(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 845 831 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.03.2015 Bulletin 2015/11

(51) Int Cl.:
B66B 5/02 *(2006.01)*

(21) Application number: **14182041.5**

(22) Date of filing: **22.08.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **10.09.2013 JP 2013187269**

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(54) **Elevator control apparatus**

(57) According to one embodiment, there is provided an elevator control apparatus (20) supplied with electric power from a battery (11) during a power outage, the battery (11) being charged with electric power supplied from a power supply during normal operation of an elevator and being charged with regenerative power generated by regenerative operation of the elevator during a power outage. During the power outage, a determiner (23a) determines whether or not a charging rate of the battery (11) is greater than or equal to a first upper limit value. An operation controller (23b) performs operation, making an operation speed of the elevator during the regenerative operation less than a rated speed, if it is determined that the charging rate of the battery (11) is greater than or equal to the first upper limit value.

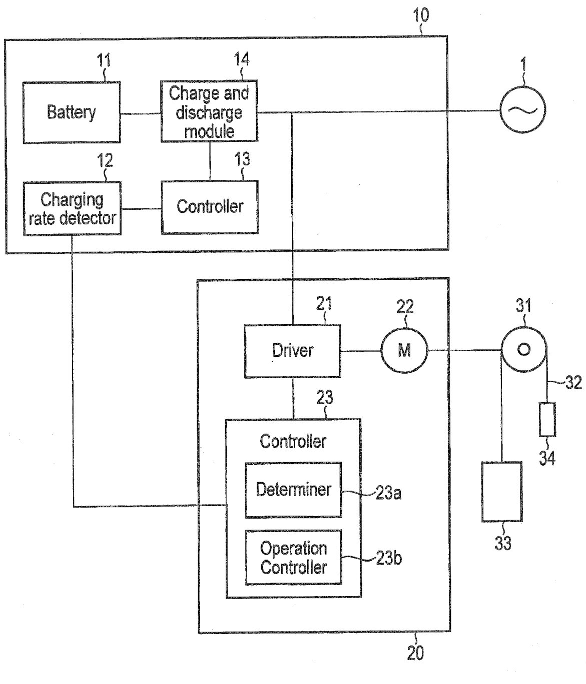

FIG.1

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Printed by Jouve, 75001 PARIS (FR)

Description

FIELD

[0001] Embodiments described herein relate generally to an elevator control apparatus.

BACKGROUND

[0002] In general, in an elevator, a car and a counterweight are suspended at each end of a rope wound about the axis of rotation of a motor, and by rotation of the motor, the car moves up and down in the opposite direction to the counterweight in a traction manner by means of the rope. Driving control, etc., of the motor is carried out by an elevator control apparatus installed in a machine room, etc., of a building in which the elevator is provided.

[0003] The elevator control apparatus operates by being supplied with required electric power from a commercial power supply (three-phase alternating current power supply). However, during a power outage, the power supply from the commercial power supply is stopped. Accordingly, a mechanism of supplying the elevator control apparatus with electric power even during a power outage is required to continue operation of an elevator during a power outage.

[0004] Thus, in recent years, elevators comprise a power storage device capable of charging a battery with electric power supplied from a commercial power supply during normal operation in which the power supply from the commercial power supply can be carried out. By bringing the power storage medium into operation during a power outage, electric power can be supplied from the power storage device (battery) to an elevator control apparatus even during the power outage, and thus, operation of an elevator can be continued.

[0005] In addition, with such a power storage device, a battery can also be charged with regenerative power (energy) generated in regenerative operation of an elevator during a power outage. The regenerative operation is such operation in which a motor generates electric power as a power generator. Also, the regenerative power is electric power which is generated when a motor functions as a power generator in regenerative operation.

[0006] Incidentally, in an elevator system comprising such an elevator control apparatus and a power storage device as described above, for example, the case where the charging rate of a battery is set at 100% (neighborhood) during normal operation to enable continuous operation for a long time during a power outage is assumed.

[0007] If a power outage occurs in such a case and regenerative operation is continuously performed in operation of an elevator immediately after the power outage, the charging rate of the battery may exceeds a charge limit (100%) due to regenerative power generated by the regenerative operation.

[0008] If the charging rate of the battery thus exceeds a charge limit, the battery cannot be charged with regenerative power generated by regenerative operation. Thus, in the power storage device, protection of stopping generation of regenerative power (that is, stopping drive of the above motor) works, and consequently, an elevator makes an emergency stop although the elevator is in operation. Such an emergency stop of an elevator leads to a situation in which passengers are confined in an elevator (car), or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is an exemplary illustration showing mainly a functional structure of an elevator system including an elevator control apparatus according to a first embodiment;
FIG. 2 is an exemplary flowchart showing a processing procedure of the elevator system during normal operation in the present embodiment;
FIG. 3 is an exemplary flowchart showing a processing procedure of the elevator system during a power outage in the present embodiment;
FIG. 4 is an exemplary illustration showing a transition of the charging rate of a battery 11 of during normal operation and during a power outage in the present embodiment;
FIG. 5 is an exemplary illustration showing mainly a functional structure of an elevator system including an elevator control apparatus according to a second embodiment;
FIG. 6 is an exemplary flowchart showing a processing procedure of the elevator system during a power outage in the present embodiment;
FIG. 7 is an exemplary illustration showing a transition of the charging rate of the battery 11 during normal operation and a power outage in the present embodiment; and
FIG. 8 is an exemplary flowchart showing a processing procedure of stopping and resuming the power supply from the battery 11 in the present embodiment.

DETAILED DESCRIPTION

[0010] Embodiments will be described hereinafter with reference to the accompanying drawings.

[0011] In general, according to one embodiment, there is provided an elevator control apparatus supplied with electric power from a battery during a power outage, the battery being charged with electric power supplied from a power supply during normal operation of an elevator and being charged with regenerative power generated by regenerative operation of the elevator during a power outage. The elevator control apparatus includes determination means and operation control means. During the power outage, the determination means determines whether or not the charging rate of the battery is greater than or equal to a first upper limit value. The operation control means performs operation, making the operating speed of the elevator during the regenerative operation less than a rated speed to suppress generation of the regenerative power, if it is determined that the charging rate of the battery is greater than or equal to the first upper limit value.

(First embodiment)

[0012] First, a first embodiment will be described. FIG. 1 is an illustration showing mainly a functional structure of an elevator system including an elevator control apparatus according to the present embodiment.

[0013] As shown in FIG. 1, the elevator system includes a power storage device 10 and an elevator control apparatus 20.

[0014] The power storage device 10 includes a battery (storage battery) 11, a charging rate detector 12, a controller 13 and a charge and discharge module 14.

[0015] The power storage device 10 is supplied with required electric power (three-phase alternating current power) from a commercial power supply 1, which is, for example, a three-phase alternating current power supply. In addition, the commercial power supply 1 is configured to supply required electric power also to the elevator control apparatus 20. The power storage device 10 is included in a system (building management system) used for management of various facilities (elevators, lighting, air conditioning, etc.) installed in, for example, a building. According to this building management system, electric power from the commercial power supply 1 is supplied also to various facilities (loads) other than the elevator control apparatus 20.

