection circuit opens the relay and then checks whether or not the relay is fusion-bonded. Herein, when it is found that the leakage detection performs normally and the relay has no fusion-bonding, the power feeding control device starts feeding electric power to the electric vehicle by closing the relay.

Thus, the relay incorporated in the power feeding control device is opened and closed twice when the electric vehicle is charged once. As the number of times of opening and closing the relay increases, a lifetime of the power feeding control device is shortened, which is undesirable.

Summary of the Invention

In view of the above, the present invention provides a power

feeding control device having a long lifetime.

In accordance with an aspect of the present invention, there is provided a power feeding control device having a power supply path from an external power source to an electric storage device installed in the electric vehicle, the power supply control device including: a relay connected in the power supply path; an electric leakage detection part which detects an electric leakage in the power supply path and makes the relay opened; an electric leakage generation part that simulates the electric leakage in the power supply path; and a control part that controls opening and closing of the relay in response to a state notification signal inputted to the control part from the electric vehicle and controls the electric leakage generation part to simulate the electric leakage when power supply to the electric vehicle is stopped.

Preferably, the power feeding control device further includes a signal input part to which the state notification signal for notifying an operational state from the electric vehicle is inputted, wherein the control part controls the electric leakage generation part to simulate the electric leakage when the power supply to the electric vehicle is stopped and a charge completion signal for notifying charge completion is inputted to the signal input part.

The power feeding control device may further includes a plug detachably connected to a receptacle which is provided in the electric vehicle, and a signal input part to which the state

notification signal for notifying the operational state from the electric vehicle is inputted via the plug, wherein the control part controls the electric leakage generation part to simulate the electric leakage when the control part determines that the power supply to the electric vehicle is stopped because the plug is disconnected by receiving no state notification signal.

The power feeding control device may further includes an operation stop part that outputs, to the control part, a stop instruction for forcibly stopping the power supply to the electric vehicle in response to user's manipulation, wherein the control part controls the electric leakage generation part to simulate the electric leakage when the power supply to the electric vehicle is stopped based on the stop instruction from the operation stop part.

The power feeding control device further includes a fusion-bonding detection part having a capacitor for smoothing a voltage at secondary side of the relay, which detects whether or not the relay is fusion-bonded based on a voltage across the capacitor when the relay is opened, and a discharge circuit part which provides a discharging path to discharge charges stored in the capacitor for a period of time when the electric leakage is simulated by the electric leakage generation part.

Preferably, the power feeding control device further includes a plug detachably connected to a receptacle provided at the electric vehicle, and a signal input part to which the state notification signal for notifying the operational state

from the electric vehicle is inputted via the plug, wherein, when a connection confirmation signal for informing that the plug has been connected to the receptacle is inputted to the signal input part as the state notification signal, the control part controls the electric leakage generation part to simulate the electric leakage in the state where the relay is opened before the power is supplied to the electric vehicle.

The power feeding control device may further includes a fusion-bonding detection part which detects whether or not the relay is fusion-bonded based on a voltage at the secondary side of the relay when the relay is opened, and an information part for informing a fusion-bonding occurrence in the relay when the fusion-bonding detection part detects that the relay is fusion-bonded and informing an abnormal operation of the electric leakage detection part in the case where no electric leakage detection signal is inputted from the electric leakage detection part when the electric leakage occurs.

With the above configuration, it is possible to check whether or not the electric leakage detection part operates normally without increasing the number of times of opening and closing the relay in the power feeding control device. This prevents the lifetime of the power feeding control device from being shortened.

Brief Description of the Drawings

The objects and features of the present invention will become apparent from the following description of embodiments, given in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic circuit diagram showing a power feeding control device in accordance with an embodiment of the present invention;

Fig. 2 is a circuit diagram of L-side and N-side voltage detectors of the power feeding control device shown in Fig. 1;

Fig. 3 is a perspective view representing an appearance of the power feeding control device in accordance with the embodiment;

Fig. 4 is a flow chart for describing an operation of the power feeding control device in accordance with the embodiment;

Figs. 5A to 5C are flow charts for describing an operation of the power feeding control device in accordance with the embodiment;

Fig. 6 is a timing chart for explaining detection operations of electric leakage and relay fusion-bonding;

Fig. 7 is a schematic circuit diagram showing a modification in accordance with another embodiment of the present invention;

Fig. 8 is a timing chart for explaining an operation of another embodiment;

Fig. 9 is a flow chart for explaining an operation of another embodiment;

Fig. 10 is timing chart for explaining an operation of the

embodiment; and

Fig. 11 is a schematic block diagram for illustrating another modification of the embodiment.

Detailed Description of the Embodiment

A power feeding control device in accordance with an embodiment of the present invention will be described in detail with reference to Figs. 1 to 10. The power feeding control device 1 of the present embodiment includes a power supply path from a power source (not shown), e.g., a commercial AC power source, to an electric storage device provided in an electric vehicle 100, and is used for controlling a power supply to the electric storage device.

The electric vehicle 100 includes an electric storage device 102 having a secondary battery such as a lithium-ion battery; and a charging circuit 103 which receives power supply from the outside via a receptacle 101 to charge the electric storage device 102. The electric vehicle 100 is driven by an electric power stored in the electric storage device 102, and may be an electric automobile, a plug-in hybrid vehicle, a fuel-cell vehicle or the like.

Fig. 3 shows an external perspective view of the power feeding control device 1. The power feeding control device 1 includes a body part 2 having an elongated rectangular parallelepiped shape for accommodating a circuit part of the

power feeding control device shown in Fig. 1 and described below. The body part 2 has a body 3 formed of a synthetic resin mold product which has a box-like shape and an opening, and a cover 4 formed of a synthetic resin product for covering the opening of the body 3. The body 3 and the cover 4 are joined with conventionally known joint means, e.g., a screw or the like.

A power source side plug P1, which is detachably connected to a receptacle (not shown) of the commercial AC power source, is connected to a cable CB1 extending from one end in a longitudinal direction of the body part 2. A vehicle side plug P2, which is detachably connected to a receptacle 101 of the electric vehicle 100, is connected to a cable CB2 extending from the other end in the longitudinal direction of the body part 2.

Within the body part 2, there is accommodated a printed circuit board (not shown) on which a circuit shown in Figs. 1 and 2, described below, is formed. On a front surface of the body part 2 (i.e., a front surface of the cover 4), an electric leakage test button B1 for testing an electric leakage breaking operation and an operation stop button B2 for forcibly stopping the power supply to the electric vehicle 100 are provided side by side, which are operable from outside the body part 2. Further, on the front surface of the body part 2, there are provided a power lamp LP1 lit on when the power feeding control device 1 is powered from the commercial AC power source; and an error lamp LP2 lit on to inform a user that an abnormal operation in an electric leakage detection part 22 and a relay RY1 is detected.

Furthermore, a flexible light-transmitting resin label 5 is attached on the front surface of the body part 2 to cover the buttons B1, B2, and the lamps LP1, LP2. On the label 5, characters and graphic symbols are provided so as to represent usage or the like of the respective buttons B1, B2, and lamps LP1, LP2.

Next, a circuit configuration of the power feeding control device 1 will be described. As shown in Fig. 1, the power feeding control device 1 is provided in between an external power source (a commercial AC power source) and the electric vehicle 100, and includes a voltage side line L1 serving as a conductive line for a voltage side electrode (L-phase), a ground side line L2 serving as a conductive line for a ground side electrode (N-phase), and a ground line L3 serving as a conductive line for a ground.

The power feeding control device 1 includes the relay RY1, a control part 20, a power supply detection part 21, the electric leakage detection part 22, an L-side voltage detector 23, an N-side voltage detector 24, a relay driving unit 25, a signal input part 26, a signal output part 27, and an electric leakage generation part 28.

The relay RY1 has normally open contacts respectively inserted into the voltage side line L1 and the ground side line L2, and turns on and off the power supply from the power source side plug P1 to the vehicle side plug P2.

The control part 20 includes an integrated circuit (IC) to thereby control the entire power feeding control device 1.

The power supply detection part 21 is interposed between the relay RY1 and the power source side plug P1 and detects a zero-cross in a voltage generated between the power side line L1 and the ground side line L2 to check whether or not an electric power is supplied from the commercial AC power source.

The electric leakage detection part 22 detects an electric leakage in the power supply path to the electric vehicle 100 (including a circuit of the electric vehicle 100 side) based on an output of a zero-phase current transformer 22a in which the power side line L1 and the ground side line L2 passes through a core thereof. When an imbalance occurs between currents flowing through the power side line L1 and the ground side line L2 due to the electric leakage, a current flows in a secondary side of the zero-phase current transformer 22a corresponding to the imbalance current.

Thus, the electric leakage detection part 22 detects the electric leakage based on an output of the secondary side of the zero-phase current transformer 22a. When detecting the electric leakage, the electric leakage detection part 22 outputs an electric leakage detection signal to an input terminal PI1 of the control part 20 and makes the relay RY1 opened.

The L-side voltage detector 23 detects a voltage generated on the power side line L1 in between the relay RY1 and the vehicle side plug P2 (i.e., a secondary side of the relay RY1).

The N-side voltage detector 24 detects a voltage generated on the ground side line L2 in between the relay RY1 and the vehicle

side plug P2 (i.e., the secondary side of the relay RY1).

The relay driving unit 25 opens or closes the relay RY1 in response to a control signal inputted from the control part 20 and a signal from the electric leakage detection part 22.

The signal input part 26 is connected to the electric vehicle 100 via a conductive line L4 (hereinafter, referred to as "signal line") provided separately from the conductive lines L1 to L3. The signal input part 26 receives a so-called CPLT signal (control pilot signal), and outputs it to the input terminal PI5 of the control part 20, the CPLT signal including an operational status notification.

The signal output part 27 outputs the CPLT signal whose signal level and waveform are modified based on a signal outputted from the output terminal PO2 of the control part 20 to the electric vehicle 100 side.

When a voltage at an output terminal PO3 of the control part 20 becomes L level, the electric leakage generation part 28 simulates a virtual electric leakage by short-circuiting between the power side line L1 and the ground side line L2. Further, the electric leakage generation part 28 is provided with a test signal generation circuit 28a for generating a test signal when the electric leakage test button B1 is pushed. When the test signal is generated by the test signal generation circuit 28a in the electric leakage generation part 28, as mentioned above, the power side line L1 is short-circuited to the ground side line L2, thereby generating the virtual electric leakage.

Further, the power feeding control device 1 has the components 20 to 28 to be connected to the power side line L1, the ground side line L2, and the ground line L3 at the power source side of the relay RY1, thereby supplying an operational power to each of the components 20 to 28.

Herein, the CPLT signal (i.e., the state notification signal) is changed in voltage level by changing, for example, a voltage dividing ratio in the circuit of the electric vehicle 100 side, and outputted from the signal output part 27 in accordance with an instruction of the control part 20 (e.g., a given voltage signal or a duty signal). Table 1, described below, shows an example of the CPLT signal. When the CPLT signal has a voltage level of +12 V (state A), it shows that no electric vehicle 100 is connected to the vehicle side plug P2 (waiting for vehicle connection). Further, when the CPLT signal has a voltage level of (+9V) (state B), it shows that the vehicle side plug P2 is connected to the electric vehicle 100 and the connection to the circuit of the electric vehicle 100 is confirmed (checking for the vehicle connection).

