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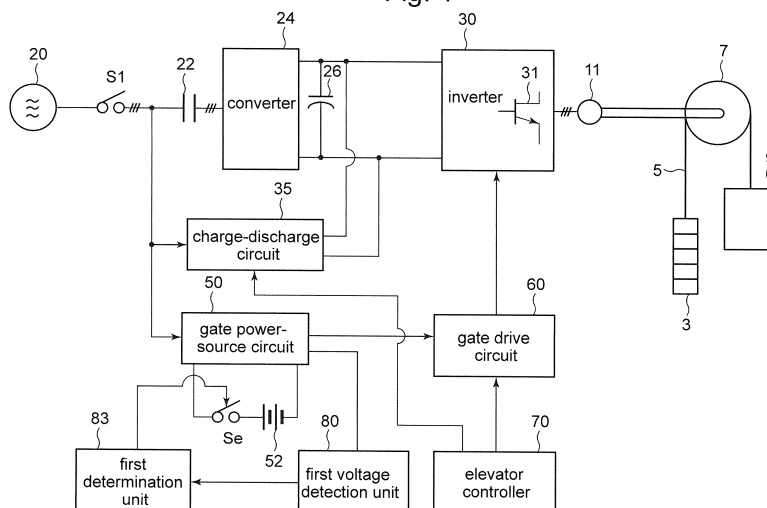
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(54) **CONTROL DEVICE FOR ELEVATOR**

(57) An elevator control system includes a converter (24) that converts an electric power from an AC power supply (20) to a DC power, a capacitor 26 that smoothes the DC power, an inverter (30) that converts the DC power to an arbitrary AC power by a gate drive circuit (60) performing on-off control of switching elements (31) and drives a motor (11) moving an elevator car (9), a gate power-source circuit (50) that generates a dc power on the basis of the AC power supply (20) and supplies the dc power to the gate drive circuit (60), a rechargeable

battery (52) that supplies a dc power to the gate drive circuit (60) when the AC power supply (20) is lost, a voltage detection unit (80) that detects the output of the gate drive circuit (60), a determination unit (83) that determines whether or not the value of the detected voltage is a threshold value or smaller, and a supply switch (Se) that supplies the dc power from the rechargeable battery (52) to the gate drive circuit (60) when the detected voltage value becomes the threshold value or smaller.

Fig. 1



Description

Disclosure of Invention

Technical Field

Problem to be Solved by the Invention

[0001] The present invention relates to an elevator control system.

Background Art

[0002] The main circuit of an elevator is provided with a converter converting an AC power to a DC power, a capacitor smoothing the converter output having voltage ripples into a smooth DC voltage, and an inverter converting the DC voltage to an arbitrary AC voltage using power semiconductor elements. The power semiconductor elements are generally composed of voltage-driven semiconductors such as IGBTs. Hence, a gate power source is necessary for driving the elements by switching their gate voltage between positive and negative.

[0003] Except when the elevator operates, the gate voltages are switched to negative for preventing the power semiconductor elements from malfunctioning. However, when the main power supply of the elevator is turned off, the outputs of the gate power source are also lost. This does not allow the gates to be negatively biased; thus, unless the voltage of the main circuit capacitor is discharged prior to the output loss of the gate power source, malfunctions of the gates could cause the semiconductor elements to form a bus short circuit.

[0004] A conventional elevator control system is known, as described in Patent Document 1, that includes an inverter for converting a DC voltage smoothed by a capacitor to an arbitrary AC voltage to control a motor for driving the elevator, a regeneration power dissipation resistor for dissipating a regeneration power generated in a motor regeneration operation through a regeneration current conduction element, and a charging circuit for charging the capacitor in advance, and further includes a voltage comparison circuit for sending an output when the capacitor voltage is larger than the output voltage of the charging circuit, and a charge storage capacitor for supplying, when the power supply is interrupted, stored electric charges as power to the voltage comparison circuit whose output makes conductive the regeneration current conduction element. In the conventional elevator control system, the capacitor is forcibly discharged through the regeneration power dissipation circuit when the power supply is interrupted, which realizes the forced discharge of the capacitor in a simple manner.

Prior Art Document

Patent Document

[0005] Patent Document 1: Japanese Patent Laid-Open No. H06-9164

[0006] However, the conventional elevator control system has a problem that when the main power supply is lost, it is not reliably guaranteed that before the output of a control power source for controlling the semiconductor elements included in the inverter is lost, electric charges stored in the capacitor smoothing the converter output voltage is discharged.

[0007] The present invention is made to solve the problem and aims to obtain an elevator control system that can appropriately control, when the main power supply is lost, the semiconductor elements by supplying a power to a control means controlling the semiconductor elements.

Means for Solving Problem

[0008] An elevator control system according to the present invention includes: a converter that converts an electric power from an AC power supply to a DC power using semiconductor elements; a capacitor that smoothes the DC power; an inverter that converts the DC power to an arbitrary AC power using switching elements and drives a motor moving an elevator car; a control means that performs on-off control of the switching elements; a control power-source means that generates a dc power on the basis of the AC power supply and supplies the dc power to the control means; a rechargeable battery that supplies a dc power to the control power-source means when the AC power supply is lost; a first voltage detection means that detects a value of a first voltage being the output of the control power-source means; a first determination means that determines whether or not the first voltage value is a first threshold value or smaller; and a supply means that supplies the dc power from the rechargeable battery to the control means when the first voltage value becomes the first threshold value or smaller.

[0009] In the elevator control system according to the present invention, the first determination means determines whether or not the first voltage value of the control power-source means is the first threshold value or smaller; and the supply means supplies an electric power from the rechargeable battery to the control means when the first voltage value becomes the first threshold value or smaller. Therefore, even when the output voltage of the control power-source means drops due to a power interruption or the like, the electric power can be continuously supplied to the control means from the rechargeable battery so that the switching elements can be appropriately controlled by the control means.

[0010] It is preferable that the elevator control system according to the present invention further includes a discharge means that discharges electric charges in the capacitor in response to loss of the AC power supply; a

second voltage detection means that detects a second voltage value being a value of the voltage across the capacitor; and a second determination means that determines whether or not the second voltage value is larger than a second threshold value, and furthermore, the supply means supplies the dc power from the rechargeable battery to the control means also when the second voltage value is larger than the second threshold value.

[0011] In the elevator control system according to the present invention, the supply means supplies the dc power from the rechargeable battery to the control means also when the second voltage value is larger than the second threshold value. Therefore, only in a case where a large current could flow due to power lines short-circuited by the switching elements of the inverter, the supply means is allowed to supply the electric power from the rechargeable battery to the control means, which thereby can reduce the battery capacity.

[0012] In the elevator control system according to the present invention, it is preferable that the control power-source means includes, at least, a first and a second control power-source means whose outputs are connected in parallel to each other, wherein the first control power-source means supplies a dc voltage to the control means, and the supply means supplies a dc voltage from the second control power-source means to the control means when the first voltage value becomes the first threshold value or smaller.

[0013] According to the elevator control system, an electric power can be supplied to the control means from the second control power-source means even when the first control power-source means fails, thereby enhancing the control power-source means' reliability against failure.

[0014] In the elevator control system according to the present invention, it is preferable that the output voltage of the second control power-source means is lower than that of the first control power-source means.

[0015] According to the elevator control system, when the first control power-source means operates normally, an electric power is supplied to the control means only from the first control power-source means but is not supplied from the second control power-source means. When the output voltage of the second control power-source means becomes higher than that of the first control power-source means, the second control power-source means supplies the electric power to the control means, which thereby allows the second control power-source means to have a reduced capacity.

[0016] In the elevator control system according to the present invention, it is preferable that the first control power-source means generates a first positive bias voltage for turning on the switching elements and a first negative bias voltage for turning off the switching elements, and the second control power-source means generates only a second negative bias voltage for turning off the switching elements.