[0016] The battery 11 is charged with, for example, electric power supplied from the commercial power supply 1 (purchase of power) during normal operation of an elevator. Electric power thus charged into the battery 11 is, for example, supplied to the elevator control apparatus 20, etc., during a power outage.

[0017] The charging rate detector 12 is a functional module having the function of detecting the charging rate of the battery 11. The charging rate of the battery 11 is the proportion (%) of the amount of electric power with which the battery 11 is presently charged to the amount of electric power with which the battery 11 can be charged.

[0018] The controller 13 is a functional module for controlling the entire power storage device 10. The charge and discharge module 14 has the function of switching charging and discharging of the battery 11 on the basis of control by the controller 13 which is based on the charging rate of the battery 11 detected by the charging rate detector 12.

[0019] The elevator control apparatus 20 includes a driver 21, a motor (M) 22 and a controller 23.

[0020] The driver 21 is configured to drive the motor 22 by supplying predetermined driving power to the motor 22. More specifically, the driver 21 is implemented as a converter device, a smoothing condenser, an inverter device, etc., which are not shown in the figures.

[0021] The converter device is connected to the commercial power supply 1. The converter device includes a diode, and is configured to convert three-phase alternating current power supplied from the commercial power supply 1 into direct current power.

[0022] The smoothing condenser is configured to smooth a pulsation (ripple) included in direct current power converted by the converter device.

[0023] The inverter device includes a diode and a switching element (for example, a transistor), and is configured to convert direct current power smoothed by the smoothing condenser into alternating current power of variable voltage and variable frequency by pulse width modulation (PWM) control and to supply it to the motor 22.

[0024] The axis of rotation of the motor 22 driven by the driver 21 is mounted with a sheave 31, and a car 33 and a counterweight 34 are suspended at each end of a rope 32 wound about the sheave 31. In such a structure, by driving (rotating) the motor 22, the car 33 and the counterweight 34 can be moved up and down in an elevator shaft in a traction manner by means of the rope 32.

[0025] The controller 23 is a functional module configured to perform operation control of an elevator. The controller 23 includes a determiner 23a and an operation controller 23b.

[0026] The determiner 23a is configured to determine whether or not the charging rate of the battery 11 during a power outage detected by the charging rate detector 12 is greater than or equal to a predetermined value (upper limit value). The operation controller 23b is configured to perform control of changing the operating speed of an elevator on the basis of a determination result by the determiner 23a.

[0027] In the elevator system in the present embodiment, during operation in which the motor 22 performs power generation as a power generator (hereinafter, expressed as regenerative operation), electric power (hereinafter, expressed as regenerative power) is generated by the power generation.

[0028] During normal operation in which the power supply from the commercial power supply 1 can be performed, regenerative power is discharged to, for example, a power supply line, and is used for power supply to the above-described various facilities. On the other hand, during a power outage in which the power supply from the commercial power supply 1 is stopped, the battery 11 is charged with regenerative power.

[0029] Next, the operation of the elevator system (the power storage device 10 and the elevator control apparatus 20) in the present embodiment will be described. Here, processing of the elevator system during normal operation and processing of the elevator system during a power outage will be described.

[0030] First, the processing of the elevator system during normal operation in the present embodiment will be described with reference to the flowchart of FIG. 2. Here, it is assumed that the battery 11 is charged with electric power supplied from the commercial power supply 1.

[0031] Here, the charging rate detector 12 included in the power storage device 10 detects the charging rate of the battery 11 (step S1). This charging rate of the battery 11 is detected by measuring, for example, a voltage value of the battery 11. This process of step S1 is periodically carried out during normal operation.

[0032] Next, the controller 13 determines whether or not the charging rate of the battery 11 detected by the charging rate detector 12 is greater than or equal to an upper limit value (second upper limit value) (step S2). This upper limit value is preset at a value to the extent that the charging rate of the battery 11 does not exceed a charge limit (that is, the charging rate of the battery 11 does not exceed 100%), for example, even if the battery 11 is charged with regenerative power generated by generative operation of a elevator during a power outage. More specifically, the upper limit value is, for example, a value within the range of 70 to 90%. In the following description, the upper limit value used in step S2 will be referred to as an upper limit value during normal operation.

[0033] If it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value during normal operation (YES in step S2), the controller 13 stops charging of the battery 11 with electric power supplied from the commercial power supply 1 by controlling the charge and discharge module 14 (step S3).

[0034] On the other hand, if it is determined that the charging rate of the battery 11 is not greater than or equal to the upper limit value during normal operation (NO in step S2), the process of step S3 is not carried out.

[0035] Since such processing is carried out, the charging rate of the battery 11 during normal operation is made, for example, less than or equal to 80% (upper limit value during normal operation), and the battery 11 can be prevented from being charged to a charge limit (100%).

[0036] If the charging rate of the battery 11 decreases to be less than the upper limit value during normal operation because electric power of the battery 11 is used for power supply to various facilities during normal operation, the battery 11 is charged again with electric power supplied from the commercial power supply 1, and the above-described processing shown in FIG. 2 is executed.

[0037] Next, the processing of the elevator system during a power outage in the present embodiment will be described with reference to the flowchart of FIG. 3.

[0038] Because the power supply from the commercial power supply 1 is stopped during a power outage, electric power necessary for powering running of an elevator is supplied from the battery 11. On the other hand, regenerative power generated by regenerative operation of an elevator during a power outage is returned from (the motor 22 included in) the elevator control apparatus 20 to the power storage device 10, and is used for charging the battery 11.

[0039] That is, in powering running of an elevator during a power outage, the battery 11 is in a discharge state, and in regenerative operation of an elevator during a power outage, the battery 11 is in a charge state. This switch of the battery 11 between charging and discharging is carried out by the charge and discharge module 14 on the basis of control by the controller 13.

[0040] Also, according to the above-described building management system, during a power outage, electric power is supplied from the power storage device 10 (the battery 11) to only required minimum facilities (loads), for example, an elevator and lighting of various facilities managed by the building management system. In addition, in the elevator system in the present embodiment, even during a power outage, an elevator is operated at a rated speed (that is, the same speed as that during normal operation).

[0041] Here, the charging rate detector 12 included in the power storage device 10 detects the charging rate of the battery 11 (step S11). The charging rate (signal) of the battery 11 thus detected by the charging rate detector 12 is delivered to the controller 23 included in the elevator control apparatus 20. This process of step S11 is periodically carried out during a power outage.

[0042] The determiner 23a included in the controller 23 determines whether or not the charging rate of the battery 11 delivered from the charging rate detector 12 is greater than or equal to an upper limit value (first upper limit value) (step S12). The upper limit value in step S12 (hereinafter, expressed as an upper limit value during a power outage) is a value greater than the above-described upper limit value during normal operation in step S2 shown in FIG. 2, and is, for example, a value within the range of 90 to 99%.

[0043] Here, the amount of regenerative power generated by the above-described regenerative operation of an elevator depends on the operating speed of the elevator (car 33). That is, if the operating speed of an elevator during regenerative operation is high-speed, the amount of regenerative power is large. On the other hand, if the operating speed of an elevator during regenerative operation is low-speed, the amount of regenerative power is small.