Furthermore, when the CPLT signal is a duty signal having a voltage level alternating between (+9V) and (-12V) (state C), it shows that the connection to the electric vehicle 100 is completed and a charge enable signal from the electric vehicle 100 side is awaited. Still further, when the CPLT signal is a duty signal having a voltage level alternating between (+6V) and (-12V) (state D), it shows that the charge enable signal is

inputted from the electric vehicle 100 side.

<TABLE 1>

STATE	STATE NOTIFICATION SIGNAL	OPERATING STATE
A	+12V	WATING FOR VEHICLE CONNECTION
B	+9V	CHECKING VEHICLE CONNECTION
C	+9V/-12V DUTY SIGNAL	VEHICLE CONNECTION COMPLETION / CHARGE ENABLE SIGNAL WAIT
D	+6V/-12V DUTY SIGNAL	CHARGE ENABLE

Fig. 2 shows a concrete circuit diagram of the L-side voltage detector 23 and the N-side voltage detector 24. The L-side voltage detector 23 includes: a series circuit of a capacitor C1, a resistance R1, and a capacitor C2 which is connected between the power side line L1 and the ground line L3; a resistance R2 connected in parallel to the capacitor C2; a capacitor C3 connected to both ends of the capacitor C2 with a diode D1 interposed therebetween; a zener diode ZD1 and a resistance R5 each of which is connected in parallel to the capacitor C3; and a comparator CP1.

The comparator CP1 compares a voltage across the capacitor C3 to a reference voltage obtained by dividing a predetermined voltage supplied from the power source by a ratio of resistors R3 and R4, thereby detecting that no power is supplied to the power side line L1. An output of the comparator CP1 is inputted

to an input terminal PI3 of the control part 20. Herein, in the state where the power source side plug P1 is connected to a power receptacle and the relay RY1 is closed, the capacitor C3 is charged via the diode D1 during a half cycle in which the power side line L1 is in a positive polarity.

At this time, the voltage across the capacitor C3 exceeds the reference voltage and the output of the comparator CP1 is inverted into H level from L level. Note that, during the other half cycle for which the power side line L1 is in a negative polarity, charges stored in the capacitor C3 are discharged through the resistance R5, so that the voltage across the capacitor C3 decreases gradually. The capacitor C3 and the resistor R5 are preferably designed to have a time constant such that the voltage across the capacitor C3 does not decrease down to below the reference voltage during the negative half cycle of the power side line L1.

The N-side voltage detector 24, like the L-side voltage detector 23, includes: a series circuit of a capacitor C11, a resistance R11, and a capacitor C12, which are connected between the ground side line L2 and the ground line L3; a resistor R12 connected in parallel to the capacitor C12; a capacitor C13 connected to both ends of the capacitor C12 with a diode D11 interposed therebetween; a zener diode ZD11 and a resistor R15 each of which is connected in parallel to the capacitor C13; and a comparator CP11.

The comparator CP11 compares a voltage across the capacitor

C13 to a reference voltage obtained by dividing a predetermined voltage from the power source by a ratio of resistors R13 and R14, thereby detecting that no power is supplied to the ground side line L2. The output of the comparator CP11 is inputted into the input terminal PI4 of the control part 20. Herein, in the state where the power source side plug P1 is connected to the power receptacle and the relay RY1 is closed, the capacitor C13 is charged via the diode D11 during a half cycle for which the ground side line L2 is in a positive polarity.

At this time, the voltage across the capacitor C13 exceeds the reference voltage divided by the resistors R13, R14, and the output of the comparator CP11 is inverted to H level from L level. Note that, in the other half cycle for which the ground side line L2 is in a negative polarity, charges stored in the capacitor C13 are discharged through the resistance R15 so that the voltage across the capacitor C13 decreases gradually. The capacitor C13 and the resistance R15 are designed to have a time constant such that the voltage across the capacitor C13 does not decrease down to below the reference voltage during the negative half cycle of the ground side line L2.

Operation of the power feeding control device 1 of the present embodiment with the above configuration will be described.

First, an operation before starting to charge will be described with reference to Fig. 4. When a user connects the power source side plug P1 to the power receptacle (S1), the power

supply control device 1 is powered from the commercial AC power source and starts operating. In the state where no vehicle side plug P2 is connected to the electric vehicle 100, the CPLT signal outputted from the signal output part 27 has a value of +12 V (state A), and is inputted to the signal input part 26 (S2). The control part 20 determines, based on the CPLT signal inputted from the signal input part 26, that no vehicle side plug P2 is connected to the electric vehicle 100. Note that, in this state, the relay RY1 is in off state.

Secondly, when the user connects the vehicle side plug P2 to the receptacle 101 of the electric vehicle 100 (S3), the voltage level of the CPLT signal is changed to +9 V by the circuit of the vehicle side (state B), and the CPLT signal is inputted to the control part 20 via the signal input part 26.

When the CPLT signal turns into the state B (Yes in S4), the control part 20 determines that the vehicle side plug P2 has been connected to the electric vehicle 100. Then, the control part 20 moves into the charge enable waiting state and changes the CPLT signal to the state C through the signal output part 27 (S5). When the CPLT signal turns into the state C, the charge circuit 103 in the electric vehicle 100 determines that the power feeding control device 1 is in the charge enable waiting state. Accordingly, the charging circuit 103 turns on a charge enable switch. When the charge enable switch turns on at the electric vehicle 100 side (S6), the voltage level of the CPLT signal is changed to +6 V by the circuit of the electric vehicle 100 side,

and the CPLT signal for informing the charge enable is outputted to the control part 20 of the power feeding control device 1.

When the voltage level of the CPLT signal is changed to +6 V (Yes in S7), the control part 20 determines that the charging has been enabled by the electric vehicle 100 and changes the CPLT signal to the state D through the signal output part 27 (S8). Further, the control part 20 controls the relay driving unit 25 to turn on the relay RY1 (S9). Accordingly, an electric power is supplied to the electric vehicle 100, thereby starting the charging (S10).

Next, an operation check of the electric leakage detection part 22 and detection of a fusion-bonding in the relay at the timing of stopping the power supply to the electric vehicle 100 will be described with reference to a flow chart in Fig. 5A.

In the state where the electric power is supplied to the electric vehicle 100 from the power feeding control device 1, the CPLT signal has a voltage level of alternating between +6 V and -12 V (state D) (S11 in Fig. 5A). From this state, when the charging is completed in the electric vehicle 100 (S12), the electric vehicle 100 changes the signal level of the CPLT signal to +9V. The control part 20 of the power feeding control device 1 constantly monitors the CPLT signal inputted through the signal input part 26, and determines that the charging is completed and stops the power supply when the control part 20 detects that the voltage level of the CPLT signal is changed to +9 V (Yes of S13).

That is, the control part 20 controls the signal output

part 27 to change the CPLT signal to the state C (S14), and, after that, controls the electric leakage generation part 28 to simulate the virtual leakage (S15). At this time, if the electric leakage detection part 22 operates normally the electric leakage is detected. Accordingly, the electric leakage detection part 22 makes the relay RY1 opened and outputs the electric leakage detection signal to the input terminal PI1 of the control part 20.

After the virtual leakage is simulated by the electric leakage generation part 28, the control part 20 checks whether or not the electric leakage detection signal is inputted to the input terminal PI1 of the control part 20. When no electric leakage detection signal is inputted to the input terminal PI1 of the control part 20, the control part 20 determines that the electric leakage detection part 22 fails to detect electric leakage (No of S16), and lights on the error lamp LP2 (S17). In the present embodiment, an abnormal operation in the leakage detection is notified by turning on the error lamp LP2. However, it is not limited thereto, and it may be notified by a sound, e.g., by using a buzzer.

On the other hand, when the electric leakage detection signal is inputted to the input terminal PI1 of the control part 20, the control part 20 determines that the electric leakage detection part 22 detects the electric leakage (Yes in S16), and moves the fusion-bonding check in the relay RY1. When the electric leakage detection part 22 detects the electric leakage,

the control part 20 opens the relay RY1. If the relay RY1 is fusion-bonded, both voltages of the power side line L1 and the ground side line L2 at the secondary side of the relay RY1 become zero.

As described above, the L-side voltage detector 23 and the N-side voltage detector 24 detect whether or not voltages exceeding respective predetermined thresholds are generated on the power side line L1 and the ground side line L2 of the secondary side of the relay RY1. The control part 20 checks whether or not the fusion-bonding occurs based on the detection results of both voltage detectors 23 and 24 (S18). Namely, when the voltages exceeding the predetermined thresholds are generated in the secondary side of the relay RY1, the control part 20 determines that the relay RY1 is fusion-bonded, and informs of the fusion-bonding occurrence in the relay RY1 by lighting on the error lamp LP2 (S19).

On the other hand, when the secondary side voltages of the relay RY1 are below the predetermined thresholds, the control part 20 determines that the relay RY1 is not fusion-bonded (the relay RY1 is opened), and the error lamp LP2 remains lit off. Herein, a fusion-bonding detection part includes the L-side voltage detector 23, the N-side voltage detector 24, and the control part 20. An information part includes the error lamp LP2.

Further, the error lamp LP2 may have different lighting patterns distinguishing a detection of the fusion-bonding from

a detection of the abnormal operation of the leakage detection. Thus, various kinds of failures may be notified by distinguishing in lighting patterns. Further, the occurrence of the relay fusion-boding may be notified by, for example, sounding an alarm or a buzzer. In this case, the buzzer may be sounded so as to have a different tone between in detecting the fusion-bonding and in detecting the abnormal operation of the leakage detection. Thus, various kinds of failures can be notified by making differences in tone.

Further, the electric vehicle 100 (or the power feeding control device 1) informs a user of the completion of charging by using sound or light. When the user is informed of the completion of charging and disconnects the vehicle side plug P2 from the receptacle 101 (S20), the CPLT signal is changed to have a value of +12 V (state A). When the CPLT signal is changed to have the value of +12 V (Yes in S21), the control part 20 determines that the vehicle side plug P2 is disconnected from the receptacle 101 of the electric vehicle 100, and returns to the vehicle connection waiting state (S22).

As described above, the control part 20 controls the electric leakage generation part 28 to simulate a virtual electric leakage (self-leakage) at the timing of stopping the power supply to the electric vehicle 100. When the electric leakage detection part 22 detects an electric leakage, it makes the relay RY1 opened. Accordingly, without increasing the number of times of opening and closing of the relay RY1, the

leakage detection operation can be checked by the electric leakage generation part 28 and the electric leakage detection part 22, and the fusion-bonding of the relay RY1 can be checked by the L-side voltage detector 23 and N-side voltage detector 24. Thus, it is possible to prevent the lifetime of the power feeding control device 1 from being shortened.

In the present embodiment, the control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage at the timing when the charge completion signal that notifies the completion of charging as the state notification signal is inputted to the signal input part 26. However, it is not limited thereto, and the electric leakage may be simulated and detected at another time when stopping of the power supply to the electric vehicle can be determined.

For instance, the control part 20 may determine stopping of the power supply by detecting that no state notification signal is inputted because of disconnection of the vehicle side plug P2. This operation will be described below with reference to Fig. 5B.