[0017] In the elevator control system, the first and sec-

ond control power-source means generate the negative bias voltages. Therefore, even when the first control power-source means fails, the switching elements can be reliably turned off by the negative bias voltage generated from the second control power-source means. Furthermore, the second control power-source means can be simplified.

[0018] In the elevator control system according to the present invention, it is preferable that the switching elements constitute an upper arm and a lower arm, and the switching elements of the lower arm are turned off by the second negative bias voltage. In the elevator control system, because a duplex system is provided for generating the negative bias voltage for the switching elements constituting the lower arm of the inverter, the whole inverter can be reliably turned off even when the first control power-source means fails. Furthermore, the second control power-source means can be further simplified.

[0019] In the elevator control system according to the present invention, it is preferable that the second control power-source means generates a single output of a second negative bias voltage which is always connected to one of the first control power-source means outputs supplied to the plurality of switching elements of the lower arm, and application means are provided that apply the single output of the second negative bias voltage to the rest of the lower arm switching elements when the first determination means determines that the first voltage value is the first threshold value or smaller. This provides a duplex system. Therefore, even when the first control power-source means fails, the whole inverter can be reliably turned off by turning off the switching element of the lower arm. Thus, it suffices that the second control power-source means generates the single output of the negative bias voltage, thereby allowing the second control power-source means to be further simplified.

Effect of the Invention

[0020] When losing the main power supply, an elevator control system according to the present invention can supply an electric power to the control means controlling switching elements such as an inverter, so that the control means can appropriately control the switching elements.

Brief Description of the Drawings

[0021]

Fig. 1 is an overall diagram of an elevator of an embodiment according to the present invention; Fig. 2 is an inner configuration view of a gate power source shown in Fig. 1; Fig. 3 is an overall diagram of an elevator of another embodiment according to the present invention; Fig. 4 is an overall diagram of an elevator of another embodiment according to the present invention; Fig. 5 is an inner connection diagram showing a first

and second gate power-source circuits in Fig. 4;
 Fig. 6 is an inner connection diagram showing another first and second gate power-source circuits;
 Fig. 7 is an inner connection diagram showing another first and second gate power-source circuits;
 and
 Fig. 8 is an inner connection diagram showing another first and second gate power-source circuits.

Numerals

[0022]

9	car
11	motor
20	three-phase AC power supply
24	converter
26	capacitor
28	inverter
28a	semiconductor element
50	gate power source
52	rechargeable battery
60	gate drive circuit
61	first voltage detection unit
81	first determination unit
162	second voltage detection unit
182	second determination unit
Se	supply switch

Best Modes for Carrying Out the Invention

Embodiment 1

[0023] An embodiment according to the present invention will be explained using Fig. 1 and Fig. 2. Fig. 1 is an overall diagram of an elevator of the embodiment according to the present invention, and Fig. 2 is an inner configuration view of a gate power source shown in Fig. 1. In Fig. 1, the elevator is configured so that an end of a counter weight 3 is connected to one end of a rope 5, the other end of the rope 5 is connected to a car 9, the rope 5 is in contact with a groove of a traction machine sheave 7, so that the car 9 is moved upward and downward by a motor 11 rotating the traction machine sheave 7.

[0024] An elevator control system includes a main power supply switch S1 being normally open for a three-phase AC power supply 22, a converter 24 converting to DC voltage with ripples through a normally open contact 22 of an electromagnetic switch, a capacitor 26 smoothing the ripples of the DC voltage, an inverter 28 including semiconductor elements 28a converting the DC voltage to an arbitrary AC voltage to drive the motor 11, and a gate drive circuit 60 performing on-off control of semiconductor switching elements 31 in the inverter 28. The capacitor 26 is charged through the main power supply switch S1, and is discharged through a charge-discharge circuit 35 connected to both ends of the capacitor 26.

[0025] A gate power source 50 is provided that serves,

similarly through the main power supply switch S1, as a dc power source for the gate drive circuit 60, and the gate power-source circuit 50 is connected to a backup rechargeable battery 52 through a supply switch Se. An elevator controller 70 is also provided that generates control command signals for controlling the gate drive circuit 60 and the charge-discharge circuit 35.

[0026] There are also provided a first voltage detector 61 that detects a first voltage value, i.e. the output voltage of the gate power-source circuit 50, and a first determination unit 83 that determines whether or not the detected first voltage value is a first threshold value or smaller, and closes the supply switch Se having been opened if the detected value is the first threshold value or smaller, to supply an electric power from the rechargeable battery 52 to the gate drive circuit 60.

[0027] In the gate power-source circuit in Fig. 2, a diode 54 connected to an end of the supply switch Se is connected to an input end of a DC-DC converter 58, and the main power supply switch S1 is connected to an input of an AC-DC converter 52. The output of the AC-DC converter 52 is connected to the input end of the DC-DC converter 58 through a diode 56 and to the other input end of the DC-DC converter 58. The gate power source 50 is configured in a manner that in a condition that the supply switch Se is closed, an electric power is supplied to the DC-DC converter 58 from a power source having a higher voltage, out of the AC-DC converter 52 and the rechargeable battery 52.

[0028] The operation of the elevator control system thus configured will be explained using Fig. 1 and Fig. 2.

< Normal Operation >

[0029] When the main power supply switch S1 is closed and then the normally open contact 22 having been opened are closed, the AC power-supply voltage is inputted to the gate power source 50, so that a DC voltage is supplied to the gate drive circuit 60. Meanwhile, from the three-phase AC power supply, the converter 24 produces a DC power to be inputted to the inverter 30. The gate drive circuit 60 controls the inverter 30 in accordance with command signals from the elevator controller 70 to halt or drive the motor 11.

<Operation at Occurrence of Power Outage >

[0030] When a power outage occurs, the main power supply switch S1 and the normally open contact 22 having been closed are opened so that charges in the capacitor 26 are discharged through the charge-discharge circuit 35. Meanwhile, the output voltage of the gate power-source circuit 50 drops. The output voltage, i.e. a first voltage value, is detected by a first voltage detection unit 80 to be inputted to the first determination unit 83. The determination unit 83 determines whether or not the first voltage value is the first threshold value or smaller, and if the first threshold value or smaller, the determination

unit closes the supply switch Se having been open to supply an electric power from the rechargeable battery 52 to the gate drive circuit 60. Thus, because the gate drive circuit 60 can be normally controlled even when a power outage occurs, the switching elements 31 in the inverter 30 can also be controlled.

[0031] The elevator control system according to the above-described embodiment includes the converter 24 that converts an electric power from the three-phase AC power supply 20 to a DC power using semiconductor elements, the capacitor 26 that smoothes the DC power, the inverter 30 that converts, using the semiconductor elements 28a, the DC power to an arbitrary AC power to drive the motor 11 moving the elevator the car 9, the gate drive circuit 60 that serves as a control means to control the switching elements 31, the gate power-source circuit 50 that serves as a control power-source means to produce a dc power on the basis of the AC power supply 22, and to supply the dc power to the gate drive circuit 60, the rechargeable battery 52 that supplies a dc power to the gate power-source circuit 50 when the AC power supply is lost, the first voltage detection unit 80 that detects the first voltage value, i.e. the output of the gate power-source circuit 50, the first determination unit 83 that determines whether or not the first voltage value is the first threshold value or smaller, and the supply switch Se that serves as a supply means to supply the dc power from the rechargeable battery 52 to the gate drive circuit 60 when the first voltage value is the first threshold value or smaller.

