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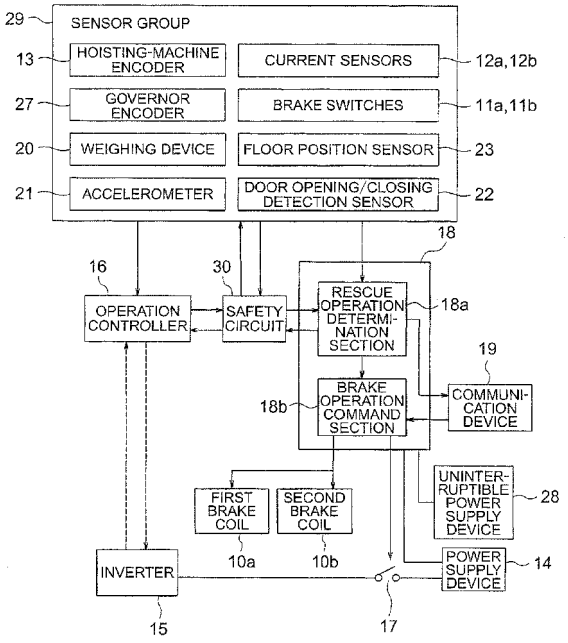
(54) ELEVATOR DEVICE

(57) Provided is an elevator apparatus, including a sensor group including a plurality of sensors, each for generating a signal based on a state of a device to be detected. Further, at least a part of the plurality of sensors are multiplexed, and a brake controller performs a brake rescue operation for controlling a braking force of a brake device to move a car based on the signals from the sensor group when the car is stopped between floors. Still further, the brake controller compares multiplexed signals of the same type received from the sensors with each other to determine whether or not the sensors function normally, and determines, based on the result of determination, whether or not the brake rescue operation can be performed.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to an elevator apparatus for controlling a braking force of a brake device to move a car when the car is stopped between floors.

Background Art

[0002] In a conventional elevator apparatus, when car position detection means detects that a car is stopped between floors, whether or not an automatic rescue operation can be performed is confirmed by failure detection means. Then, when it is determined that the automatic rescue operation can be performed, an operation mode of a controller is switched to an automatic rescue operation mode. In the automatic rescue operation mode, an operation for repeating a braking operation and a releasing operation is performed by an electromagnetic brake to move the car to a position at which a door can be opened (for example, see Patent Document 1).

[0003]

Patent Document 1: JP 2000-247558 A

Disclosure of the Invention

Problem to Be Solved by the Invention

[0004] The conventional elevator apparatus as described above does not have means for preventing an erroneous operation due to a failure of a sensor or erroneous detection. Therefore, for example, when a car-position switch cannot be detected, the car undesirably passes through a door zone (area in which the door can be opened) at a terminal landing to enter a terminal area of a hoistway. As result, a long time is required to rescue a passenger (s). Moreover, in the case of erroneous detection of a car speed, the car speed reaches an overspeed. Then, a safety device is operated. As a result, a long time is required to rescue the passenger(s).

[0005] The present invention has been made to solve the problem described above, and has an object of providing an elevator apparatus capable of quickly performing a rescue operation.

Means for Solving the Problem

[0006] An elevator apparatus according to the present invention includes: a car; a hoisting machine including a hoisting-machine motor to raise and lower the car; an operation controller for controlling the hoisting-machine motor to control an operation of the car; a brake device for braking running of the car; a sensor group including a plurality of sensors, each for generating a signal based on a state of a device to be detected; and a brake controller for performing a brake rescue operation for controlling a braking force of the brake device to move the car based on the signals from the sensor group when the car is stopped between floors, in which at least a part of the plurality of sensors are multiplexed, and the brake controller compares multiplexed signals of the same type received from the plurality of sensors with each other to determine whether or not the plurality of sensors function normally, and determines, based on a result of determination, whether or not the brake rescue operation can be performed.

Brief Description of the Drawings

[0007]

FIG. 1 is a configuration diagram illustrating an elevator apparatus according to Embodiment 1 of the present invention, in which a part of the elevator apparatus is represented by blocks.

FIG. 2 is a block diagram illustrating a control system of the elevator apparatus illustrated in FIG. 1 in a more specific manner.

Fig. 3 is a flowchart illustrating an operation of a brake controller illustrated in FIG. 2.

Best Mode for Carrying Out the Invention

[0008] Hereinafter, a preferred embodiment of the present invention is described referring to the drawings.