In the state where a power is supplied to the electric vehicle 100 from the power feeding control device 1, the CPLT signal is in the state D (S11 in Fig. 5A). In this state, when the vehicle side plug P2 is disconnected from the receptacle 101 of the electric vehicle 100 (S23), the CPLT signal is changed to have a value of +12 V (state A) (Yes in S24). That is, when no state notification signal is inputted, the CPLT signal changes

to the state A. Accordingly, when the CPLT signal is changed to the state A from the state D, the control part 20 determines that no state notification signal is inputted from the electric vehicle 100 side, i.e., the vehicle side plug P2 is disconnected from the receptacle 101 of the electric vehicle 100, and then moves to a process upon stopping the power supply to the electric vehicle 100.

The control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage (S25). At that time, when the electric leakage detection part 22 is found to operate normally and detect the electric leakage, the electric leakage detection part 22 opens the relay RY1 and outputs the electric leakage detection signal to the input terminal PI1 of the control part 20. After simulating the virtual electric leakage by the electric leakage generation part 28, the control part 20 monitors whether or not the electric leakage detection signal is inputted to the input terminal PI1, and determines whether or not the leakage detection operates normally.

When no electric leakage detection signal is inputted to the input terminal PI1 of the control part 20, the control part 20 determines that the electric leakage detection part 22 can detect no electric leakage (No of S26) and lights on the error lamp LP2. Then, the user is informed of an abnormal of the leakage detection operation (S27).

On the other hand, when the electric leakage detection signal is inputted to the input terminal PI1 of the control part

20, the control part 20 determines that the electric leakage detection part 22 detects the electric leakage normally (Yes of S26) and then moves to a fusion-bonding check of the relay RY1. When the electric leakage detection part 22 detects the electric leakage, it opens the relay RY1. If the relay RY1 is not fusion-bonded, each of the power side line L1 and ground side line L2 has a voltage of zero at the secondary side of the relay RY1.

As described above, the L-side voltage detector 23 and the N-side voltage detector 24 detect whether or not the power side line L1 and the ground side line L2 have voltages of respective predetermined thresholds or more. The control part 20 checks whether or not the fusion-bonding occurs based on the detection results of both voltage detectors 23 and 24 (S28). Namely, when the power side line L1 and the ground side line L2 at the secondary side of the relay RY1 have voltages of the predetermined thresholds or more, the control part 20 determines that the relay RY1 is fusion-bonded, and informs of the fusion-bonding of the relay RY1 by lighting on the error lamp LP (S29).

On the other hand, when the power side line L1 and the ground side line L2 at the secondary side of the relay RY1 have voltages less than the respective predetermined thresholds, the control part 20 determines that the relay RY1 is not fusion-bonded (the relay RY1 is opened normally), and the error lamp LP2 remains turned off. At this time, the control part 20 controls the signal output part 27 to output the CPLT signal having the voltage of

+12 V (state A), and returns to the vehicle connection waiting state (S30).

The control part 20 moves to a process in stopping of the power supply when the operation stop button B2 (operation stop part) provided on the power supply control device 1 is pressed. This operation will be described below with reference to Fig. 5C.

In the state where a power is supplied to the electric vehicle 100 from the power supply control device 1, the CPLT signal is in the state D (S11 of Fig. 5A). When the operation stop button B2 is pressed in this state (S31), the control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage in response to the push operation (stop instruction) through the operation stop button B2 (S32). At this time, when the electric leakage detection part 22 operates normally and detects the leakage, the electric leakage detection part 22 opens the relay RY1 and outputs the electric leakage detection signal to the input terminal PI1 of the control part 20.

After simulating the virtual electric leakage by the electric leakage generation part 28, the control part 20 monitors whether or not the electric leakage detection signal is inputted to the input terminal PI1, and determines whether or not the leakage detection operates normally.

When no electric leakage detection signal is inputted, the control part 20 determines that the electric leakage detection

part 22 fails to detect the electric leakage (No in S33), and informs the user of the abnormal of the leakage detection operation by lighting on the error lamp LP2 (S34).

On the other hand, when the electric leakage detection signal is inputted, the control part 20 determines that the electric leakage detection part 22 can detect the electric leakage normally (Yes of S33), and then moves to the fusion-bonding check of the relay RY1. When detecting the electric leakage, the electric leakage detection part 22 opens the relay RY1. Therefore, if there is no fusion-bonding in the relay RY1, each of the power side line L1 and the grounding side line L2 has a voltage of zero at the secondary side of the relay RY1.

As described above, the L-side voltage detector 23 and the N-side voltage detector 24 detect whether or not the power side line L1 and the ground side line L2 have voltages of the respective predetermined thresholds or more at the secondary side of the relay RY1. The control part 20 determines, based on the detection results of both the voltage detectors 23 and 24, whether or not the fusion-bonding occurs (S35). Namely, when the power side line L1 and the ground side line L2 have the voltages equal to or more than the predetermined thresholds at the secondary side of the relay RY1, the control part 20 determines that the relay RY1 is fusion-bonded (Yes of S35), and informs of the fusion-bonding of the relay RY1 by turning on the error lamp LP2 (S36).

On the other hand, when voltages of the power side line L1 and the ground side line L2 at the secondary side of the relay RY1 are less than the predetermined thresholds, the control part 20 determines that the relay RY1 is not fusion-bonded (the relay RY1 is opened), and leaves the error lamp LP2 off. At this time, the control part 20 controls the signal output part 27 to change the CPLT signal to 0 V , and informs the electric vehicle 100 side that the power supply has been stopped (S37).

In the above described embodiment, when the charge completion signal is inputted from the electric vehicle 100, when the control part 20 determines that the vehicle side plug P2 is disconnected from the electric vehicle 100 by detecting no state notification signal, and when the operation stop button B2 is pressed in the power supply control device 1 side, the power feeding control device 1 checks the operation of the leakage detection and the fusion-bonding of the relay RY1 by simulating the virtual electric leakage. Therefore, it is possible to prevent increasing the number of times of opening and closing of the relay RY1.

As for the fusion-bonding of the relay RY1, the control part 20 determines whether or not the voltage is generated in the secondary side of the relay RY1 when the relay RY1 is opened, based on the detection results of the L-side voltage detector 23 and the N-side voltage detector 24. Fig. 6 shows the timing chart for explaining operation check of the electric leakage detection part 22 and the fusion-bonding check of the relay RY1

at the time of completing the charging.

At the time t1 of completing the charging, the voltage level of the CPLT signal is changed to +9 V from +6 V at the electric vehicle 100 side. At the time t2, when a time period of about 30 ms needed for confirming the signal is elapsed since the CPLT signal has been changed, the control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage.

When detecting the electric leakage, the electric leakage detection part 22 outputs the electric leakage detection signal to the control part 20 and opens the relay RY1. At the time t3 when a predetermined time period has passed from t2, the control part 20 checks the operation of the electric leakage detection part 22. Further, the control part 20 checks the fusion-bonding of the relay RY1 at the time t5 when a predetermined time period DT2 elapses after the time t2.

Herein, the control part 20 determines whether or not the relay RY1 is fusion-bonded based on the detection results of the L-side voltage detector 23 and the N-side voltage detector 24. In the L-side voltage detector 23, a voltage of the power side line L1 is divided and then smoothed by the capacitors C2 and C3 to provide a DC (direct current) voltage which is compared with the reference voltage. In the N-side voltage detector 24, a voltage of the power side line L2 is divided and then smoothed by the capacitors C12 and C13 to provide a DC voltage which is compared with the reference voltage.

Therefore, after the relay RY1 is opened, a time lag will occur due to residual charges in the capacitors until the outputs of both the voltage detectors 23 and 24 become L level. Since the time lag changes with a capacitor capacity, the predetermined time DT2 is necessary to be set longer than the time lag. Thus, it takes a longer time until the fusion-bonding is checked.

In order to solve this problem, as shown in Fig. 7, there may be provided a switching element Q1 for discharging the charges stored in the capacitors C2 and C3 of the L-side voltage detector 23; and the switching element Q2 for discharging the charges stored in the capacitors C12 and C13 of the N-side voltage detector 24. That is, the charges stored in the capacitors C2, C3, and the capacitors C12, C13, are discharged through discharging paths provided by discharge circuit parts including the switching elements Q1 and Q2, respectively. These switching elements Q1 and Q2 are normally turned off. In the present embodiment, the switching elements Q1, Q2 are formed of transistors, but may include switching elements other than the transistors.

When the electric leakage generation part 28 simulates the virtual electric leakage upon checking the operation of the leakage detection and the fusion-bonding, the control part 20 turns on the switching elements Q1, Q2 for a period of time to provide the discharging path. When the switching element Q1 is turned on, the charges stored in the capacitors C2, C3 are discharged. When the switching element Q2 is turned on, the

charges stored in the capacitors C12, C13 are discharged. This shortens the time lag until the detection results of the L-side voltage detector 23 and the N-side voltage detector 24 are changed to L level, thereby reducing the time lag until the fusion-bonding is checked.

Such operation will be described with reference to the timing chart shown in Fig. 8. When the charging is completed in the electric vehicle 100 at the time t11, the voltage level of the CPLT signal is changed to +9 V from +6 V at the side of the electric vehicle 100. At the time t12, i.e., after about 30 ms since the CPLT signal is changed, the signal becomes stable.

At the time t12, the control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage. When detecting this electric leakage, the electric leakage detection part 22 outputs the electric leakage detection signal to the control part 20 and opens the relay RY1. Further, after simulating the virtual electric leakage by the electric leakage generation part 28, the control part 20 turns on the switching elements Q1, Q2 during a period of time from the time t13 to the time t15, thereby discharging the charges stored in the capacitors C2 and C3 of the L-side voltage detector 23, and the capacitors C12 and C13 of the N-side voltage detector 24.

Furthermore, at the time t13 when a predetermined time period has passed from the time t12, the control part 20 checks the operation of the leakage detection. Besides, the control part 20 checks the fusion-bonding at the time t16 when a

predetermined time period DT5 elapses after time t15 at which the switching elements Q1, Q2 are turned off.

Herein, the time period DT4, starting from the time when the electric leakage is generated to the time when the switching elements Q1, Q2 are turned off, is set to be a time period (e.g., 130 ms) obtained by adding the time period (e.g., 50mS) for which the virtual electric leakage is simulated and the time period (e.g., 80mS) for which the charges stored in the capacitors of the L-side voltage detector 23 and the N-side voltage detector 24 are discharged, in the case where the relay RY1 opens normally. Further, in the case where the relay RY1 is fusion-bonded, the switching elements Q1, Q2 are turned off at the time t15 and the capacitors of the L-side voltage detector 23 and the N-side voltage detector 24 are charged. Herein, a certain amount of time is needed to change the outputs of the L-side voltage detector 23 and the N-side voltage detector 24 to the H level.

For that reason, a certain waiting time may be provided before the fusion-bonding is checked. For example, when the power source supplies a voltage of 85V, the waiting time does not exceed 100mS. Therefore, the waiting time period DT5 needed before the fusion-bonding is checked after turning off the switching elements Q1, Q2 may be set to 100mS. Consequently, a total time period until the fusion-bonding is checked after the virtual electric leakage is simulated may be set to be 230mS (a sum of DT4(=130 mS) and DT5(=100 mS)), for example. Thus, the total time can be reduced as compared with that of the sequence

shown in Fig. 6, thereby making it faster to detect and announce the fusion-bonding in the case where the relay RY1 is fusion-bonded. This makes it possible to improve safety.