[0032] According to the elevator control system, the determination unit 83 determines whether or not the first voltage value of the gate power-source circuit 50 is the first threshold value or smaller, and if the first threshold value or smaller, the determination unit closes the supply switch Se having been open, to supply an electric power from the rechargeable battery 52 to the gate drive circuit 60. Thus, because the electric power can be continuously supplied to the gate drive circuit 60 from the rechargeable battery 52 even when the output voltage of the gate power-source circuit 50 drops due to a power outage or the like, the switching elements 31 can be appropriately controlled by the gate drive circuit 60.

Embodiment 2

[0033] Another embodiment according to the present invention will be explained, using Fig. 3. Fig. 3 is an overall diagram of an elevator of another embodiment according to the present invention. In Fig. 3, the same numerals as those in Fig. 1 designate the same components, whose explanations will be omitted.

[0034] In Fig. 3, an elevator control system is configured such that a second voltage detector 180 detects a second voltage value across the capacitor 26, and a second determination unit 183 closes the supply switch Se having been open, to supply an electric power from the rechargeable battery 52 to the gate drive circuit 60 in a

condition that the first voltage value is the first threshold value or smaller and the second voltage value is larger than a second threshold value.

[0035] Under normal conditions, the elevator control system configured as described above operates in the same manner as that of Embodiment 1.

<Operation at Occurrence of Power Outage >

[0036] When a power outage occurs, the main power supply switch S1 and the normally open contact 22 having been closed are opened so that charges in the capacitor 26 are discharged through the charge-discharge circuit 35. Meanwhile, the output voltage of the gate power-source circuit 50 drops. The output voltage, i.e. the first voltage value, and the voltage across the capacitor 26 are detected and inputted to the second determination unit 183 by the first voltage detection unit 80 and the second voltage detector 180, respectively. The second determination unit 183 determines whether or not the first voltage value is the first threshold value or smaller and determines whether or not the second voltage value is larger than the second threshold value. Then, if the first voltage value is the first threshold value or smaller and the second voltage value is larger than the second threshold value, the second determination unit closes the switch S2 having been opened, to supply an electric power from the rechargeable battery 52 to the gate drive circuit 60. This enables the gate drive circuit 60 to be normally controlled even when a power outage occurs and to be supplied with an electric power, taking the magnitude of a short circuit current into account, when the voltage across the capacitor 26 is larger than the second threshold value.

[0037] An elevator control system according to the above-described embodiment preferably includes the charge-discharge circuit 35 discharging electric charges in the capacitor 26 in response to loss of the three-phase AC power supply 20, the second voltage detection unit 180 detecting the second voltage value of the capacitor 26, the second determination unit 183 determining whether or not the second voltage value is larger than the second threshold value, and the supply switch Se supplying an electric power to the gate drive circuit 60 from the rechargeable battery 52 when the first voltage value is the first threshold value or smaller and the second voltage value is larger than the second threshold value. That is, because the electric power is supplied to the gate drive circuit 60 from the rechargeable battery 52 only when the voltage value of the capacitor 26 is larger than the second threshold value, the capacity of the battery 52 can be reduced.

Embodiment 3

[0038] Another embodiment according to the present invention will be explained using Fig. 4 and Fig. 5. Fig. 4 is an overall diagram of an elevator of another embodiment according to the present invention; and Fig. 5 is an

inner connection diagram of a first and second gate power-source circuits in Fig. 4. In Fig. 4, the same numerals as those in Fig. 1 denote the same components.

[0039] In Embodiments 1 and 2, one gate power-source circuit 50 is provided; however, in this embodiment, a first gate power-source circuit 150 and a second gate power-source circuit 250 are provided, as shown in Fig. 4, which serve as a duplex system. The inverter 30 has an upper arm 32 and a lower arm 34 which include the switching elements 31: the upper arm 32 includes switching elements 31uu, 32uv, and 31uw, and the lower arm 34 includes switching element s31du, 31dv, and 31dw.

[0040] A voltage monitoring unit 200 is configured to detect output voltages of the first and second gate power-source circuits 150 and 250 and to generate an isolation signal for isolating the gate drive circuit 60 when the two output voltage values drop below predetermined threshold values.

[0041] In Fig. 5, each of the first and second gate power-source circuits 150 and 250 operates in a flyback manner and has six power output components for driving the six switching elements 31 of the inverter 30. In the first gate power-source circuit 150, a voltage is applied to a capacitor 154 from the three-phase AC power supply through a full-wave rectifying bridge 152. Both ends of the capacitor 154 are connected to the primary winding of a transformer 158 through a switching semiconductor element 156. The first power output components are provided with twelve windings in pairs thereof, and each pair is for generating positive and negative bias voltages to turn on and off the switching elements 31 of the upper arm 32 and the lower arm 34.

[0042] In the first power output component, one end of the secondary winding of the transformer 158 is connected to one end of a diode D11 (D12 through D16), the other end of the secondary winding is connected to one end of a diode D21 (D22 through D26), and a center point of the secondary winding is connected to one end of each of two smoothing capacitors C11 (C12 through C16) and C21 (C22 through C26). The other end of the smoothing capacitor C11 (C12 through C16) is connected to the other end of the diode D11 (D12 through D16), and the other end of the capacitor C21 (C22 through C26) is connected to the diode D21 (D22 through D26).

[0043] In the second gate power-source circuit 250, a voltage is applied to a capacitor 254 from the battery 52. Both ends of the capacitor 254 are connected to the primary winding of the transformer 158 through a switching semiconductor element 256. The second power output components are provided with twelve windings in pairs thereof, and each pair is for generating positive and negative bias voltages to turn on and off the switching elements 31 included in the inverter 30.

[0044] In the second power output component, one end of the secondary winding of a transformer 258 is connected to one end of a diode D31 (D32 through D36), the other end of the secondary winding is connected to

one end of a diode D41 (D42 through D46), and a center point of the secondary winding is connected to one end of each of two smoothing capacitors C31 (C32 through C36) and C41 (C42 through C46). The other end of the smoothing capacitor C31 (C32 through C36) is connected to the other end of the diode D31 (D32 through D36), and the other end of the capacitor C41 (C42 through C46) is connected to the diode D41 (D42 through D46).

[0045] Furthermore, the outputs of the second power output components are always connected to the first power output components in parallel.

[0046] When V1-1 and V2-1 denote the positive bias voltage and the negative bias voltage of the first gate power-source circuit 150, respectively, and V1-2 and V2-2 denote the positive bias voltage and the negative bias voltage of the second gate power-source circuit 250, respectively, the absolute values of the respective output voltages have relations below.

$$|V1-1| > |V1-2|, |V2-1| > |V2-2|$$

The above-described relations prevent the output current of the second gate power-source circuit 250 from flowing under a normal condition where the first gate power-source circuit 150 does not fail.

[0047] Operations of the elevator control system thus configured will be explained using Fig. 4 and Fig. 5.

<Normal operation>

[0048] When the main power supply switch S1 is closed and then the normally open contact 22 having been opened are closed, the AC power-supply voltage is inputted to the first gate power-source circuit 150, so that a DC voltage is supplied to the gate drive circuit 60.

[0049] Meanwhile, the converter 24 produces from the three-phase AC power supply, a DC power to be inputted to the inverter 30. The first gate drive circuit 150 controls the inverter 30 in accordance with command signals from the elevator controller 70 to halt or drive the motor 11.

<Operation at Abnormality>

[0050] When the voltages of the first gate power-source circuit 150 drop, for some reason, below the output voltages of the second gate power-source circuit 250, the outputs of the second gate power-source circuit 250 are inputted as gate signals to the switching elements 31 of the inverter 31. Therefore, even when the first gate power-source circuit 150 fails, the inverter 30 can be driven through the gate drive circuit 60 by the second gate power-source circuit 250. Furthermore, when a power outage occurs, the rechargeable battery 52 serves an input source, so that the inverter 30 can be driven through the gate drive circuit 60 fed by the second gate power-source circuit 250.