[0044] Thus, if it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value during a power outage (YES in step S12), the operation controller 23b included in the controller 23 performs control of operation, making the operating speed of an elevator during a power outage less than a rated speed to suppress generation of regenerative power. Thereby, low-speed operation of an elevator is started (step S13).

[0045] Regenerative power generated by regenerative operation of an elevator is returned to the side of the power storage device 10 as described above. When regenerative power is thus returned to the power storage device 10, the battery 11 is charged with the regenerative power. The regenerative power is, however, also used to operate each module included in the power storage device 10 except for charging of the battery 11. That is, if the amount of regenerative power is small, the regenerative power is used for those other than charging of the battery 11, and thus, even if the regenerative power is generated, the battery 11 is not charged.

[0046] Thus, if the charging rate of the battery 11 is greater than or equal to the upper limit value during a power outage, the operation controller 23b performs operation, reducing the operating speed to the extent of generating only the amount of regenerative power with which the battery 11 is not charged (charging of the battery 11 is not influenced). For example, the operating speed of an elevator in this case is about a one tenth of a rated speed (operating speed during normal operation).

[0047] On the other hand, if it is determined that the charging rate of the battery 11 is not greater than or equal to the upper limit value during a power outage (NO in step S12), the process of step S13 is not carried out.

[0048] Since such processing is carried out, if the charging rate of the battery 11 during a power outage is, for example, greater than or equal to 95% (upper limit value during a power outage), operation can be continued while generation of regenerative power is suppressed, by reducing the operating speed.

[0049] In addition, according to the above-described processing, since the operating speed is made low even during regenerative operation, the charging rate of the battery 11 does not increase, and during a power outage, electric power necessary for powering running of an elevator is supplied from the battery 11. In this case, the charging rate of the battery 11 decreases in accordance with operation of an elevator. Thus, after low-speed operation of an elevator is started, the charging rate of the battery 11 detected periodically as described above may decrease to be less than the above-described upper limit value during normal operation (for example, 80%). In this case, regenerative operation is performed at a rated speed to enable the battery 11 to be charged with regenerative power. Accordingly, if the charging rate of the battery 11 decreases, the battery 11 can be charged with regenerative power generated by regenerative operation.

[0050] As described above, in the present embodiment, during a power outage, if it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value during a power outage (for example, 95%), operation is performed, making the operating speed of an elevator less than a rated speed to suppress generation of regenerative power. Thereby, in the present embodiment, the charging rate of the battery 11 is prevented from exceeding a charge limit (that is, the charging rate of the battery 11 is prevented from exceeding 100%), and an emergency stop of an elevator during a power outage can be prevented.

[0051] Also, in the present embodiment, the charging rate of the battery 11 during normal operation (the charging rate of the battery 11 charged with electric power from the commercial power supply 1) is made less than or equal to the upper limit value during normal operation (for example, 80%). Thereby, a margin can be allowed until the charging rate of the battery 11 reaches a charge limit. Thus, in the present embodiment, even if regenerative operation is successively performed in operation of an elevator immediately after a power outage, the charging rate of the battery 11 can be prevented from exceeding a charge limit.

[0052] More specifically, according to the present embodiment, the charging rate of the battery 11 during normal operation and during a power outage transitions as shown in FIG. 4, and thus the charging rate of the battery 11 can be prevented from exceeding a charge limit.

[0053] If the charging rate of the battery 11 is greater than or equal to the upper limit value during a power outage, electric power supplied from the battery 11 may be more consumed to reduce the charging rate of the battery 11.

[0054] More specifically, even in a case where operation is performed, making the operating speed during regenerative operation less than a rated speed as described above, if an elevator is in powering running, the operating speed of the elevator may be set at the rated speed. According to such a structure, electric power supplied from the battery 11 can be more consumed, and thus, the charging rate of the battery 11 can be prevented from exceeding a charge limit. Also, powering running of an elevator can be determined in the elevator control apparatus 20 by acquiring the load of the car 33 and information on a destination floor before operation of an elevator.

[0055] In addition, to more consume electric power supplied from the battery 11, operation may performed, making the operating speed of an elevator in the case where an elevator is in powering running greater than a rated speed.

[0056] Moreover, if the charging rate of the battery 11 is greater than or equal to the upper limit value during a power outage and powering running of an elevator taken by no passengers can be performed, electric power from the battery 11 may be consumed by automatically performing the powering running, to reduce the charging rate of the battery 11. The case where powering running of an elevator taken by no passengers can be performed includes, for example, a case where an elevator taken by no passengers (that is, the car 33 the load of which is lighter than the counterweight 34) moves downward in the elevator shaft.

[0057] In the present embodiment, although the battery 11 has been described as being included in the power storage device 10, the battery 11 may be installed, for example, in the elevator control apparatus 20. In this case, the elevator control apparatus 20 includes a functional module corresponding to the charging rate detector 12 and the above-described processing shown in FIG. 2 and FIG. 3 is carried out in the elevator control apparatus

20.

(Second embodiment)

[0058] Next, a second embodiment will be described. FIG. 5 is an illustration showing mainly a functional structure of an elevator system including an elevator control apparatus according to the present embodiment.

[0059] Portions identical to those in FIG. 1 described above will be denoted by the same reference numerals as those in FIG. 1, and the detailed explanations thereof will be omitted. Here, mainly portions different from those in FIG. 1 will be described.

[0060] As shown in FIG. 5, the elevator system includes a power storage device 100. The power storage device 100 includes a solar power generation device 101.

[0061] The solar power generation device 101 is installed, for example, on the roof of a building, etc., and is a power generation device configured to perform power generation by using solar energy (natural energy). This solar power generation device 101 includes a solar battery panel configured to convert sunlight into electric power, an inverter configured to convert a direct current voltage output from the solar battery panel into an alternating current voltage, etc.

[0062] In the present embodiment, the battery 11 included in the power storage device 100 can be charged with electric power generated by the solar power generation device 101 like this during normal operation and during a power outage.

[0063] Next, the operation of the elevator system (the power storage device 100 and the elevator control apparatus 20) in the present embodiment will be described. Here, processing of the elevator system during normal operation and processing of the elevator system during a power outage will be described.

[0064] First, the processing of the elevator system during normal operation in the present embodiment will be described. Here, for convenience, the flowchart shown in FIG. 2 is referred to for explanations. Here, it is assumed that the battery 11 is charged with electric power supplied from the commercial power supply 1 and electric power obtained from the solar power generation device 101.

[0065] In the processing of the elevator system during normal operation in the present embodiment, steps S1 and S2 shown in FIG. 2 are carried out as in the above-described first embodiment.

[0066] If it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value during normal operation in step S2, the controller 13 stops charging of the battery 11 by controlling the charge and discharge module 14 in step S3. In this case, the charging of the battery 11 with electric power supplied from the commercial power supply 1 and electric power generated by the solar power generation device 101 is stopped. In this case, electric power generated by the solar power generation device 101 is not used for charging of the battery 11, but is used for power supply to various facilities including the elevator control apparatus 20, etc.