Even when the vehicle side plug P2 is disconnected in the state where the relay RY1 is fusion-bonded, the vehicle side plug P2 is powered. With the present embodiment, since checking and informing the fusion-bonding can be performed before disconnecting the vehicle side plug P2 by the user is completed (e.g., one second), the safety can be improved. Note that Electrical Appliance and Material Safety requests that a voltage across plug pins has to be 45V or less at one second after the plug pins are removed from pin receivers. As described above, in the present embodiment, since the fusion-bonding can be checked and informed within one second, it is sufficient to ensuring safety.

Further, in the above power feeding control device 1, although the virtual electric leakage is simulated to check both the operation of the electric leakage detection part 22 and the fusion-bonding at the timing of stopping the power supply, the operation check of the electric leakage detection part 22 may be performed at the timing of starting the power supply. This operation will be described with reference to the timing chart shown in Fig. 9.

When the user inserts the power source side plug P1 into the power receptacle, an electric power of the commercial AC power source is supplied to the power feeding control device 1 and the

power feeding control device 1 starts operating. In the state where no vehicle side plug P2 is connected to the electric vehicle 100, a CPLT signal outputted from the signal output part 27 has a voltage of +12 V (state A), and the CPLT signal is inputted into the signal input part 26 (S50). At this point, the control part 20 determines that no vehicle side plug P2 is connected to the electric vehicle 100 based on the CPLT signal inputted from the signal input part 26.

Next, when the user inserts the vehicle side plug P2 into the receptacle 101 of the electric vehicle 100 (S51), the voltage of the CPLT signal inputted to the signal input part 26 changes into +9 V (state B).

When the CPLT signal changes into the state B (Yes in S52), the control part 20 of the power feeding control device 1 determines that the vehicle side plug P2 is connected to the electric vehicle 100, and controls the electric leakage generation part 28 to simulate the virtual electric leakage (S53). At this time, when operating normally, the electric leakage detection part 22 detects the electric leakage and outputs the electric leakage detection signal to the input terminal PI1 of the control part 20.

After controlling the electric leakage generation part 28 to simulate the virtual electric leakage, the control part 20 monitors whether or not the electric leakage detection signal is inputted to the input terminal PI1. When no electric leakage detection signal is inputted, the control part 20 determines that

the electric leakage detection part 22 cannot detect the electric leakage (No in S54), and informs the user of the electric leakage detection error by lighting on the error lamp LP2 (S55).

On the other hand, when the electric leakage detection signal is inputted to the input terminal PI1 of the control part 20, the control part 20 determines that the electric leakage detection part 22 can detect the electric leakage normally (Yes in S54), and moves to a charge enable waiting state. Then, the control part 20 controls the signal output part 27 to change the CPLT signal into the state C (S56).

When the CPLT signal is changed into the state C, the charge circuit 103 of the electric vehicle 100 determines that the power feeding control device 1 is in the charge enable waiting state, and makes a switch for enabling the charging operable. When the switch for enabling the charging is turned on at the side of the electric vehicle 100, the voltage level of the CPLT signal is changed to +6 V at the side of the electric vehicle 100, and the signal for enabling the charging is outputted to the power feeding control device 1.

When the voltage level of the CPLT signal is changed to +6 V (Yes in S57), the control part 20 determines that the charging to the electric vehicle 100 is enabled, and controls the signal output part 27 to change the CPLT signal into the state D (S58). Further, the control part 20 controls the relay driving unit 25 to close the relay RY1, thereby starting the charging (S59).

As described above, in the state where the relay RY1 is

opened before the power is supplied to the electric vehicle 100, a connection confirmation signal (the CPLT signal of +9 V) for informing that the vehicle side plug P2 is inserted into the receptacle 101 of the electric vehicle 100, as the state notification signal, is inputted into the signal input part 26. At this time, the control part 20 controls the electric leakage generation part 28 to simulate the virtual electric leakage.

Thus, the power feeding control device 1 can determine whether or not the electric leakage detection part 22 operates normally before starting the power supply to the electric vehicle 100. Therefore, after the normal operation of the electric leakage detection part 22 is checked, the power supply can be started. Further, since the virtual electric leakage is simulated in the state where the relay RY1 is opened, it is not necessary to open the relay RY1 upon detecting the electric leakage. As a result, the number of times of opening and closing of the relay RY1 is reduced, which prevents the lifetime of the power feeding control device 1 from being shortened.

In the above embodiments, although the portable power feeding control device 1 is used for connecting to the power receptacle, it may be of floortype. For instance, as shown in Fig. 11, the circuit part shown in Fig. 1 may be built in a body part 10 of standing type installed near a parking space, or in the body part 10 attached on a wall of dwellings such as a house. In such power feeding control device 1 of a standing type, the wiring from the power source may be connected to the primary side

of the relay RY1 in advance, which eliminates the need for the cable CB1 which connects between the power source and the power side plug P1.

While the invention has been shown and described with respect to the embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A power feeding control device having a power supply path from an external power source to an electric storage device installed in the electric vehicle, the power feeding control device comprising:

a relay connected in the power supply path;

an electric leakage detection part which detects an electric leakage in the power supply path and makes the relay opened;

an electric leakage generation part that simulates the electric leakage in the power supply path; and

a control part that controls opening and closing of the relay in response to a state notification signal inputted to the control part from the electric vehicle and controls the electric leakage generation part to simulate the electric leakage when power supply to the electric vehicle is stopped.

2. The power feeding control device of claim 1, further comprising:

a signal input part to which the state notification signal for notifying an operational state from the electric vehicle is inputted,

wherein the control part controls the electric leakage generation part to simulate the electric leakage when the power supply to the electric vehicle is stopped and a charge completion

signal for notifying charge completion is inputted to the signal input part.

3. The power feeding control device of claim 1, further comprising:

a plug detachably connected to a receptacle which is provided in the electric vehicle; and

a signal input part to which the state notification signal for notifying the operational state from the electric vehicle is inputted via the plug,

wherein the control part controls the electric leakage generation part to simulate the electric leakage when the control part determines that the power supply to the electric vehicle is stopped because the plug is disconnected by receiving no state notification signal.

4. The power feeding control device of any one of claims 1 to 3, further comprising:

an operation stop part that outputs, to the control part, a stop instruction for forcibly stopping the power supply to the electric vehicle in response to user's manipulation,

wherein the control part controls the electric leakage generation part to simulate the electric leakage when the power supply to the electric vehicle is stopped based on the stop instruction from the operation stop part.

5. The power feeding control device of any one of claims 1 to 4, further comprising:

a fusion-bonding detection part having a capacitor for smoothing a voltage at secondary side of the relay, which detects whether or not the relay is fusion-bonded based on a voltage across the capacitor when the relay is opened; and

a discharge circuit part which provides a discharging path to discharge charges stored in the capacitor for a period of time when the electric leakage is simulated by the electric leakage generation part.

6. The power feeding control device of claim 1, further comprising:

a plug detachably connected to a receptacle provided at the electric vehicle; and

a signal input part to which the state notification signal for notifying the operational state from the electric vehicle is inputted via the plug;

wherein, when a connection confirmation signal for informing that the plug has been connected to the receptacle is inputted to the signal input part as the state notification signal,

the control part controls the electric leakage generation part to simulate the electric leakage in the state where the relay is opened before the power is supplied to the electric vehicle.

7. The power feeding control device of any one of claims 1

to 4, further comprising:

a fusion-bonding detection part which detects whether or not the relay is fusion-bonded based on a voltage at the secondary side of the relay when the relay is opened; and

an information part for informing a fusion-bonding occurrence in the relay when the fusion-bonding detection part detects that the relay is fusion-bonded and informing an abnormal operation of the electric leakage detection part in the case where no electric leakage detection signal is inputted from the electric leakage detection part when the electric leakage occurs.

FIG. 1

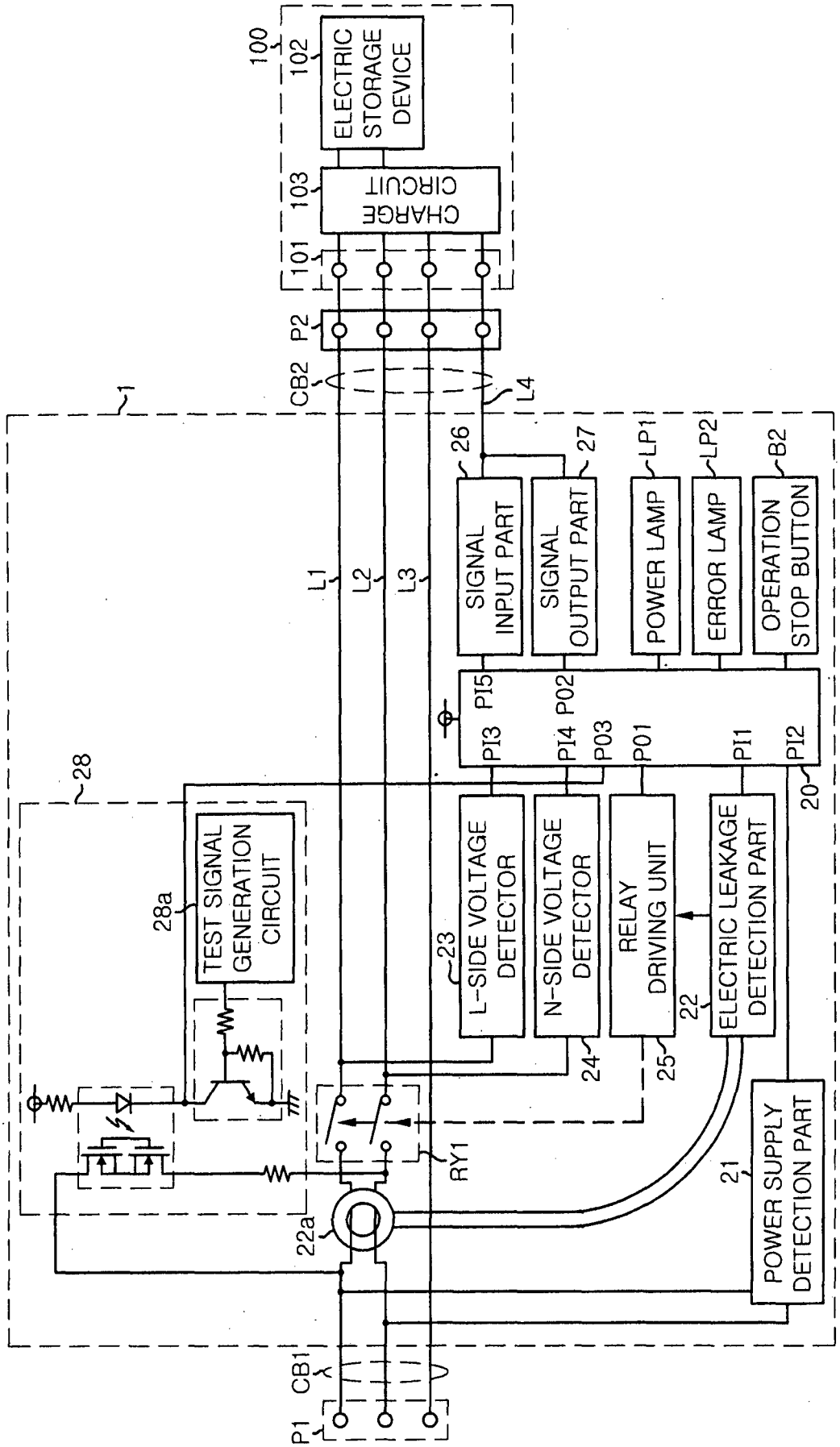

100
102
ELECTRIC STORAGE DEVICE
103
CHARGE CIRCUIT
101
P2
CB2
L4
1
26
27
LP1
LP2
B2
SIGNAL INPUT PART
SIGNAL OUTPUT PART
POWER LAMP
ERROR LAMP
OPERATION STOP BUTTON
L1
L2
L3
PI5
PI3
PI4
P02
P03
P01
PI1
PI2
20
28
28a
TEST SIGNAL GENERATION CIRCUIT
23
L-SIDE VOLTAGE DETECTOR
N-SIDE VOLTAGE DETECTOR
RELAY DRIVING UNIT
ELECTRIC LEAKAGE DETECTION PART
22
24
25
RY1
21
POWER SUPPLY DETECTION PART
22a
CB1
P1