Embodiment 4

[0051] In Embodiment 3, both of the first gate power-

source circuit 150 and the second gate power-source circuit 250 generate the positive bias voltages and the negative bias voltages in order to configure, as shown in Fig. 5, a duplex gate-power-source circuit system; however, in this embodiment, a second gate power-source circuit 1250 is configured, as shown in Fig. 6, to generate only the negative bias voltage without generating the positive bias voltage, and the respective outputs of the negative bias voltage, i.e. the outputs of the second power output components, are always connected in parallel to those of the corresponding first power output components.

[0052] In the elevator control system thus configured, a duplex system ensures the negative bias voltage. By the duplex system, the switching elements 31 can be reliably turned off, because the negative bias voltage can be applied to the switching elements 31 in the inverter 30 from the second gate power-source circuit 1250 even when the first gate power-source circuit 150 cannot generate the negative bias voltage.

[0053] According to the duplex system, the elevator control system of this embodiment can be simplified in comparison to that of Embodiment 3, because positive-bias-voltage generation parts can be eliminated in the second gate power-source circuit 1250.

Embodiment 5

[0054] In Embodiment 4, the duplex system for gate power-source circuit is configured only for the negative bias voltage, as shown in Fig. 6; however, in this embodiment, a second gate power-source circuit 2250 is configured, as shown in Fig. 7, to generate only three outputs of the negative bias voltage applied to the switching elements 31 of the lower arm 34 in the inverter. The three outputs of the negative bias voltage, i.e. the outputs of the second power output components, are always connected in parallel to those of the corresponding first power output components.

[0055] In the elevator control system thus configured, a duplex system ensures the negative bias voltage for the switching elements 31 of the lower arm 34 in the inverter 30; thus, even when a failure occurs in a negative-bias-voltage-generation part of the first gate power-source circuit 150, the corresponding output of the negative bias voltage can be applied from the second gate power-source circuit 2250 to the switching elements 31 of the lower arm 34, thereby preventing the switching elements 31 from malfunctioning.

[0056] In this embodiment, because three negative-bias-voltage-generation parts can be eliminated that are for the switching elements 31 of the upper arm 32 in the inverter 30, the second gate power-source circuit 2250 can be simply configured in comparison to that in Embodiment 4.

Embodiment 6

[0057] In Embodiment 5, the second gate power-source circuit 2250 generates, as shown in Fig. 7, only three outputs of the negative bias voltage for the switching elements 31 of the lower arm 34 in the inverter 30, and the three outputs of negative bias voltage, i.e. the outputs of the second power output components, are always connected in parallel to those of the corresponding first power output components; however, in this embodiment, a second gate power-source circuit 3250 is configured, as shown in Fig. 8, to generate only one output of the negative bias voltage applied to the switching element 31 of the lower arm 34 in the inverter 30, and the one output of the negative bias voltage is always connected in parallel to the negative bias voltage output of the first gate power-source circuit 150. Then, the one output of the negative bias voltage is connected through switches S1-S4 to the rest of the negative bias voltage outputs to be inputted to two switching elements 31 of the lower arm 34 in the inverter 30.

[0058] According to the elevator control system thus configured, when a failure is detected in generation parts generating the rest of the negative bias voltages in the first gate power-source circuit 150, the switches S1-S4 are turned on to apply the negative bias voltage from the second gate power-source circuit 3250 to the switching elements 31 of the lower arm 34, thereby preventing the switching elements 31 from malfunctioning.

[0059] In this embodiment, because two negative-bias-voltage-generation parts can be eliminated that are for the switching elements 31 of the lower arm 34 in the inverter 30, the second gate power-source circuit can be simplified in comparison to that in Embodiment 5.

[0060] In addition, the switching elements 31 in the inverter 30 used in Embodiments 1 to 6 may be made up of a silicon semiconductor, however it is preferable that the switching elements are made up of a wide band gap semiconductor having a band gap wider than silicon. A wide band gap semiconductor includes, for example, silicon carbide, gallium nitride material, and diamond.

[0061] The switching elements 31 made up of such a wide band gap semiconductor have a high performance in withstanding voltage and have a high tolerance for current density, therefore the switching elements 31 can be miniaturized; thus, by using the miniaturized switching elements 31, an inverter using the miniaturized switching elements can be made smaller. In addition, even when the switching elements 31 in the inverters 30 of Embodiments 1 through 6 are made up of a wide band gap semiconductor, the switching elements 31 can be appropriately controlled even if the AC power supply is lost.

Industrial Applicability

[0062] The present invention is applicable to elevator control systems.

Claims**1.** An elevator control system comprising:

a converter that converts an electric power from an AC power supply to a DC power using semiconductor elements;
 a capacitor that smoothes the DC power;
 an inverter that converts the DC power to an arbitrary AC power using switching elements and drives a motor moving an elevator car;
 a control means that performs on-off control of the switching elements;
 a control power-source means that generates a dc power on the basis of the AC power supply and supplies the dc power to the control means;
 a rechargeable battery that supplies a dc power to the control power-source means when the AC power supply is lost;
 a first voltage detection means that detects a value of a first voltage being the output of the control power-source means;
 a first determination means that determines whether or not the first voltage value is a first threshold value or smaller; and
 a supply means that supplies the dc power from the rechargeable battery to the control means when the first voltage value becomes the first threshold value or smaller.

2. The elevator control system according to claim 1, further comprising:

a discharge means that discharges electric charges in the capacitor in response to loss of the AC power supply;
 a second voltage detection means that detects a second voltage value being a value of the voltage across the capacitor; and
 a second determination means that determines whether or not the second voltage value is larger than a second threshold value,

wherein the supply means supplies the dc power from the rechargeable battery to the control means also when the second voltage value is larger than the second threshold value.

3. The elevator control system according to claim 1 or claim 2, wherein the control power-source means includes, at least, a first and a second control power-source means whose outputs are connected in parallel to each other, and wherein the first control power-source means supplies a dc voltage to the control means, and the supply means supplies the dc power from the second control power-source means to the control means when the first voltage value becomes the first threshold value or smaller.

4. The elevator control system according to claim 1 or claim 2, wherein the output voltage of the second control power-source means is lower than that of the first control power-source means.

5. The elevator control system according to claim 4, wherein the first control power-source means generates a first positive bias voltage for turning on the switching elements and a first negative bias voltage for turning off the switching elements, and the second control power-source means generates only a second negative bias voltage for turning off the switching elements.

6. The elevator control system according to claim 5, wherein the switching elements constitute an upper arm and a lower arm, and the switching elements of the lower arm are turned off by the second negative bias voltage.

7. The elevator control system according to claim 5, wherein the second control power-source means generates a single output of the second negative bias voltage which is always connected to one of the first control power-source means outputs supplied to the plurality of switching elements of the lower arm, and wherein application means are provided that apply the single output of the second negative bias voltage to the rest of the lower arm switching elements when the first determination means determines that the first voltage value is the first threshold value or smaller.

8. The elevator control system according to any one of claims 1 to 7, wherein the switching elements are made up of a wide band gap semiconductor.