[0067] Since such processing is carried out, the charging rate of the battery 11 during normal operation is made, for example, less than or equal to 80% (upper limit value during normal operation), and the battery 11 can be prevented from being charged to a charge limit (100%).

[0068] As stated above, the processing of the elevator system during normal operation in the present embodiment is the same as that in the above-described first embodiment, except that the charging of the battery 11 with electric power supplied from the commercial power supply 1 and electric power generated by the solar power generation device 101 is stopped in step S3 described above. Thus, the detailed explanations thereof are omitted.

[0069] Next, the processing of the elevator system during a power outage in the present embodiment will be described with reference to the flowchart of FIG. 6.

[0070] As explained in the above-described first embodiment, during a power outage, the power supply from the commercial power supply 1 is stopped, and thus electric power necessary for powering running of an elevator is supplied from the battery 11. On the other hand, regenerative power generated by regenerative operation of an elevator during a power outage is returned from (the motor 22 included in) the elevator control apparatus 20 to the power storage device 100, and is used for charging of the battery 11. Moreover, the battery 11 is charged with electric power obtained from the solar power generation device 101.

[0071] That is, in powering running of an elevator during a power outage, the battery 11 is in a discharge state, and in regenerative operation of an elevator during a power outage, the battery 11 is in a charge state. This switch of the battery 11 between charging and discharging is carried out by the charge and discharge module 14 on the basis of control by the controller 13.

[0072] Also, as in the above-described first embodiment, according to the above-described building management system, during a power outage, electric power is supplied from the power storage device 100 (the battery 11) to only required minimum facilities (loads), for example, an elevator and lighting, of various facilities. Thereby, in the elevator system in the present embodiment, an elevator can be operated at a rated speed (that is, the same speed as that during normal operation) even during a power outage.

[0073] In the processing of the elevator system during a power outage in the present embodiment, first, the process of step S21 corresponding to the above-described process of step S11 shown in FIG. 3 is carried out.

[0074] When the process of step S21 is carried out, the controller 13 included in the power storage device 100 determines whether or not the charging rate of the battery 11 detected by the charging rate detector 12 is greater than or equal to an upper limit value (third upper limit value) (step S22). The upper limit value in step S22 (hereinafter, expressed as an upper limit value for solar power generation) is, for example, a value within the range of 70 to 90%.

[0075] If it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value for solar power generation (YES in step S22), the controller 13 stops charging of the battery 11 with electric power obtained from the solar power generation device 101 (that is, charging by solar power generation) by controlling the charge and discharge module 14 (step S23). In this case, electric power generated by the solar power generation device 101 is not used for charging of the battery 11, but is used for power supply to various facilities (for example, the elevator control apparatus 20 and lighting), etc.

[0076] Next, the process of step S24 corresponding to the above-described process of step S12 shown in FIG. 3 is carried out. In the following description, an upper limit value used in step S24 is referred to as an upper limit value for regenerative power for convenience. This upper limit value for regenerative power is the same value as the upper limit value during a power outage explained in the above-described first embodiment, and is, for example, 95%. The upper limit value for regenerative power is set at a value greater than the above-described upper limit value for solar power generation.

[0077] If it is determined that the charging rate of the battery 11 is greater than or equal to the upper limit value for regenerative power in step S24, the process of step S25 corresponding to the above-described process of step S13 shown in FIG. 3 is carried out.

[0078] Also, if it is determined that the charging rate of the battery 11 is not greater than or equal to the upper limit value for solar power generation in step S22 or if it is determined that the charging rate of the battery 11 is not greater than or equal to the upper limit value for regenerative power in step S24, the processing is finished.

[0079] Since such processing is carried out, if the charging rate of the battery 11 during a power outage is, for example, greater than or equal to 80% (the upper limit value for solar power generation), the charging with electric power obtained from the solar power generation device 101 is stopped, and thus the charging rate of the battery 11 is prevented from increasing. Also, if the charging rate of the battery 11 is, for example, greater than or equal to 95% (the upper limit value for regenerative power), operation can be continued while generation of regenerative power is suppressed, by reducing the operating speed.

[0080] If the charging rate of the battery 11 detected periodically as described above decreases to be less than or equal to the above-described upper limit value during normal operation (for example, 80%) after low-speed operation of an elevator is started, regenerative operation is performed at a rated speed to enable the battery 11 to be charged with regenerative power. Similarly, if the charging rate of the battery 11 decreases to be less than a predetermined value after the charging by solar power generation is stopped, the charging by solar power generation is resumed by controlling the charge and discharge module 14. Thereby, if the charging rate of the battery 11 decreases, the battery 11 can be charged with regenerative power and by solar power generation.

[0081] As described above, in the present embodiment, if the charging rate of the battery 11 during a power outage is greater than or equal to the upper limit value for solar power generation (for example, 80%), the charging of the battery 11 with electric power obtained from the solar power generation device 101 is stopped. Also, if the charging rate of the battery 11 is greater than or equal to the upper limit value for regenerative power (for example, 95%), operation is performed, making the operating speed of an elevator less than a rated speed to suppress generation of regenerative power. Thereby, in the present embodiment, the charging rate of the battery 11 is prevented from exceeding a charge limit (that is, the charging rate of the battery 11 is prevented from exceeding 100%), and an emergency stop of an elevator during a power outage can be prevented.

[0082] Also, in the present embodiment, more power consumption can be reduced by using the solar power generation device 101 as compared to that in the above-described first embodiment.

[0083] Moreover, in the present embodiment, the charging rate of the battery 11 during normal operation (the charging rate of the battery 11 charged with electric power from the commercial power supply 1 and electric power generated by the solar power generation device 101) is less than or equal to the upper limit value during normal operation (for example, 80%). Thereby, in the present embodiment, a margin can be allowed until the charging rate of the battery 11 reaches a charge limit.

[0084] More specifically, according to the present embodiment, because the charging rate of the battery 11 during normal operation and during a power outage transitions as shown in FIG. 7, the charging rate of the battery 11 can be prevented from exceeding a charge limit.

[0085] If the charging rate of the battery 11 is greater than or equal to the upper limit value for regenerative power, electric power supplied from the battery 11 may be more consumed. The structure for more consuming electric power supplied from the battery 11 is as explained in the above-described first embodiment, and thus the detailed explanations thereof are omitted. Similarly, also if the charging rate of the battery 11 is greater than or equal to the upper limit value for solar power generation, electric power supplied from the battery 11 may be more consumed.

[0086] Also, in the present embodiment, although the battery 11 has been described as being included in the power storage device 100, the battery 11 may be installed, for example, in the elevator control apparatus 20. In this case, the elevator control apparatus 20 includes a functional module corresponding to the charging rate detector 12 and the above-described processing is carried out in the elevator control apparatus 20.

[0087] Also, in the present embodiment, although the battery 11 has been described as being charged with electric power generated by the solar power generation device 101, the solar power generation device 101 may be other power generation devices, for example, a wind power generation device, as long as power generation is performed with natural energy.