FIG. 2

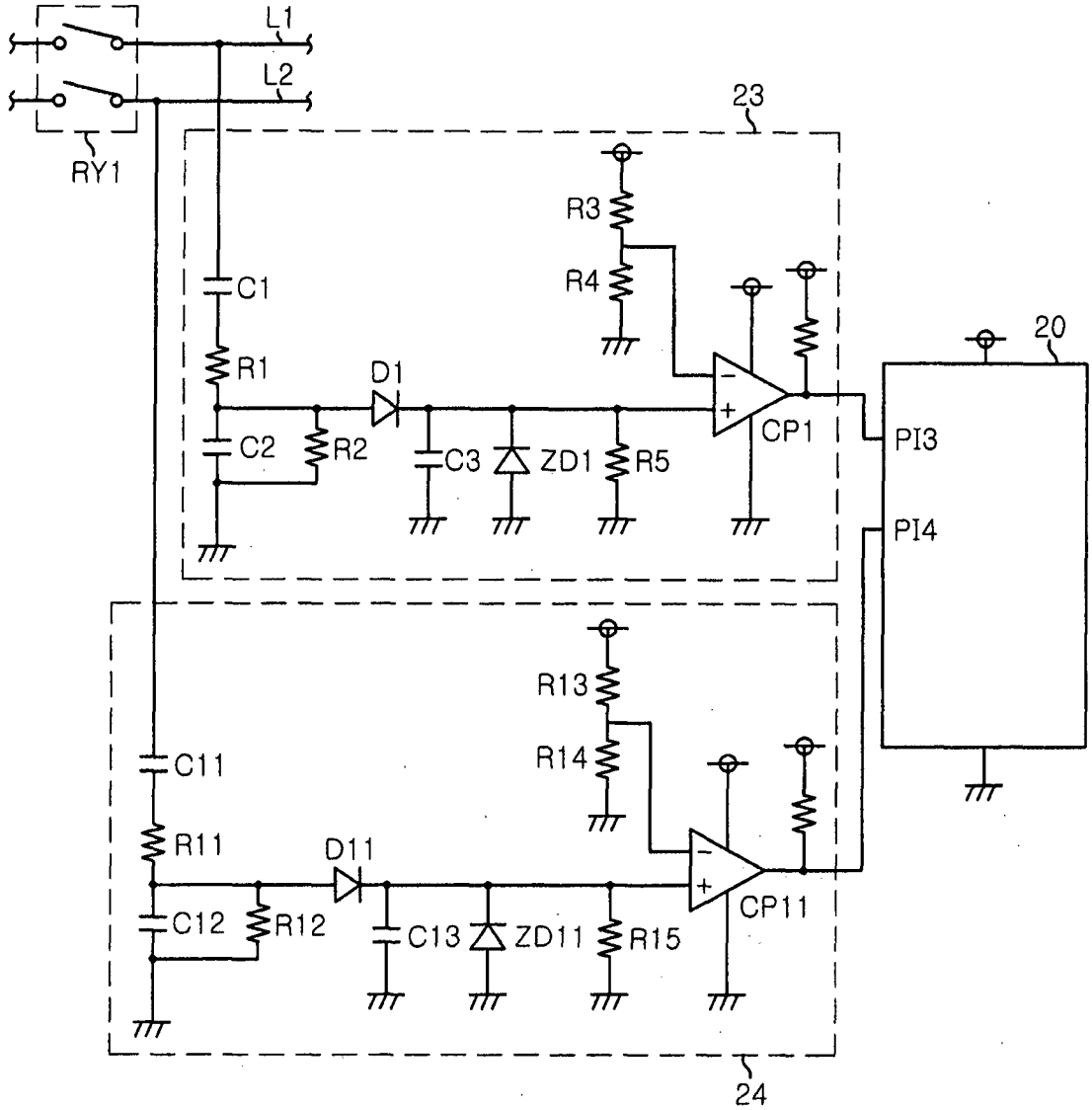

L1
L2
RY1
23
R3
R4
C1
R1
D1
C2
R2
C3
ZD1
R5
CP1
20
PI3
PI4
R13
R14
C11
R11
D11
C12
R12
C13
ZD11
R15
CP11
24

FIG.3

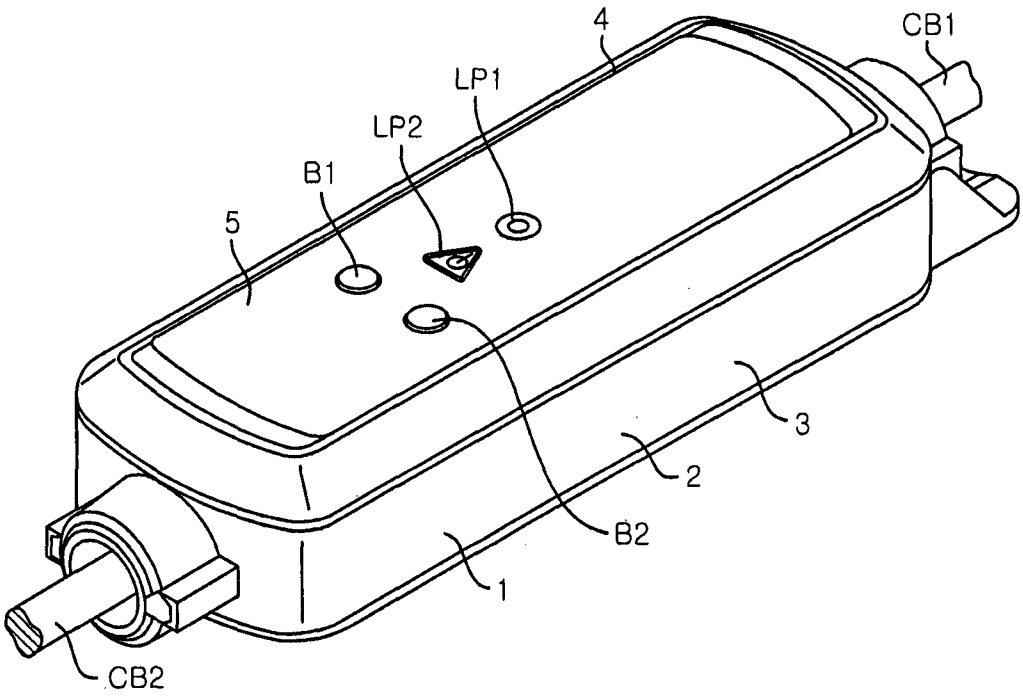


FIG. 4

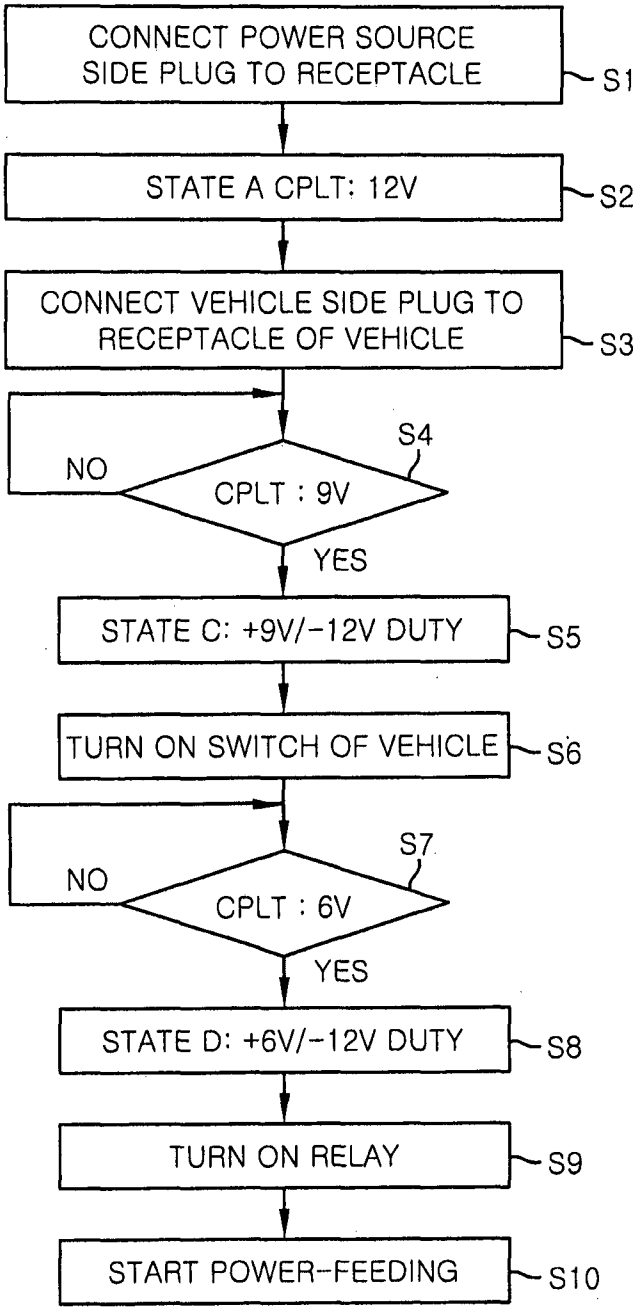

CONNECT POWER SOURCE SIDE PLUG TO RECEPTACLE
S1
STATE A CPLT: 12V
S2
CONNECT VEHICLE SIDE PLUG TO RECEPTACLE OF VEHICLE
S3
S4
NO
CPLT : 9V
YES
STATE C: +9V/−12V DUTY
S5
TURN ON SWITCH OF VEHICLE
S6
S7
NO
CPLT : 6V
YES
STATE D: +6V/−12V DUTY
S8
TURN ON RELAY
S9
START POWER-FEEDING
S10