Embodiment 1

[0009] FIG. 1 is a configuration diagram illustrating an elevator apparatus according to Embodiment 1 of the present invention, in which a part of the elevator apparatus is represented by blocks. In the drawing, a car 1 and a counterweight 2 are suspended in a hoistway by a plurality of main ropes 3 corresponding to suspension means, and are raised and lowered in the hoistway by a driving force of a hoisting machine 4.

[0010] The hoisting machine 4 includes a drive sheave 5 around which the main ropes 3 are looped, a hoisting-machine motor 6 for rotating the drive sheave 5, a brake drum (brake wheel) 7 which is rotated integrally with a rotary shaft of the hoisting-machine motor 6 and the drive sheave 5, and a brake device 8 for braking the rotation of the brake drum 7 and that of the drive sheave 5.

[0011] The brake device 8 includes a first brake lining 9a and a second brake lining 9b which are brought into contact with and separated away from the brake drum 7, a first brake spring and a second brake spring (not shown) for pressing the brake linings 9a and 9b against the brake drum 7 to apply a braking force thereto, and a first brake coil 10a and a second brake coil 10b for separating the brake linings 9a and 9b away from the brake drum 7 against the brake springs to release the braking force.

[0012] The brake device 8 is provided with a first brake switch 11a for detecting an opening/closing operation of

the brake lining 9a and a second brake switch 11b for detecting an opening/closing operation of the brake lining 9b. A first current sensor 12a is provided to the first brake coil 10a. A second current sensor 12b is provided to the second brake coil 10b. The hoisting machine 4 is provided with a hoisting-machine encoder 13 for generating a signal according to the rotation of the drive sheave 5.

[0013] Electric power is supplied from a power supply device 14 through an inverter 15 to the hoisting-machine motor 6. The inverter 15 is controlled by an operation controller 16. A cutoff switch 17 is provided between the power supply device 14 and the inverter 15. By opening the cutoff switch 17, the supply of the electric power to the inverter 15 is cut off to stop driving the hoisting-machine motor 6.

[0014] The supply of the electric power to the brake coils 10a and 18b is controlled by a brake controller 18. Specifically, a braking force generated by the brake device 8 is controlled by the brake controller 18. The brake controller 18 controls the brake device 8 based on a command from the operation controller 16 at the time of a normal operation. The brake controller 18 also controls opening/closing of the cutoff switch 17. Further, the brake controller 18 is mutually communicable to a communication device 19 for a notification to a remotely located maintenance center.

[0015] The car 1 includes a weighing device 20 for detecting a live load in the car 1, an accelerometer 21 for detecting an acceleration of the car 1, a door opening/closing detection sensor 22 for detecting an open/closed state of a car door, and a floor position sensor 23 for detecting whether or not the car 1 is present at a position at which the car door can be opened.

[0016] In an upper part of the hoistway, a governor 24 is provided. A governor rope 25 is looped around a governor sheave of the governor 24. Both ends of the governor rope 25 are connected to an actuating lever 26 of a safety device (not shown) which is mounted to the car 1. In this manner, the governor sheave is rotated at a speed according to a running speed of the car 1. The governor 24 brings the car 1 to an emergency stop when the speed of the car 1 reaches a preset overspeed. The governor 24 is provided with a governor encoder 27 for generating a signal according to the rotation of the governor sheave.

[0017] FIG. 2 is a block diagram illustrating a control system of the elevator apparatus illustrated in FIG. 1 in a more specific manner. The brake controller 18 includes a rescue operation determination section 18a for determining whether or not a rescue operation can be performed and for selecting a method of the rescue operation, and a brake operation command section 18b for issuing a command to apply voltages to the brake coils 10a and 10b.

[0018] Signals from a sensor group 29 are input to the rescue operation determination section 18a. The sensor group 29 includes a plurality of sensors, each for generating a signal based on a state of a device to be detected, specifically, the hoisting-machine encoder 13, the governor encoder 27, the weighing device 20, the accelerometer 21, the current sensors 12a and 12b, the brake switches 11a and 11b, the floor position sensor 23, and the door opening/closing detection sensor 22.

[0019] The rescue operation determination section 18a selects the method of the rescue operation based on the state of the elevator apparatus, which can be determined from a state of a safety circuit 30, and the signals from the sensor group 29 when the elevator apparatus is placed in a state in which the normal operation cannot be performed.

[0020] The method of the rescue operation, which is selected by the rescue operation determination section 18a, includes a method for driving the hoisting-machine motor 6 to move the car 1 to a landing floor (hoisting-machine rescue operation), a method for controlling the brake device 8 to move the car 1 to the landing floor by a load imbalance between the car 1 and the counterweight 2 (brake rescue operation), a method for controlling the brake device 8 by a remote operation performed at the maintenance center to move the car 1 to the landing floor (remote rescue operation), and a method for notifying the maintenance center so that a rescue by an expert worker is waited for (rescue by the worker).