Fig. 1

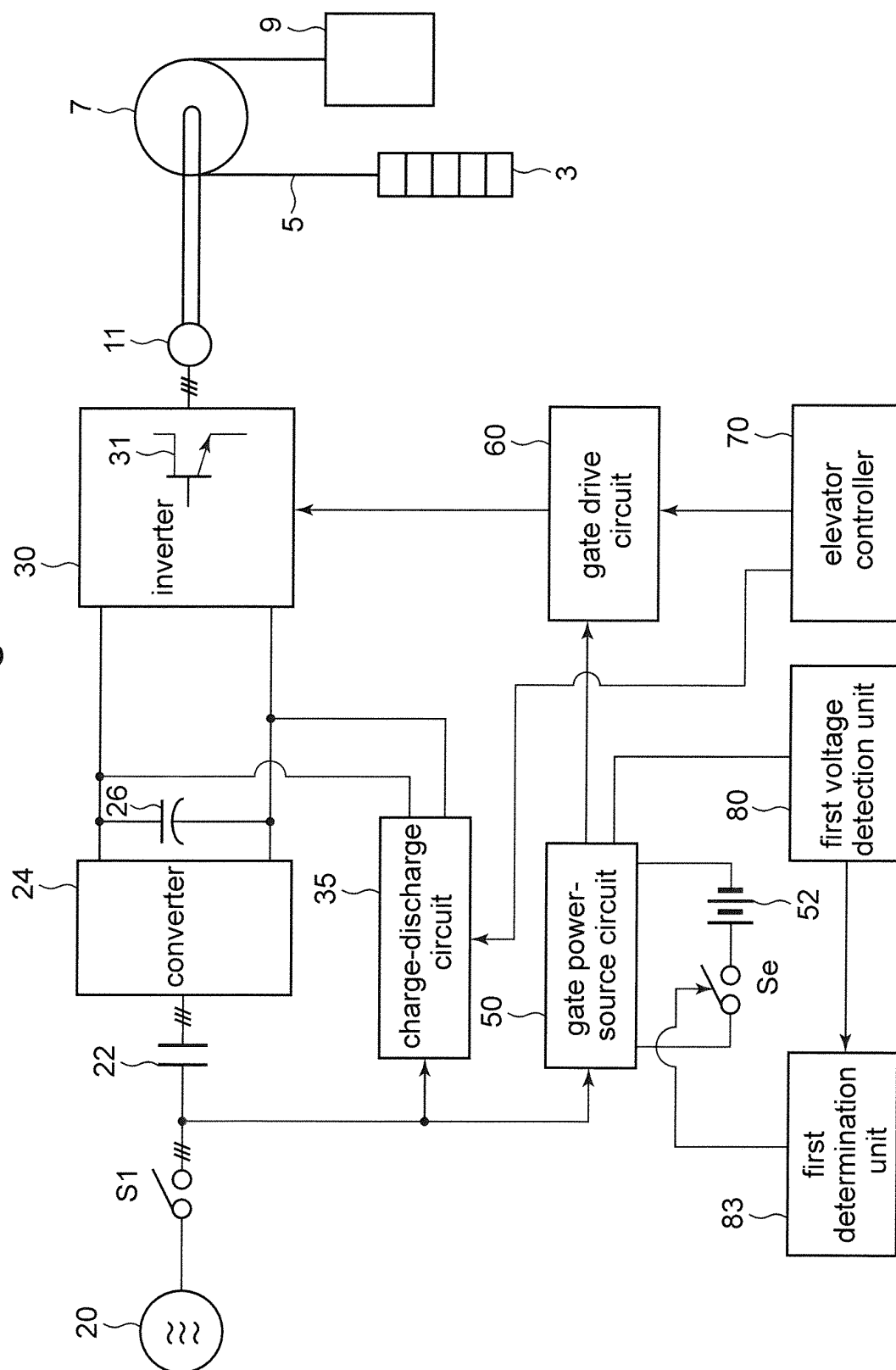


Fig. 2

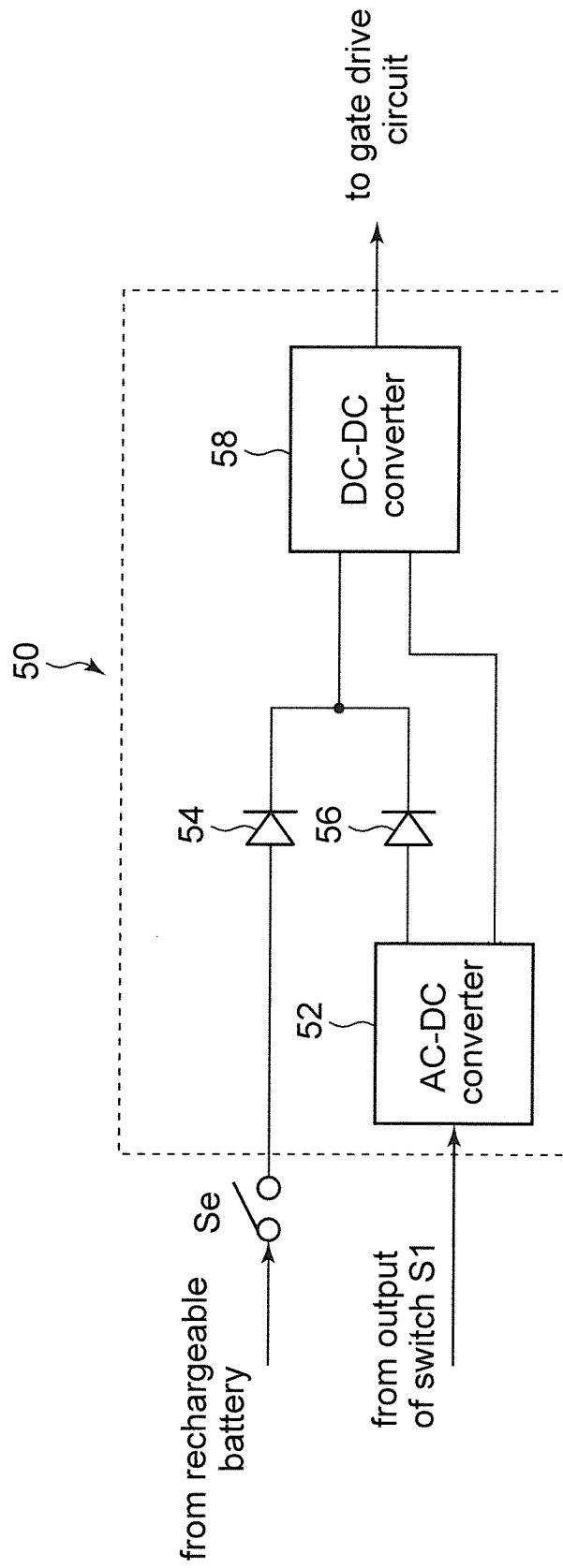


Fig. 3

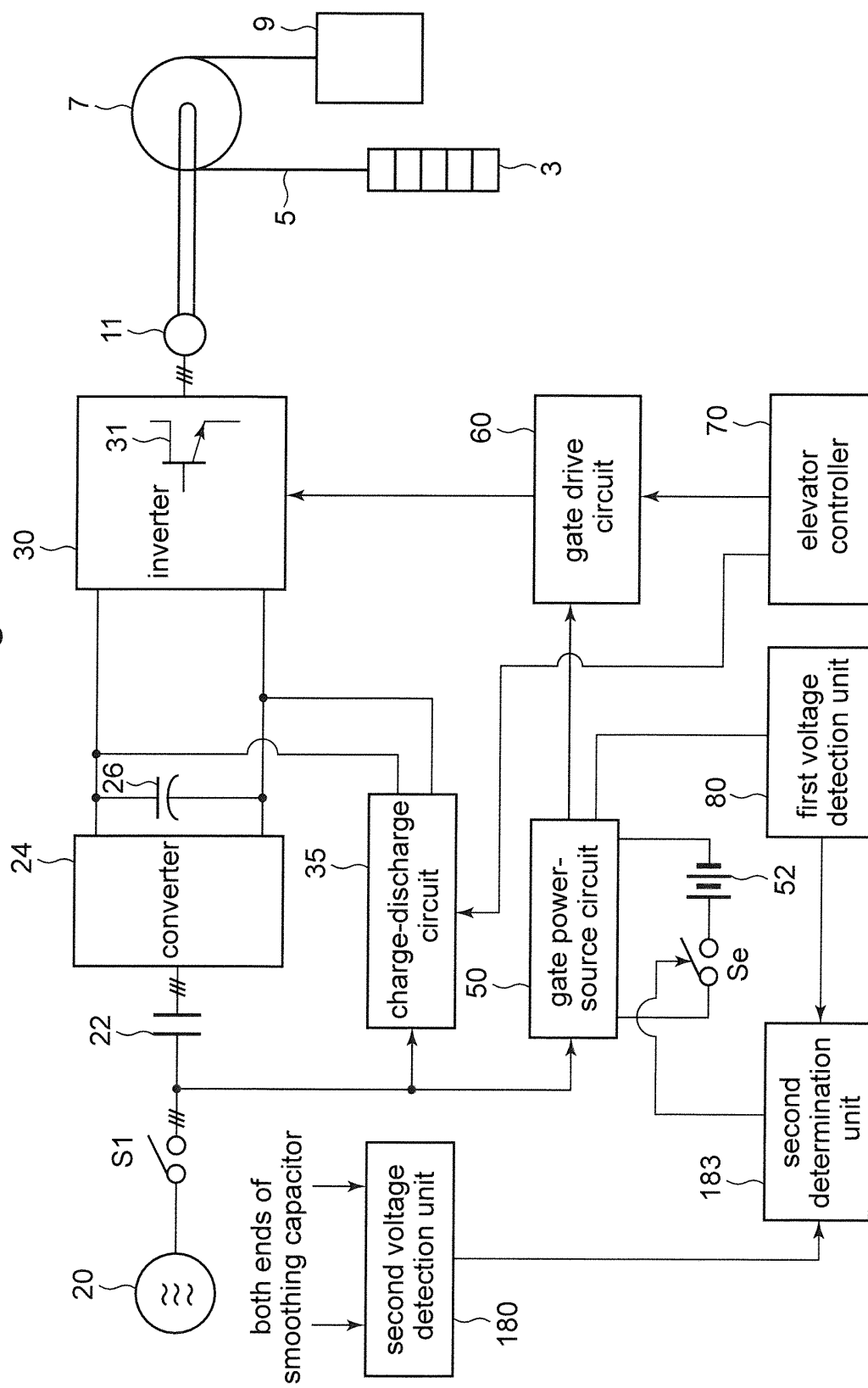


Fig. 4

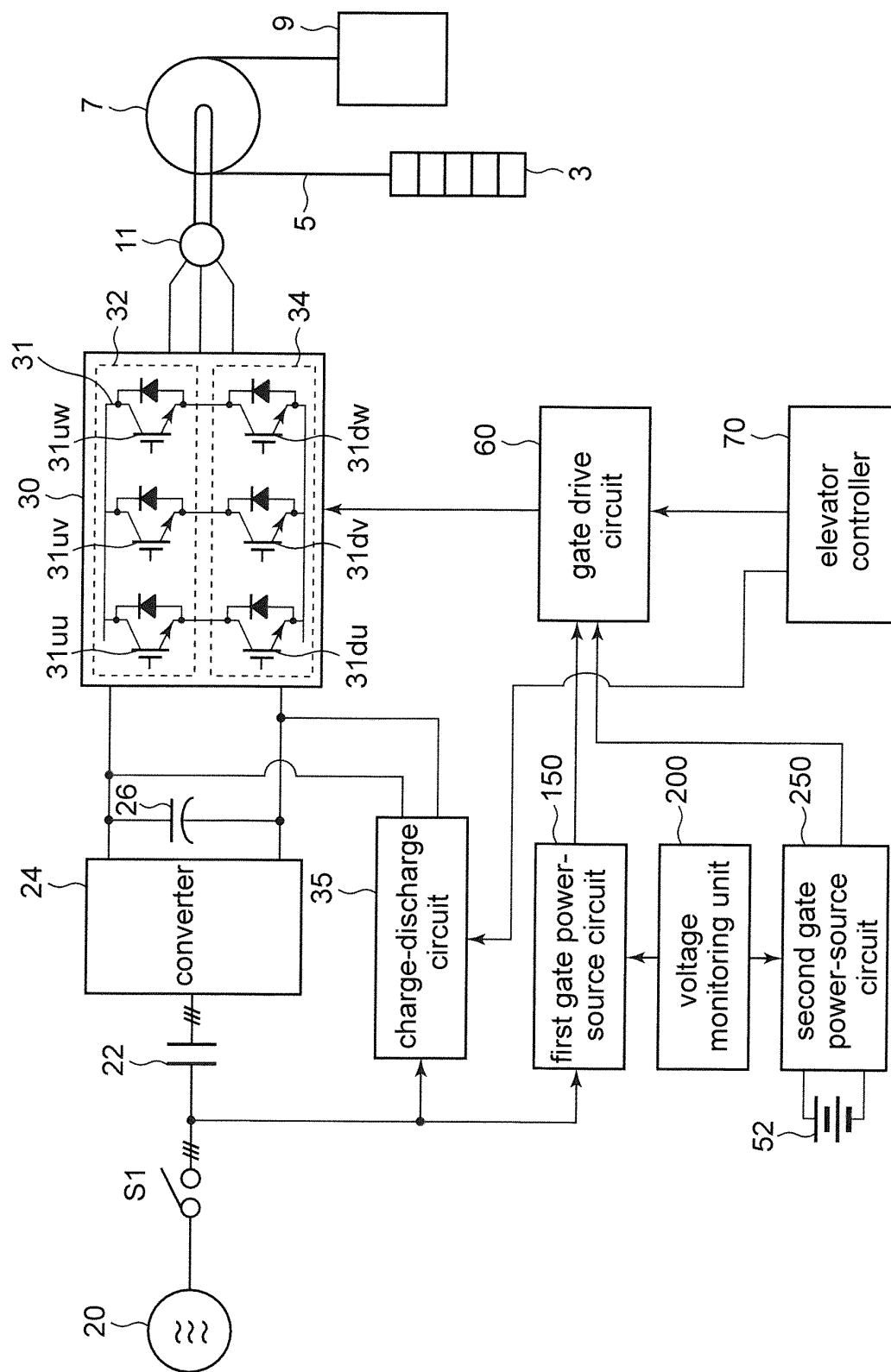


Fig.5

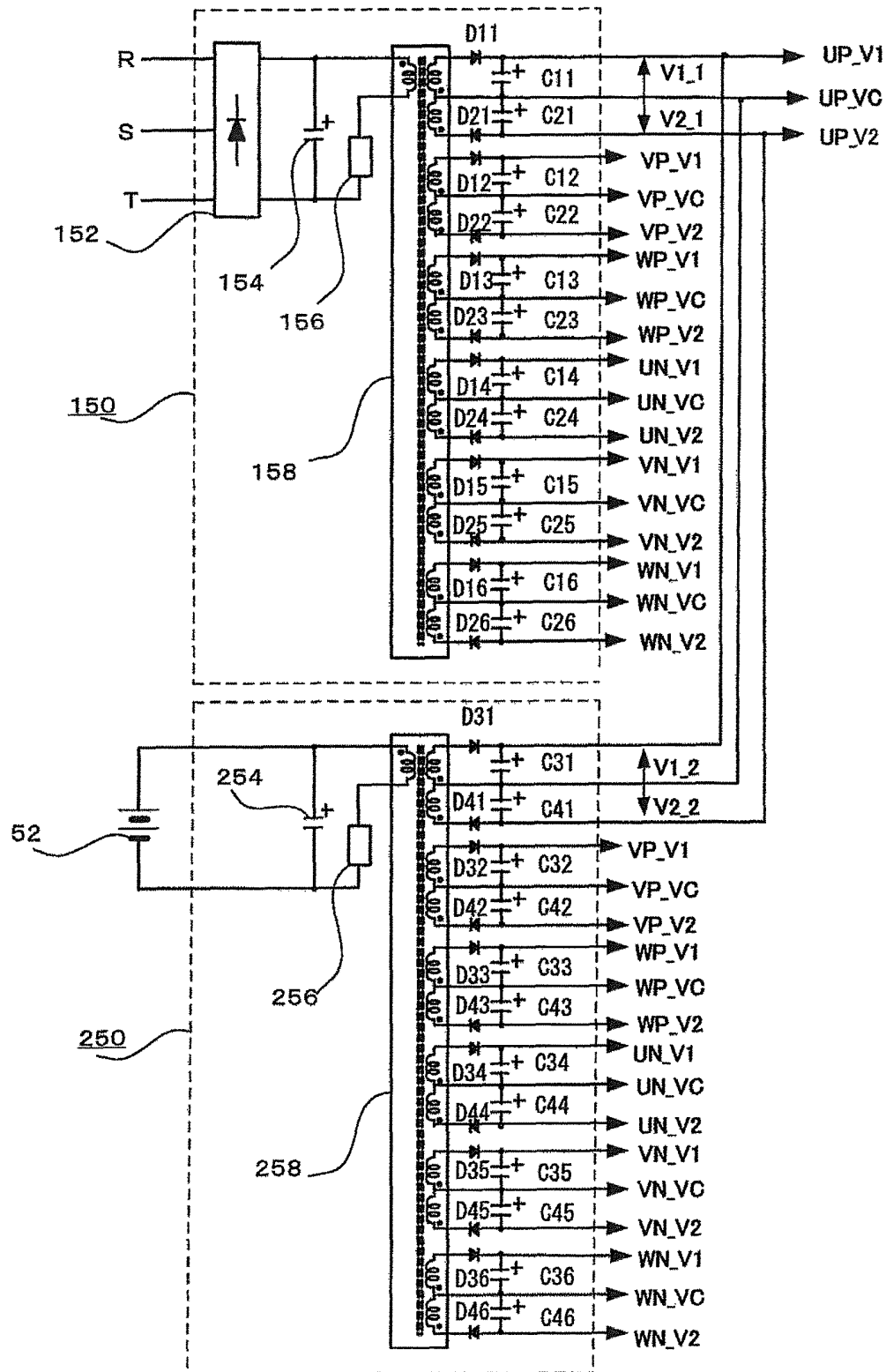


Fig.6

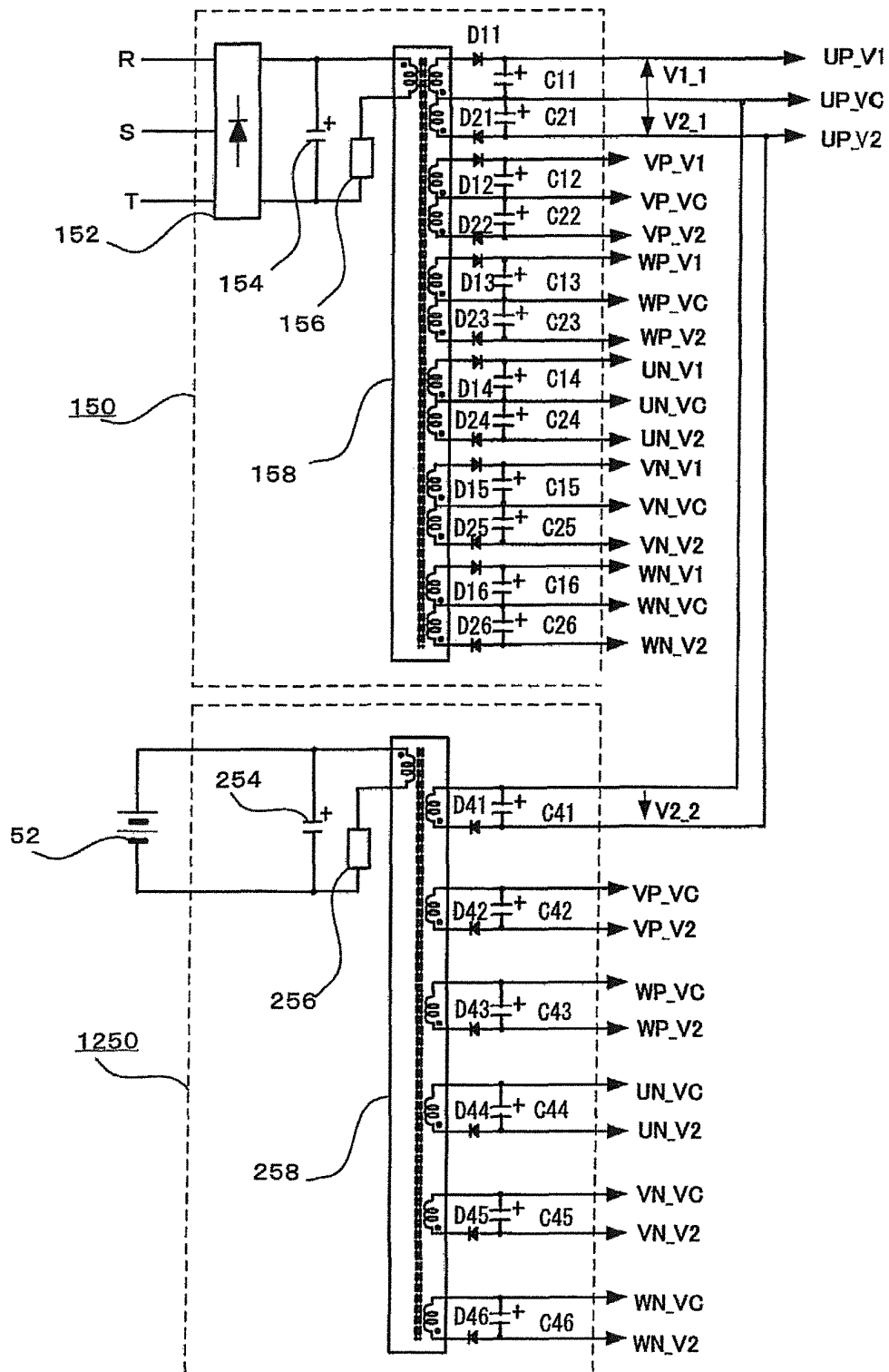


Fig.7

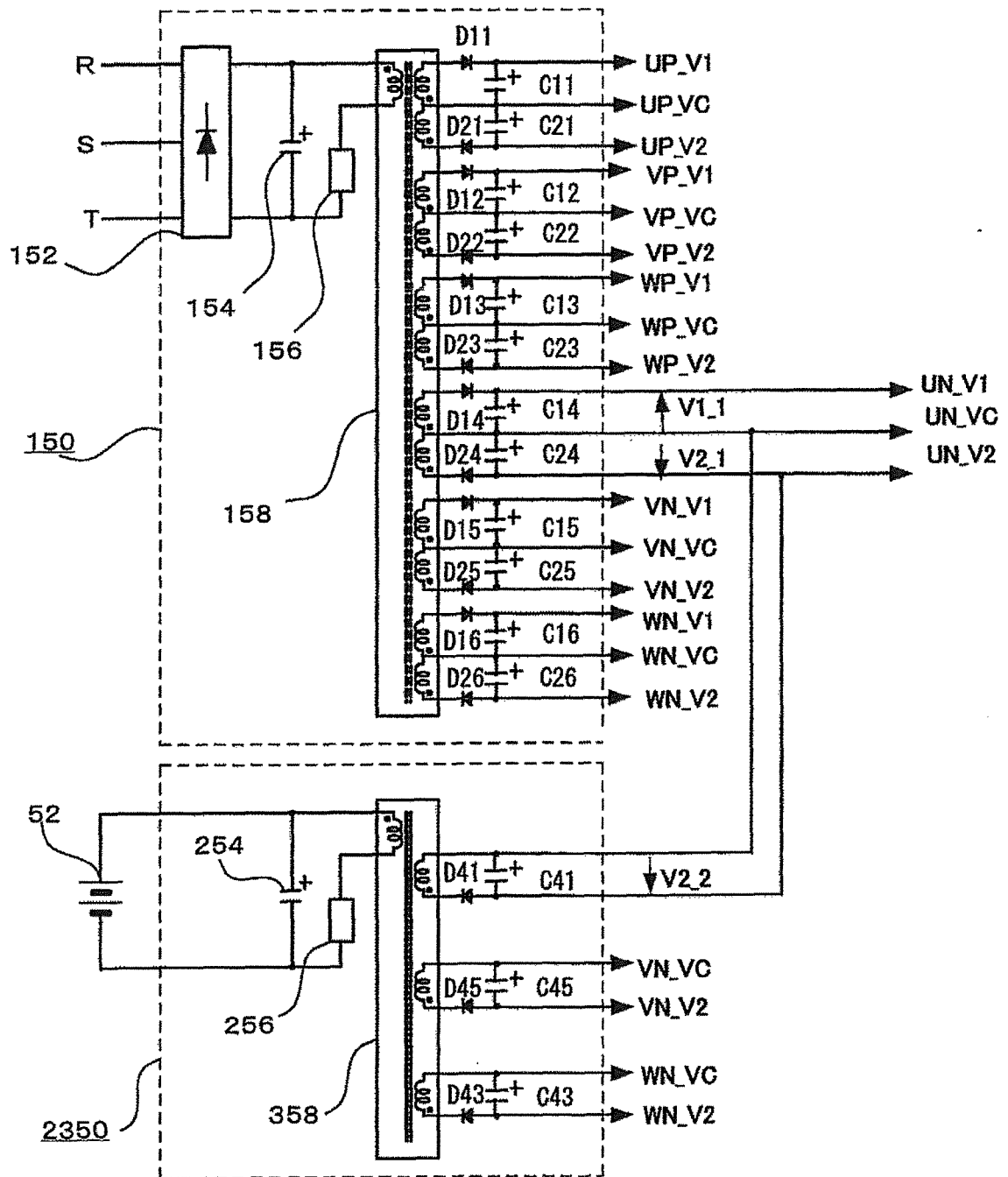
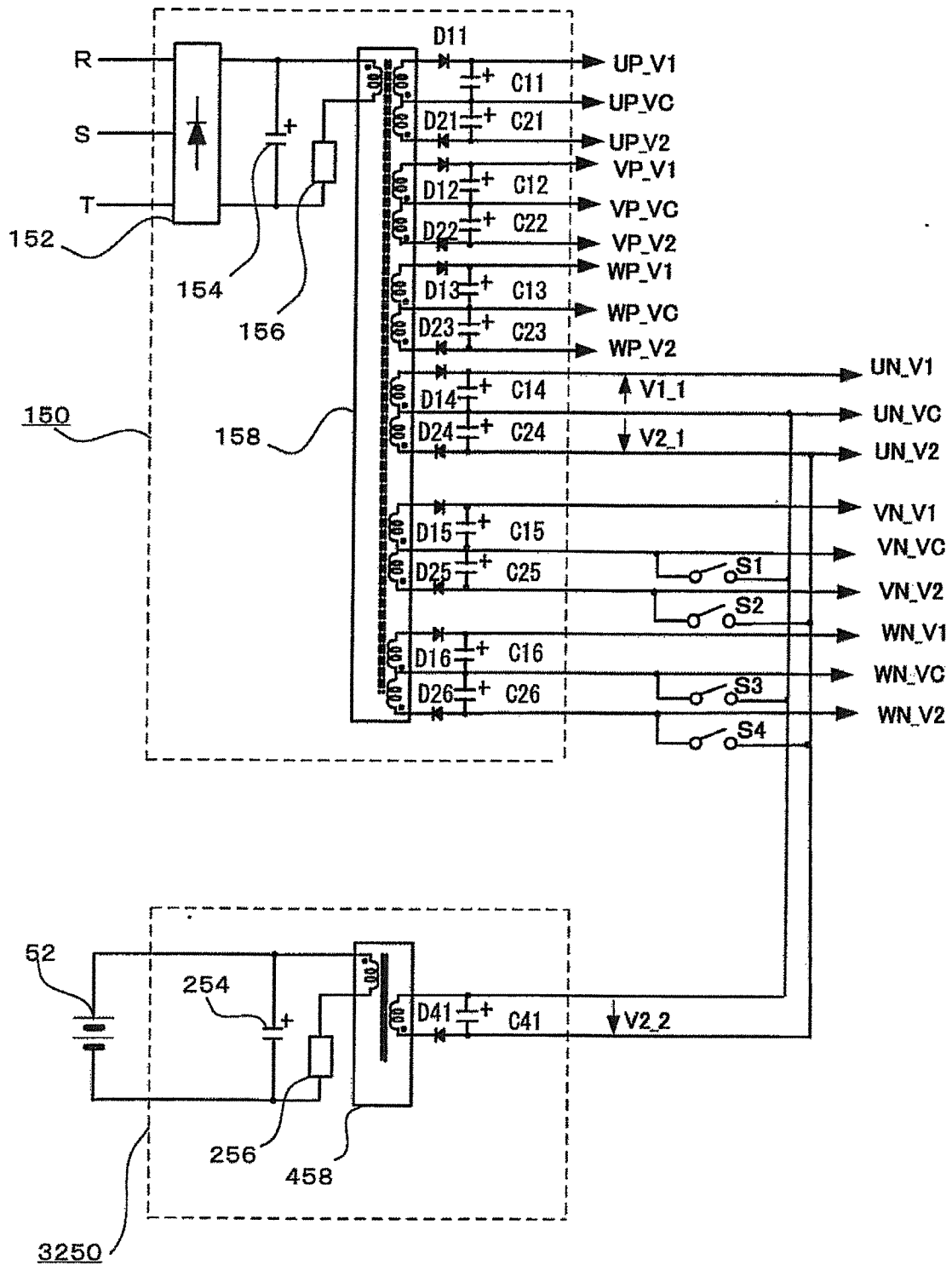


Fig.8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/002964

A. CLASSIFICATION OF SUBJECT MATTER

B66B5/02(2006.01) i, B66B1/34(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)

B66B5/02, B66B1/34, H02M7/42-7/98

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

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Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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.
Y A	JP 2010-16994 A (Hitachi Industrial Equipment System Co., Ltd.), 21 January 2010 (21.01.2010), paragraphs [0024] to [0031], [0059] (Family: none)	1, 3, 8 2, 4-7
Y	JP 2005-192298 A (Meidensha Corp.), 14 July 2005 (14.07.2005), paragraph [0018] (Family: none)	1, 3, 8
Y	JP 2-168825 A (Fujitsu Ltd.), 28 June 1990 (28.06.1990), claims; page 3, upper right column, line 12 to lower left column, line 3 (Family: none)	3

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

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Date of the actual completion of the international search

22 November, 2011 (22.11.11)

Date of mailing of the international search report

06 December, 2011 (06.12.11)

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/002964

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 2008-131724 A (Yaskawa Electric Corp.), 05 June 2008 (05.06.2008), claims 1 to 4 (Family: none)	1-8
A	JP 2005-137179 A (Sumitomo Electric Industries, Ltd.), 26 May 2005 (26.05.2005), paragraph [0020] (Family: none)	8

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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