FIG. 5A

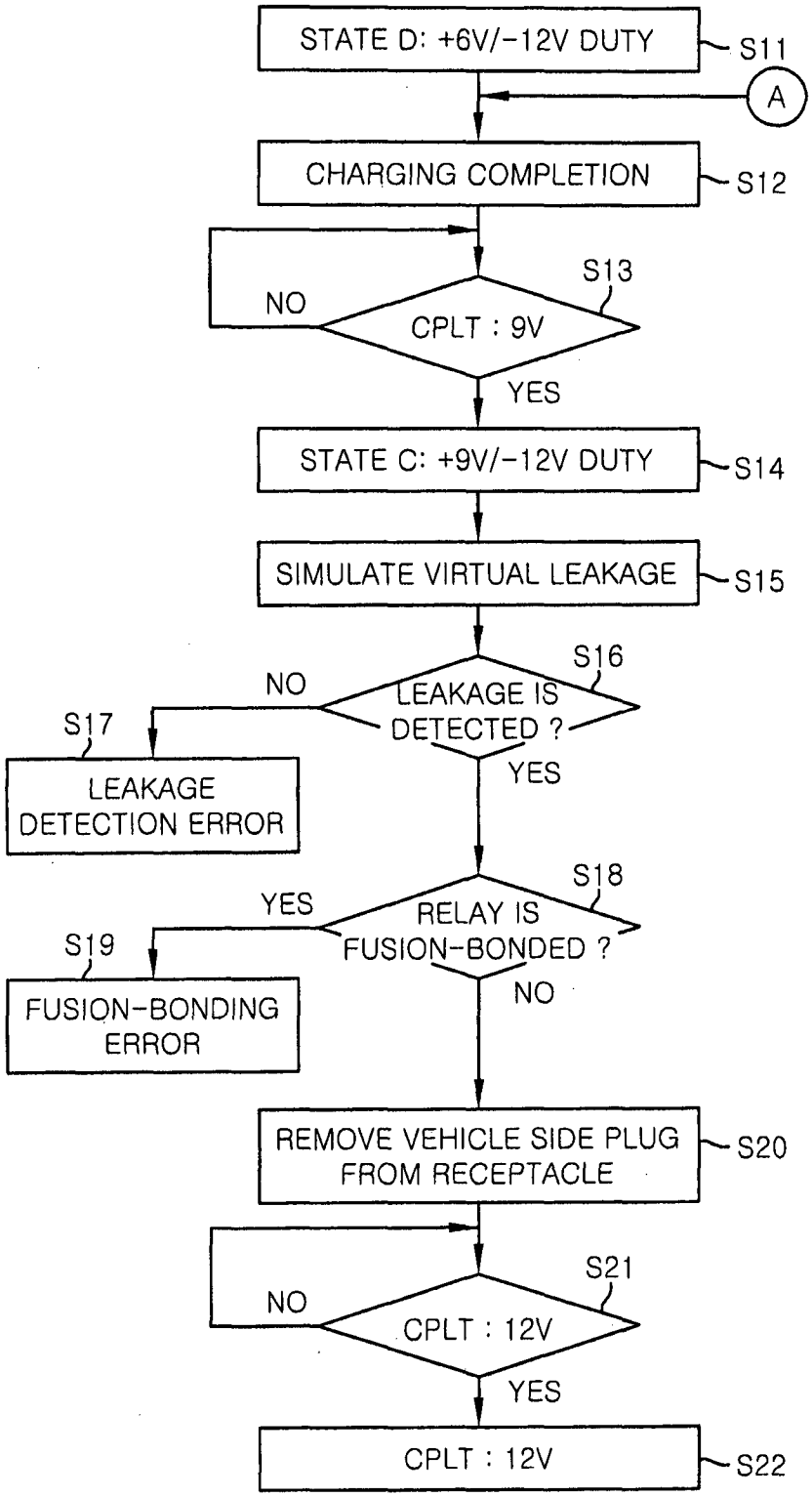

STATE D: +6V/-12V DUTY
S11
A
CHARGING COMPLETION
S12
S13
NO
CPLT : 9V
YES
STATE C: +9V/-12V DUTY
S14
SIMULATE VIRTUAL LEAKAGE
S15
S16
NO
LEAKAGE IS DETECTED ?
S17
LEAKAGE DETECTION ERROR
YES
S18
YES
RELAY IS FUSION-BONDED ?
S19
FUSION-BONDING ERROR
NO
REMOVE VEHICLE SIDE PLUG FROM RECEPTACLE
S20
S21
NO
CPLT : 12V
YES
CPLT : 12V
S22

FIG. 5B

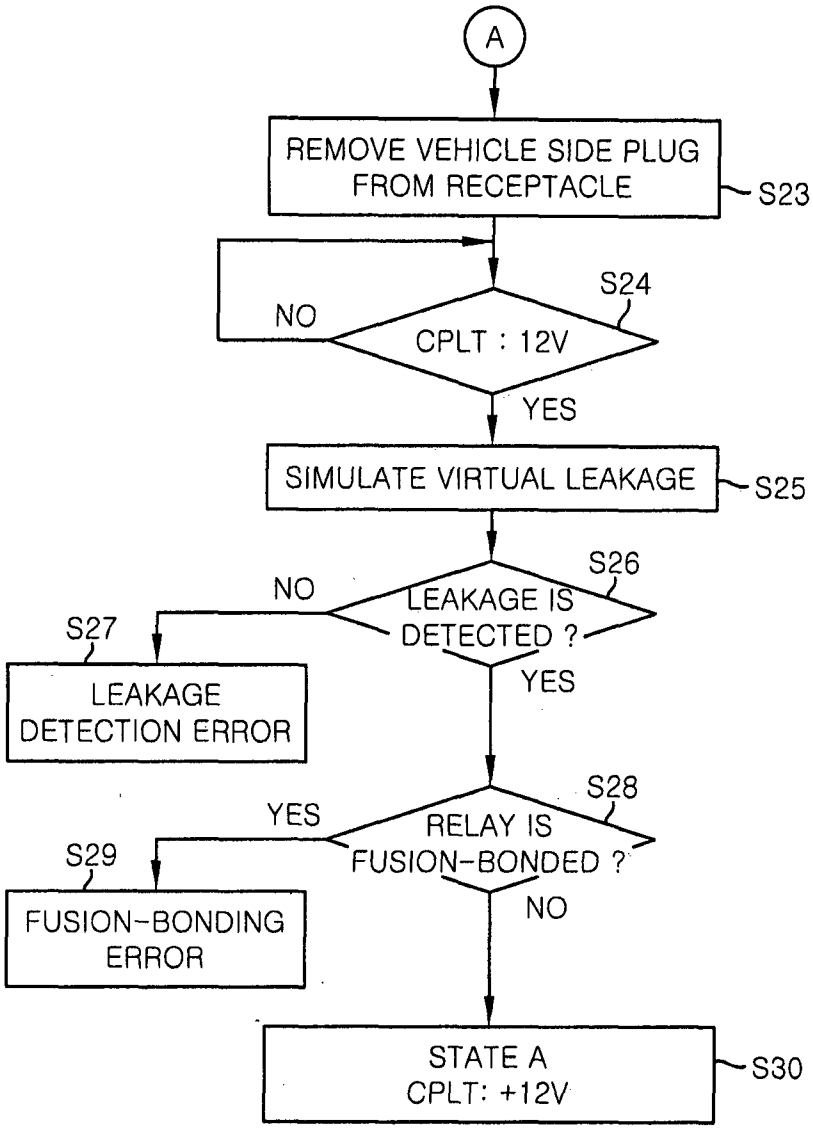

A
REMOVE VEHICLE SIDE PLUG FROM RECEPTACLE
S23
S24
NO
CPLT : 12V
YES
SIMULATE VIRTUAL LEAKAGE
S25
S26
NO
LEAKAGE IS DETECTED ?
S27
LEAKAGE DETECTION ERROR
YES
S28
YES
RELAY IS FUSION-BONDED ?
S29
FUSION-BONDING ERROR
NO
STATE A
CPLT: +12V
S30

FIG. 5C

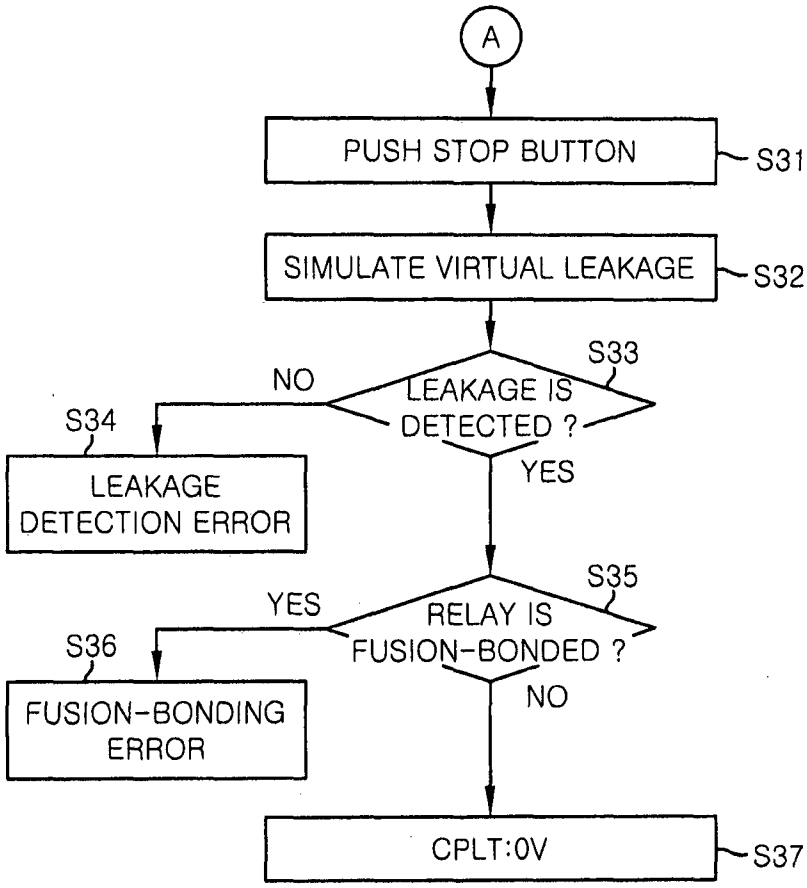

A
PUSH STOP BUTTON
S31
SIMULATE VIRTUAL LEAKAGE
S32
S33
LEAKAGE IS DETECTED ?
NO
S34
LEAKAGE DETECTION ERROR
YES
S35
RELAY IS FUSION-BONDED ?
YES
S36
FUSION-BONDING ERROR
NO
CPLT:0V
S37