[0088] In general, if the charging rate of the battery 11 (remaining battery level) becomes less than or equal to a predetermined value (for example, a value within the range of 5 to 45%) in the power storage device 100, the power supply from the battery 11 is stopped. In other words, if the charging rate of the battery 11 exceeds a predetermined value, the power supply from the battery 11 is carried out.

[0089] Here, it is assumed that the charging rate of the battery 11 becomes less than or equal to a predetermined value (for example, 20%) and the power supply from the battery 11 is stopped in the case where the solar power generation device 101 is used as in the present embodiment.

[0090] In this case, because the elevator control apparatus 20 cannot operate due to a stop of the power supply from the battery 11, regenerative power is not generated. Thus, the battery 11 cannot be charged with regenerative power.

[0091] On the other hand, even after the power supply from the battery 11 is stopped, the solar power generation device 101 can operate, and thus the battery 11 can be charged with electric power obtained from the solar power generation device 101. Thereby, if the charging rate of the battery 11 exceeds 20%, the power supply from the battery 11 is resumed.

[0092] However, the amount of charging of the battery 11 with electric power obtained from the solar power generation device 101 is very small. Thus, even if the charging rate of the battery 11 exceeds 20% and the power supply to the elevator control apparatus 20, etc., is resumed, the charging rate of the battery 11 becomes less than or equal to 20% in a short time due to the operation of the elevator control apparatus 20. In this case, the power supply from the battery 11 is stopped and an elevator makes an emergency stop.

[0093] That is, if the charging rate of the battery 11 becomes less than or equal to 20% in the case where the solar power generation device 101 is used as in the present embodiment, a stop (discharge stop) and a resumption (discharge start) of the power supply from the battery 11 are repeated, and consequently an emergency stop of an elevator occurs frequently.

[0094] Thus, in the present embodiment, a hysteresis is provided for a set value (remaining battery level) for stopping the power supply from the battery 11 and for a set value (remaining battery level) for resuming the power supply from the battery 11.

[0095] Hereinafter, the processing procedure of stopping and resuming the power supply from the battery 11 on the basis of the charging rate (remaining battery level) of the battery 11 in the present embodiment will be described with reference to the flowchart of FIG. 8. Here, the state in which the power supply is carried out from the battery 11 to the elevator control apparatus 20, etc., is assumed.

[0096] Here, the charging rate detector 12 included in the power storage device 100 detects the charging rate of the battery 11 as described above (step S31).

[0097] Next, the controller 13 determines whether or not the charging rate of the battery 11 detected by the charging rate detector 12 is less than or equal to a predetermined set value (first set value) (step S32). The set value in step S32 (hereinafter, expressed as a set value for a discharge stop) is a value for determining a stop of the power supply from the battery 11, and is, for example, 20%.

[0098] If it is determined that the charging rate of the battery 11 is less than or equal to the set value for a discharge stop (step S32), the controller 13 stops the power supply from the battery 11 (discharge of the battery 11) by controlling the charge and discharge module 14 (step S33). In this case, the power supply to the elevator control apparatus 20 is stopped, and thus the operation of an elevator is stopped.

[0099] In the present embodiment, even during a power outage after the power supply to the elevator control apparatus 20 is stopped, the battery 11 can be charged with electric power obtained from the solar power generation device 101 as described above.

[0100] After the battery 11 is thus charged with electric power obtained from the solar power generation device 101, the charging rate detector 12 detects the charging rate of the battery 11 (step S34).

[0101] Next, the controller 13 determines whether or not the charging rate of the battery 11 detected by the charging rate detector 12 is greater than or equal to a predetermined value (second set value) (step S35). The set value in step S35 (hereinafter, expressed as a set value for a discharge start) is a value for determining a start (resumption) of the power supply from the battery 11. This set value for a discharge start is a value greater than the above-described set value for a discharge stop, and is, for example, a value within the range of 10 to 50%. If the set value for a discharge stop is, for example, 20% as described above, the set value for a discharge start is set at, for example, 30%.

[0102] If it is determined that the charging rate of the battery 11 is greater than or equal to the set value for a discharge start (step S35), the controller 13 resumes the power supply from the battery 11 (discharge of the battery 11) by controlling the charge and discharge module 14 (step S36).

[0103] If it is determined that the charging rate of the battery 11 is not less than or equal to the set value for a discharge stop in the above-described step S32, the processing is finished and the power supply from the battery 11 is continued.

[0104] Also, if it is determined that the charging rate of the battery 11 is not greater than or equal to the set value for a discharge start in the above-described step S35, the battery 11 is charged with electric power obtained from the solar power generation device 101. In this case, the processing is repeated, returning to the above-described step S34, until the charging rate of the battery 11 exceeds the set value for a discharge start.

[0105] Since such processing is carried out, an emergency stop of an elevator can be prevented from occurring in a short time after the power supply from the battery 11 is resumed.

[0106] If the battery 11 is installed in the elevator control apparatus 20 as described above, the processing shown in FIG. 8 is carried out in the elevator control apparatus 20.

[0107] According to at least one embodiment that has been described above, an elevator control apparatus capable of preventing an emergency stop of an elevator during a power outage can be provided.

[0108] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

[0109] It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges

Claims

1. An elevator control apparatus (20) which is supplied with electric power from a battery (11) during a power outage, the battery (11) being charged with electric power supplied from a power supply during normal operation of an elevator and being charged with regenerative power generated by regenerative operation of the elevator during a power outage, **characterized by** comprising:

   determination means (23a) for, during the power outage, determining whether or not a charging rate of the battery (11) is greater than or equal to a first upper limit value; and

   operation control means (23b) for performing operation, making an operating speed of the elevator during the regenerative operation less than a rated speed to suppress generation of the regenerative power, if it is determined that the charging rate of the battery (11) is greater than or equal to the first upper limit value.

2. The elevator control apparatus (20) according to Claim 1, **characterized in that** the charging rate of the battery (11) during the normal operation is less than or equal to a second upper limit value which is less than the first upper limit value.

3. The elevator control apparatus (20) according to Claim 1 or 2, **characterized in that** the operation control means (23b) performs operation at the rated speed, if it is determined that the charging rate of the battery (11) is greater than or equal to the first upper limit value and the elevator performs powering running.

4. The elevator control apparatus (20) according to any one of Claims 1 to 3, **characterized in that** the operation control means (23b) performs operation, making the operating speed of the elevator greater than the rated speed, if it is determined that the charging rate of the battery (11) is greater than or equal to the first upper limit value and the elevator performs powering running.