FIG. 6

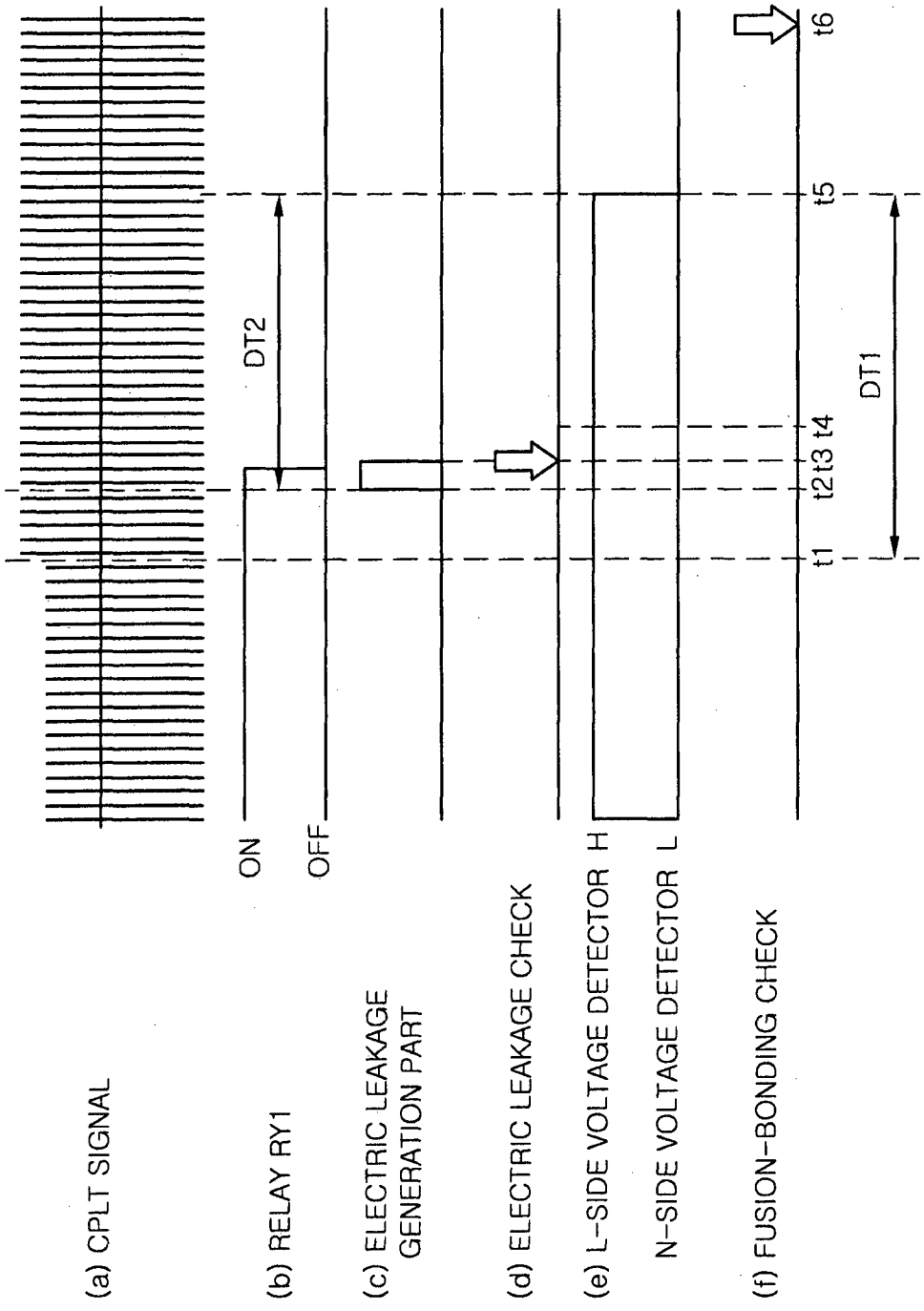

(a) CPLT SIGNAL
(b) RELAY RY1
ON
OFF
DT2
(c) ELECTRIC LEAKAGE GENERATION PART
(d) ELECTRIC LEAKAGE CHECK
(e) L-SIDE VOLTAGE DETECTOR H
N-SIDE VOLTAGE DETECTOR L
(f) FUSION-BONDING CHECK
t1
t2t3 t4
t5
t6
DT1

FIG. 7

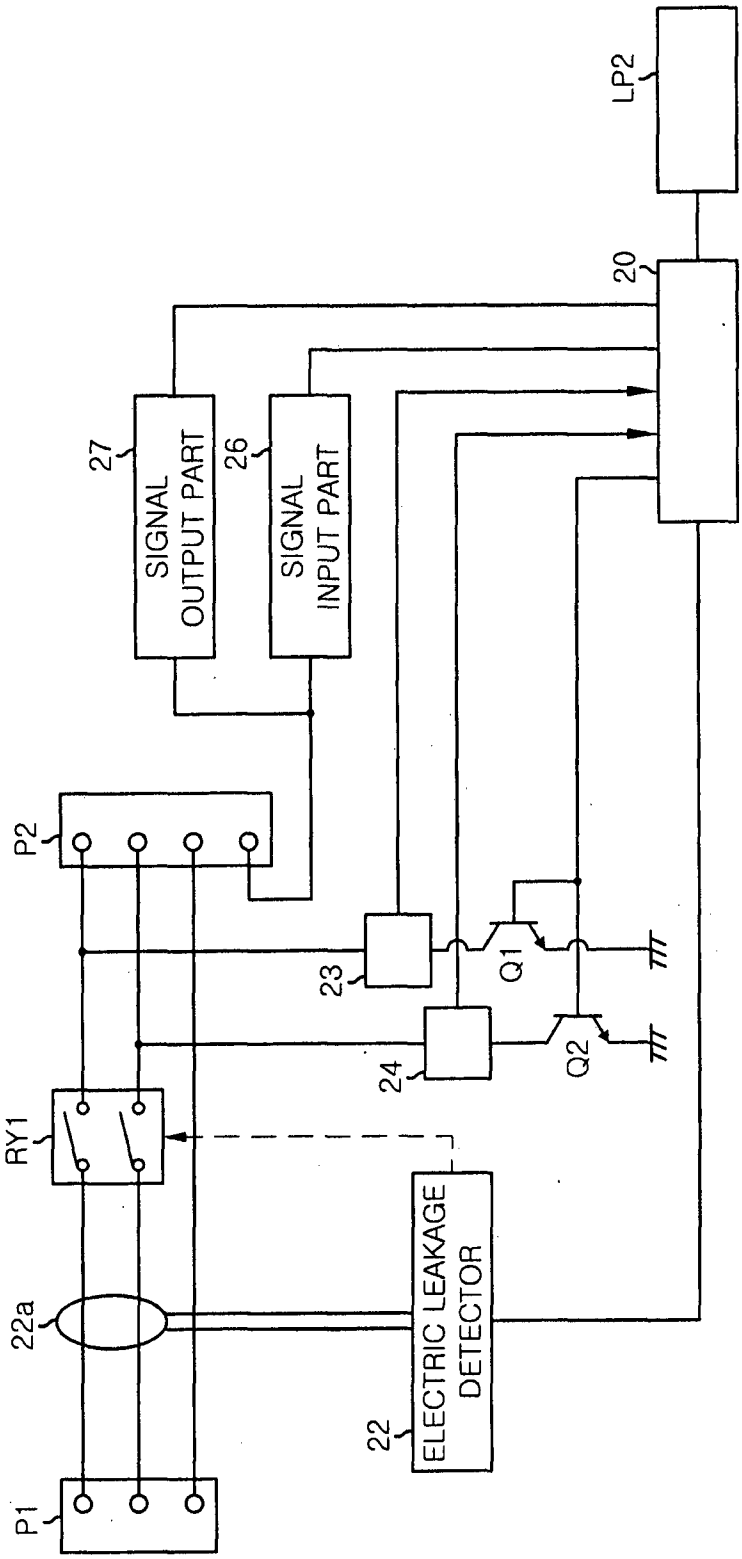

LP2
20
27
SIGNAL OUTPUT PART
26
SIGNAL INPUT PART
P2
23
Q1
24
Q2
RY1
22a
ELECTRIC LEAKAGE DETECTOR
22
P1

FIG. 8

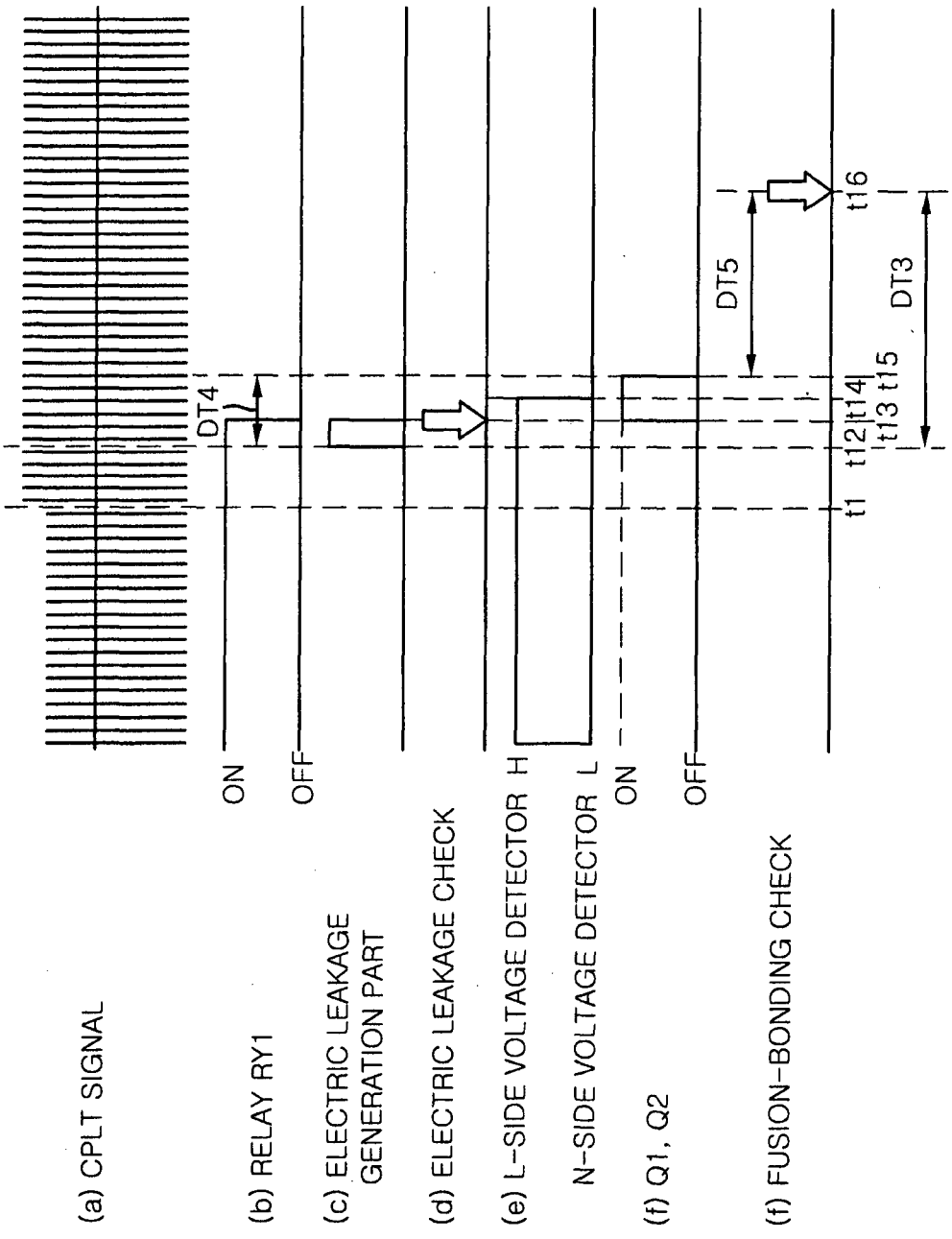

(a) CPLT SIGNAL
(b) RELAY RY1
ON
OFF
DT4
(c) ELECTRIC LEAKAGE GENERATION PART
(d) ELECTRIC LEAKAGE CHECK
(e) L-SIDE VOLTAGE DETECTOR H
N-SIDE VOLTAGE DETECTOR L
(f) Q1, Q2
ON
OFF
(f) FUSION-BONDING CHECK
DT5
DT3
t1
t12
t13
t14
t15
t16

FIG. 9

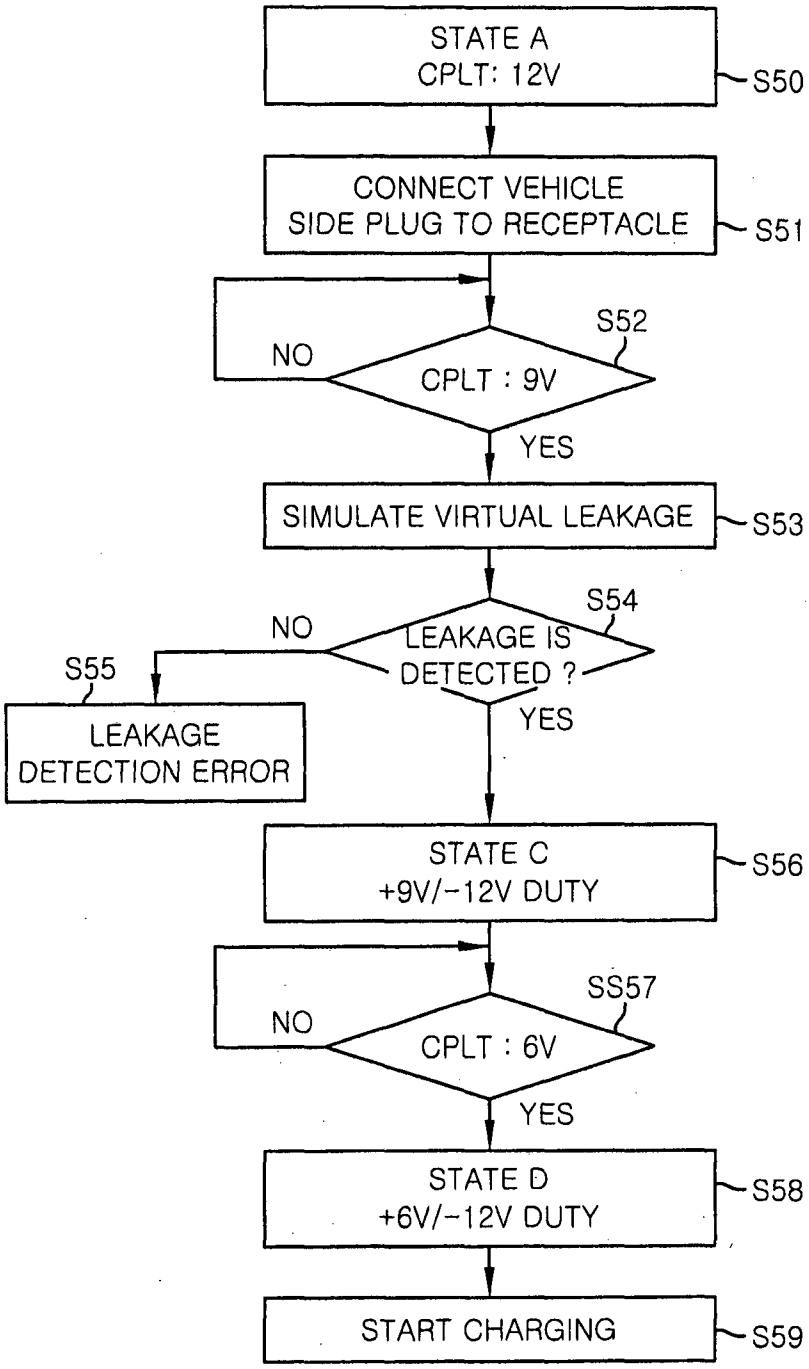

STATE A
CPLT: 12V
S50
CONNECT VEHICLE
SIDE PLUG TO RECEPTACLE
S51
S52
NO
CPLT : 9V
YES
SIMULATE VIRTUAL LEAKAGE
S53
S54
NO
LEAKAGE IS
DETECTED ?
S55
LEAKAGE
DETECTION ERROR
YES
STATE C
+9V/-12V DUTY
S56
SS57
NO
CPLT : 6V
YES
STATE D
+6V/-12V DUTY
S58
START CHARGING
S59

FIG. 10

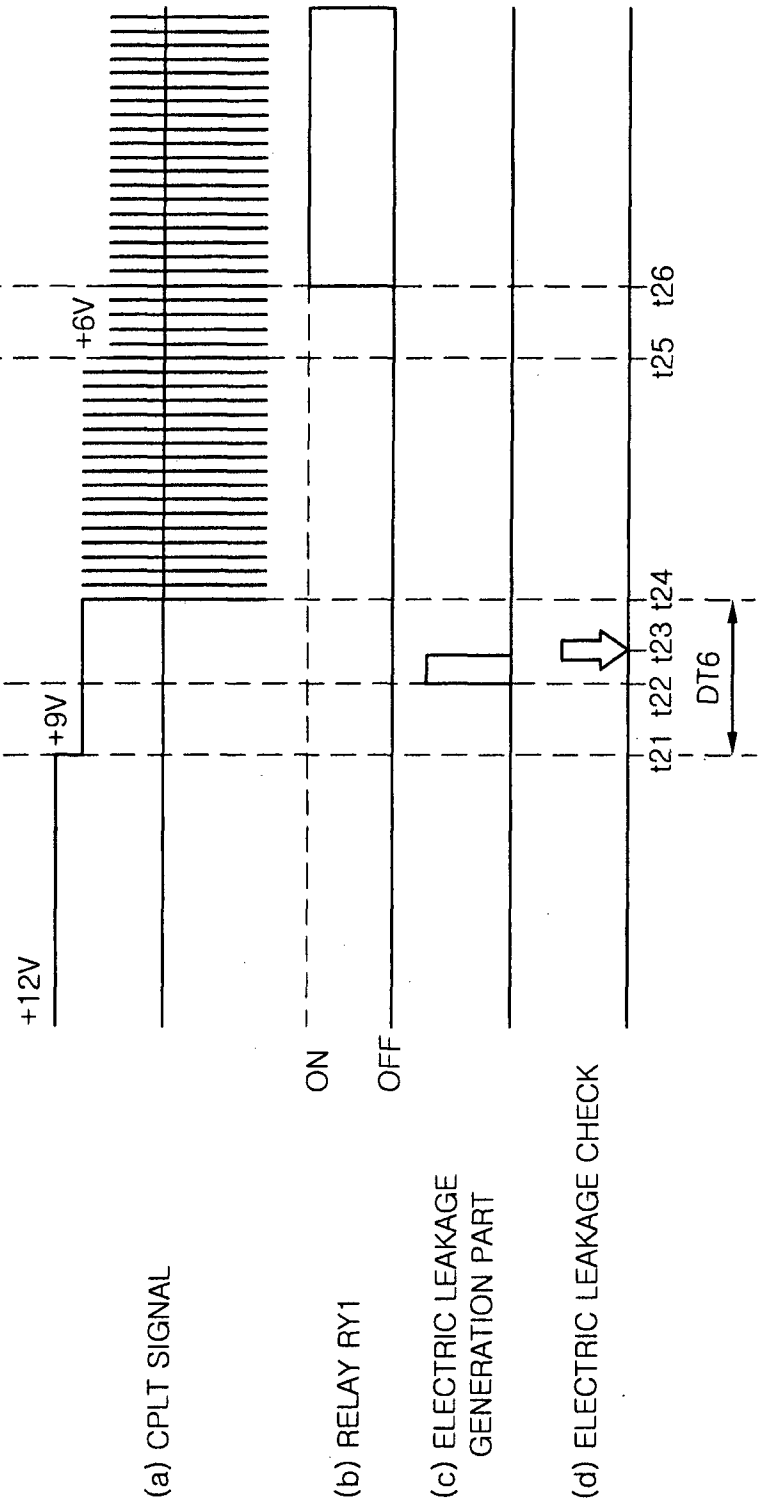
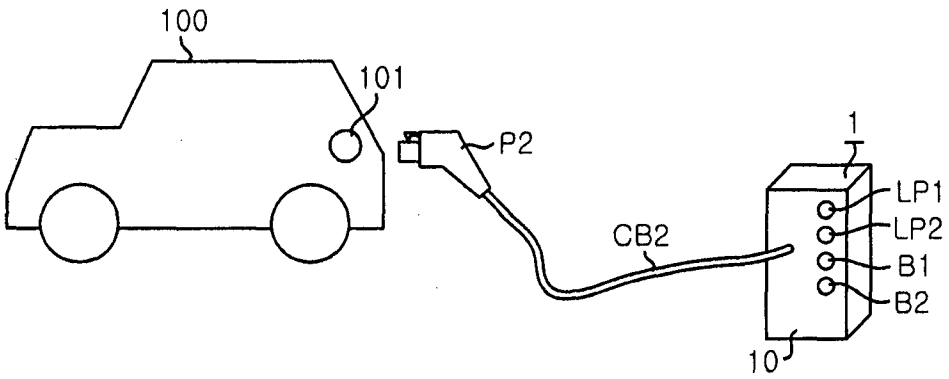

+12V
+9V
+6V
t21
t22
t23
t24
t25
t26
DT6
ON
OFF
(a) CPLT SIGNAL
(b) RELAY RY1
(c) ELECTRIC LEAKAGE GENERATION PART
(d) ELECTRIC LEAKAGE CHECK

FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/000137

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H02J7/00(2006.01)i, B60L11/18(2006.01)i, G01R31/02(2006.01)i, H02H3/16(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H02J7/00, B60L11/18, G01R31/02, H02H3/16

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2012
Registered utility model specifications of Japan 1996-2012
Published registered utility model applications of Japan 1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2008/153173 A1 (TOYOTA JIDOSHA KABUSHIKI KAISHA) 2008.12.18, the whole document & JP 2008-312380 A & US 2010/0033140 A1 & EP 2159898 A1 & CN 101682203 A	1-7
A	WO 2009/014143 A1 (PANASONIC ELECTRIC WORKS CO., LTD.) 2009.01.29, the whole document & JP 2009-33789 A & JP 2009-33790 A & JP 2009-32413 A & US 2010/0194354 A1 & EP 2184827 A1 & AU 2008280932 A & CA 2693300 A & CN 101755371 A & RU 2010106114 A	1-7
A	JP 2010-178454 A (MITSUBISHI MOTORS CORPORATION) 2010.08.12, the whole document (No Family)	1-7

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23.05.2012	05.06.2012

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Shuichi Miyamoto 5T 3357 Telephone No. +81-3-3581-1101 Ext. 3568

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/000137

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-217245 A (MATSUSHITA ELECTRIC WORKS CO., LTD.) 2000.08.04, the whole document (No Family)	1-7