5. The elevator control apparatus (100) according to any one of Claims 1 to 4, **characterized in that**:

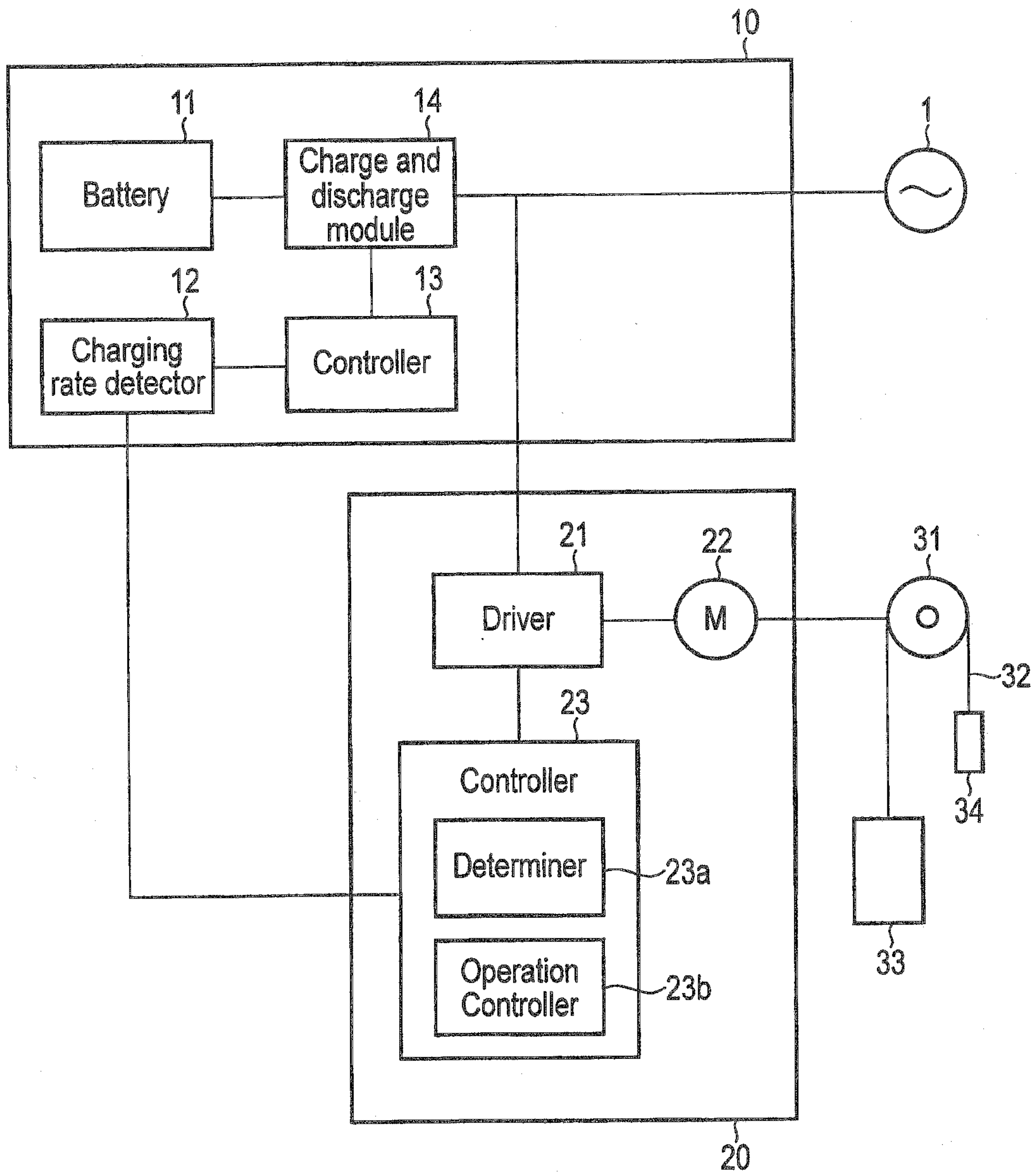
   the battery (11) is charged with electric power obtained from a power generation device (101) configured to perform power generation with natural energy during the normal operation and during the power outage; and

   charging of the battery (11) with electric power obtained from the power generation device (101) is stopped, if the charging rate of the battery (11) is greater than or equal to a third upper limit value which is less than the first upper limit value during the power outage.

6. The elevator control apparatus (100) according to Claim 5, **characterized in that** the power generation device (101) includes a solar power generation device.

7. The elevator control apparatus (100) according to Claim 5 or 6, **characterized in that** supply of electric power from the battery (11) to the elevator control apparatus (100) is stopped when the charging rate of the battery (11) is less than or equal to a first set

value, and is resumed when the charging rate of the battery (11) is greater than or equal to a second set value which is greater than the first set value.


10
11
Battery
14
Charge and discharge module
1
12
Charging rate detector
13
Controller
21
Driver
22
M
31
32
23
Controller
Determiner
23a
Operation Controller
23b
34
33
20

F I G. 1

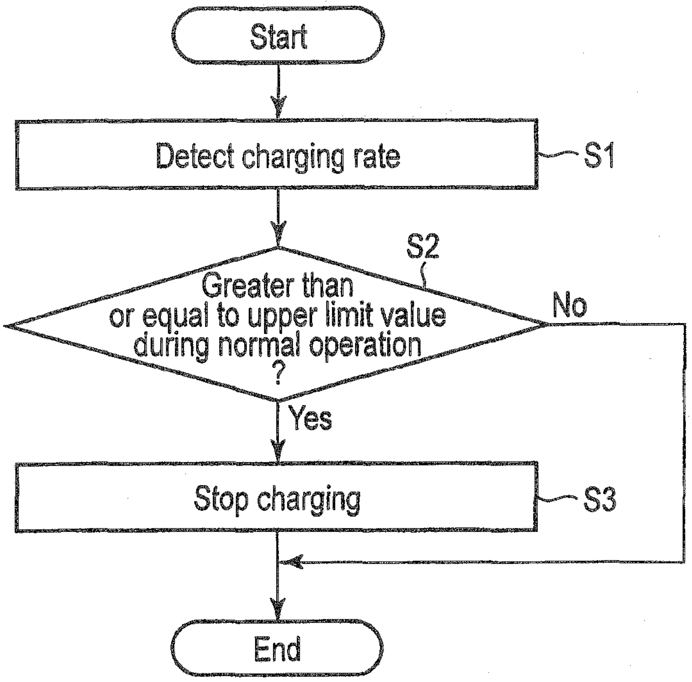

Start
Detect charging rate
S1
S2
Greater than or equal to upper limit value during normal operation ?
No
Yes
Stop charging
S3
End

FIG. 2

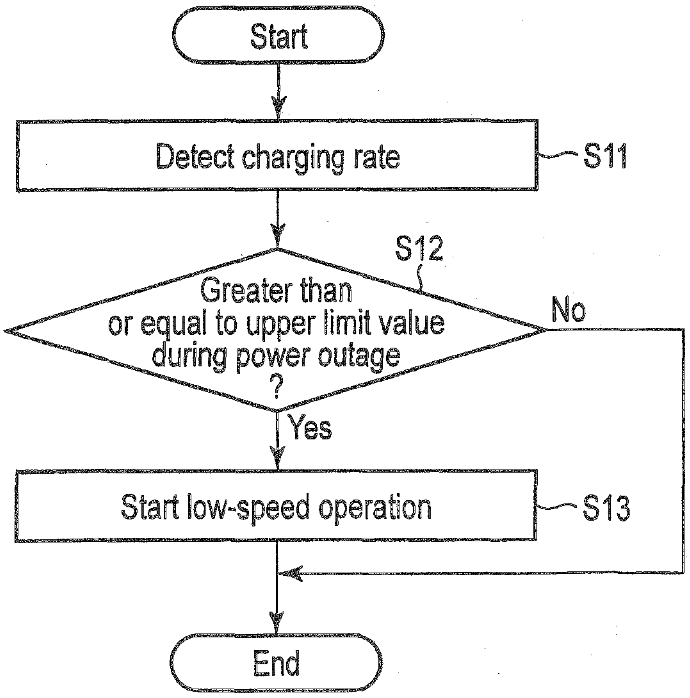

Start
Detect charging rate
S11
S12
Greater than or equal to upper limit value during power outage ?
No
Yes
Start low-speed operation
S13
End

FIG. 3

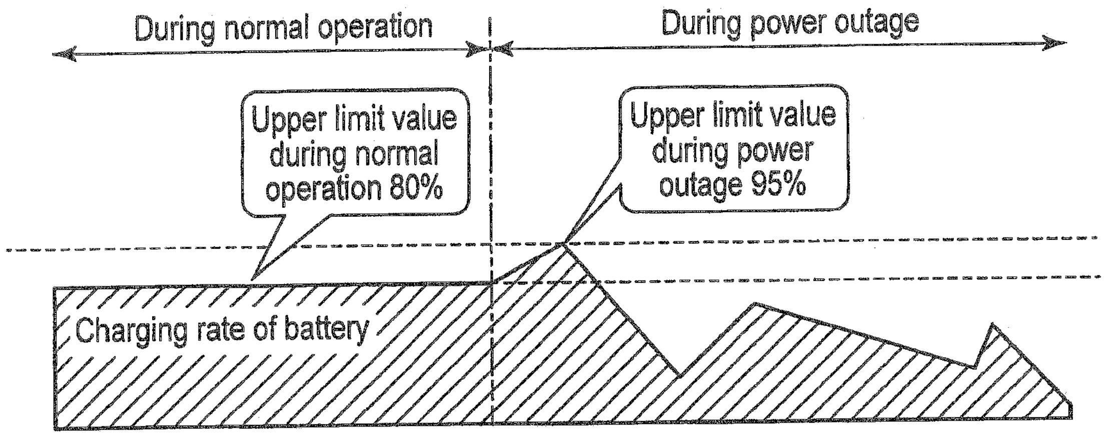
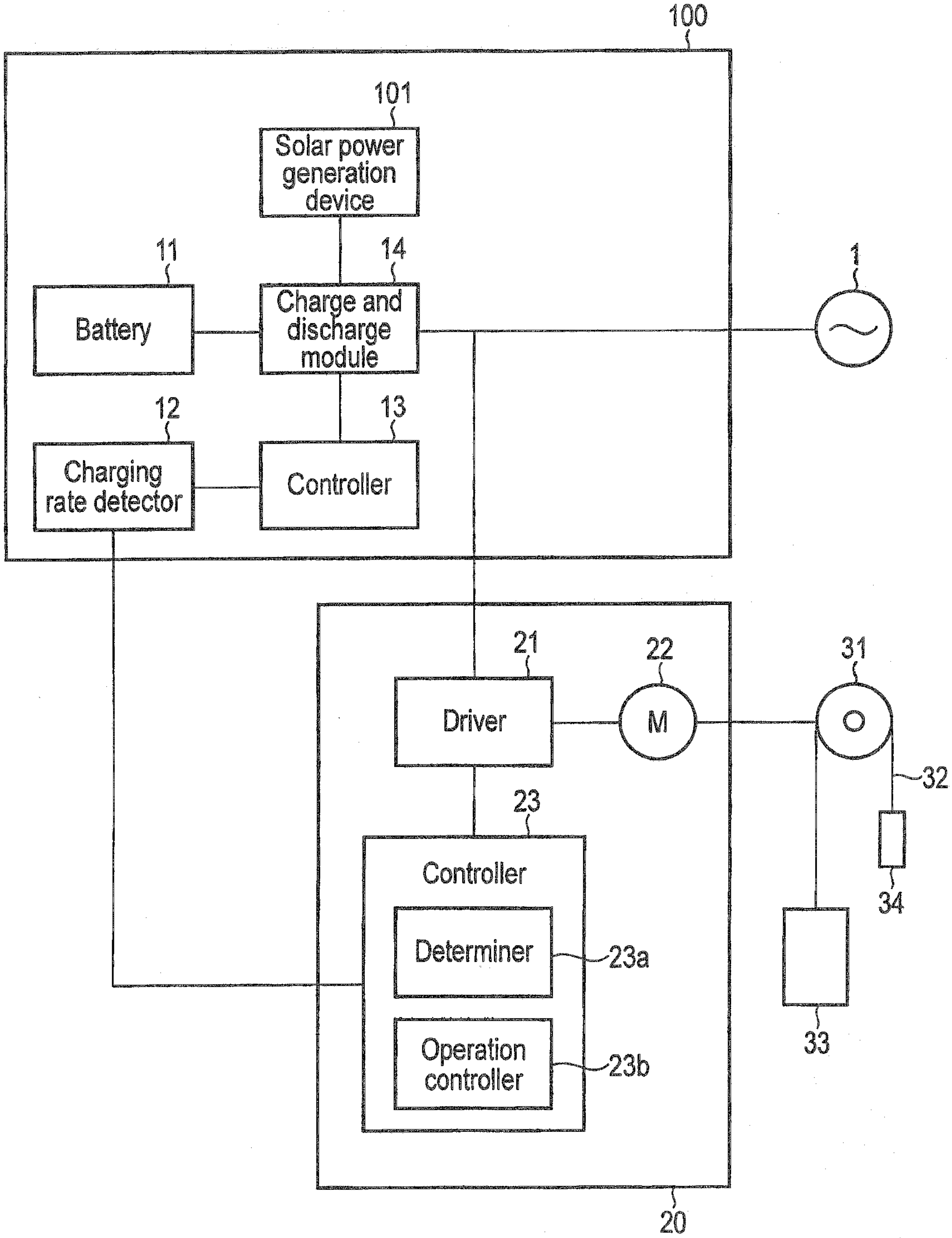

During normal operation
During power outage
Upper limit value during normal operation 80%
Upper limit value during power outage 95%
Charging rate of battery

FIG. 4


100
101
Solar power generation device
11
Battery
14
Charge and discharge module
1
12
Charging rate detector
13
Controller
21
Driver
22
M
31
32
34
23
Controller
Determiner
23a
Operation controller
23b
33
20

F I G. 5

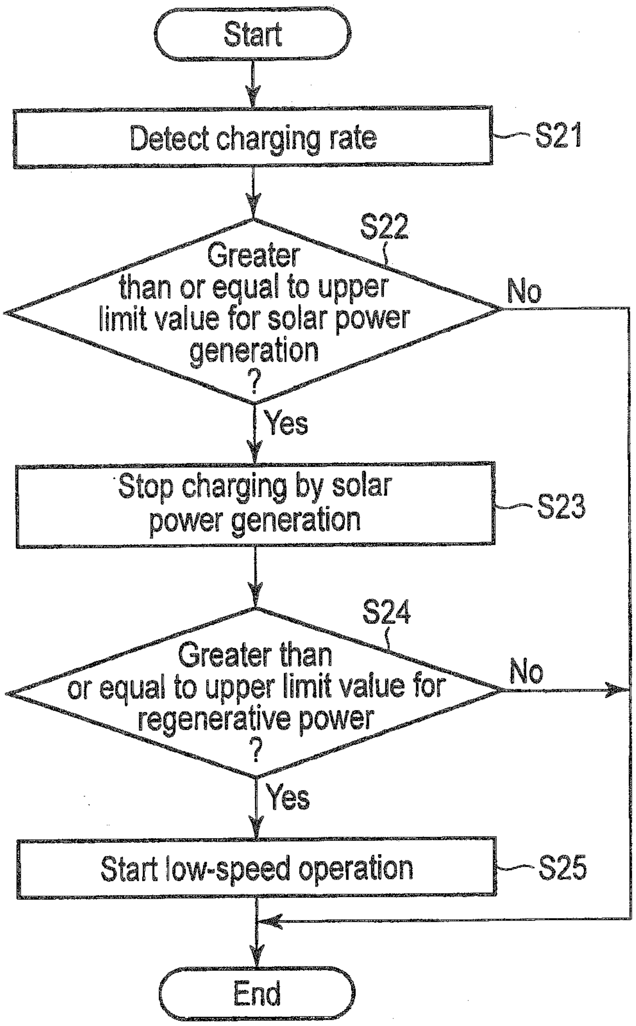

Start
Detect charging rate
S21
S22
Greater than or equal to upper limit value for solar power generation ?
No
Yes
Stop charging by solar power generation
S23
S24
Greater than or equal to upper limit value for regenerative power ?
No
Yes
Start low-speed operation
S25
End

FIG. 6

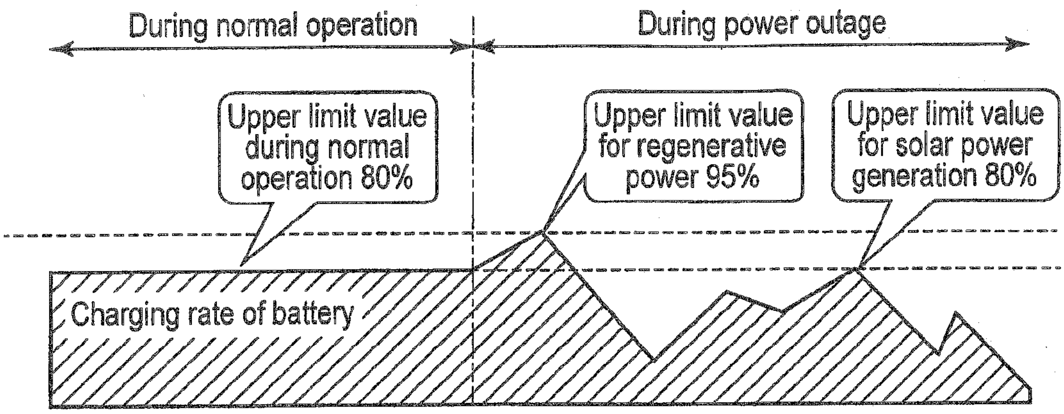

During normal operation
During power outage
Upper limit value during normal operation 80%
Upper limit value for regenerative power 95%
Upper limit value for solar power generation 80%
Charging rate of battery

FIG. 7

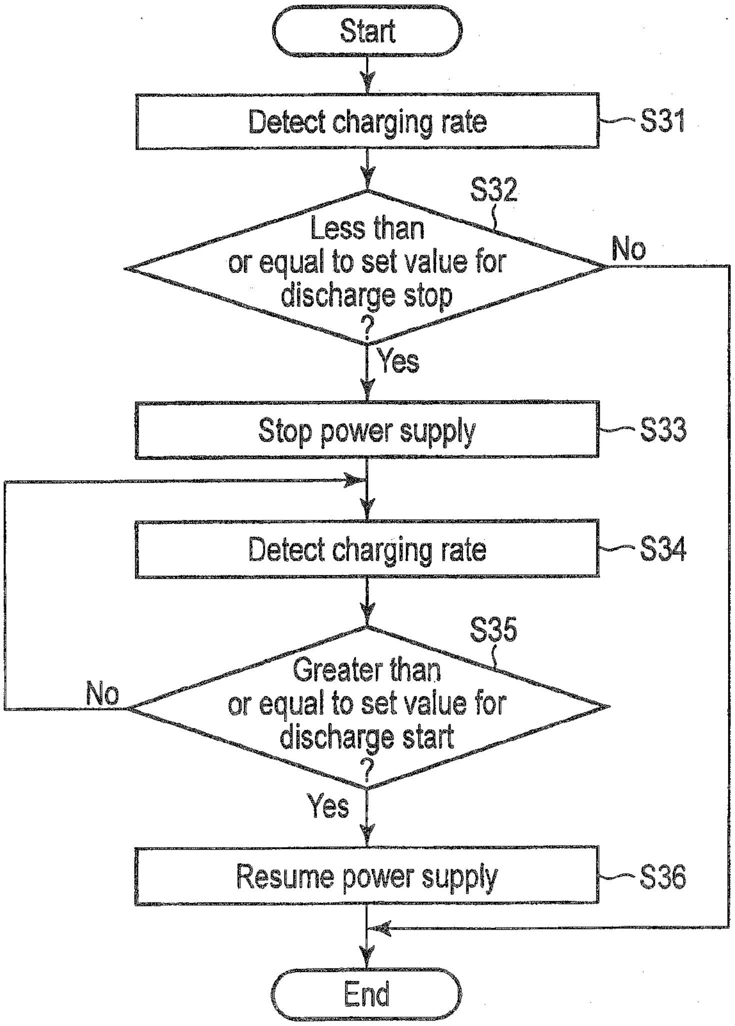

Start
Detect charging rate
S31
S32
Less than or equal to set value for discharge stop ?
No
Yes
Stop power supply
S33
Detect charging rate
S34
S35
Greater than or equal to set value for discharge start ?
No
Yes
Resume power supply
S36
End

FIG. 8

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 2041

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2009 143711 A (MITSUBISHI ELECTRIC CORP) 2 July 2009 (2009-07-02)	1-4	INV. B66B5/02
Y	* the whole document * * paragraphs [0024] - [0073] * * figures 1-5 *	5-7	
X	EP 2 500 309 A1 (INVENTIO AG [CH]) 19 September 2012 (2012-09-19)	1-7	
Y	* abstract *	5-7	

TECHNICAL FIELDS SEARCHED (IPC)

B66B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	23 January 2015	Oosterom, Marcel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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23-01-2015

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		JP 2009143711 A	02-07-2009
EP 2500309 A1	19-09-2012	AU 2012230560 A1	12-09-2013
		CN 103582604 A	12-02-2014
		CO 6811820 A2	16-12-2013
		EP 2500309 A1	19-09-2012
		EP 2686263 A1	22-01-2014
		SG 192570 A1	30-09-2013
		US 2014008155 A1	09-01-2014
		WO 2012126728 A1	27-09-2012

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82