[0021] The rescue operation determination section 18a notifies the communication device 19 of the result of determination and issues an operation command based on the result of determination to the brake operation command section 18b. The brake operation command section 18b controls the voltages respectively applied to the brake coils 10a and 10b to perform the rescue operation based on the command from the rescue operation determination section 18a or the communication device 19. Moreover, the brake operation command section 18b opens the cutoff switch 17 at the time of the rescue operation performed by the control of the brake device 8 to prevent an unexpected operation (runaway drive due to a failure of the operation controller 16 or the like) of the hoisting-machine motor 6.

[0022] The electric power is supplied to the brake controller 18 by the power supply device 14. Moreover, the electric power can also be supplied from an uninterruptible power supply device 28 to the brake controller 18. Therefore, even in a state in which the electric power cannot be supplied from the power supply device 14 due to a power failure, the brake device 8 can be controlled by the brake controller 18. Further, the uninterruptible power supply device 28 can also supply the electric power to the hoisting-machine motor 6 and the operation controller 16.

[0023] The safety circuit 30 is connected to the sensor group 29 and the operation controller 16. If a state in which service is not available or a state in which an emergency stop needs to be made occurs in any one of the devices connected to the safety circuit 30, the safety circuit 30 is interrupted and the state is transmitted to the entire control system.

[0024] Each of the sensors included in the sensor group 29 is multiplexed (for example, duplexed). According to the multiplexing of the sensors, a signal receiving section (such as a light-receiving element or a power-receiving element) of the brake controller 18 is multiplexed for each state signal.

[0025] Moreover, each of a command output section of the operation controller 16 for the brake controller 18 and a command output section of the communication device 19 for the brake controller 18 is multiplexed. According to the multiplexing of the command output sections, each of command input sections of the brake controller 18, which respectively receive the command from the operation controller 16 and that from the communication device 19, is multiplexed.

[0026] The brake controller 18 compares the multiplexed state signals of the same type, which are received from the sensors included in the sensor group 29, to determine whether or not each of the sensors functions normally. Here, the state signals of the same type include the results of calculation respectively obtained based on the state signals of the same type. Specifically, the results of calculation performed based on the state signals of the same type may be compared with each other instead.

[0027] As a criterion of the determination, for example, when a difference between the state signals of the same type, which are compared with each other, is smaller than a preset threshold value, it is determined that a normal detection is performed. The determination described above may be performed in a single circuit or in a plurality of circuits to further compare the results of determination so as to confirm whether the determination circuit itself is normal.

[0028] The brake controller 18 determines, based on the result of determination of the normality of the functions of the sensor group 29, whether or not the hoisting machine rescue operation, the brake rescue operation, and the remote rescue operation can be performed. For example, in the case where the normality of the door opening/closing detection sensor 22 cannot be confirmed, it is determined that the hoisting machine rescue operation and the brake rescue operation, which are carried out based only on the determination made by the brake controller 18, cannot be performed. Moreover, in the case where the normality of the encoders 13 and 27 is not confirmed, it is determined that the brake rescue operation cannot be performed.

[0029] A sensor having high reliability in the operation or a sensor which does not affect the safety even if an erroneous determination is made is not necessarily required to be multiplexed.

[0030] The operation controller 16 and the brake controller 18 respectively include microcomputers independent of each other. Specifically, the functions of each of the operation controller 16 and the brake controller 18 can be executed by computation processing performed by the microcomputer.

[0031] FIG. 3 is a flowchart illustrating an operation of the brake controller 18 illustrated in FIG. 2. While the normal operation is performed (Step 1), the brake controller 18 confirms the state of the safety circuit 30 in a predetermined cycle so as to confirm whether or not the rescue operation is required (Step S2). In this step, even when the emergency stop of the car 1 or the like is confirmed, it is determined that the rescue operation is not required in the case where it is determined, based on the information from the weighing device 20, that no passenger is present in the car 1 or it is determined, based on the information from the floor position sensor 23, that the car 1 is present at the position where the door can be opened. Even in the above-mentioned cases, however, it is necessary to independently determine whether or not the normal operation can be continued so as to restart the normal operation.

[0032] When it is determined that the rescue operation is not required as a result of the determination of the necessity of the rescue operation, the normal operation is continued. On the other hand, when it is determined that the rescue operation is required, the possibility of the hoisting-machine rescue operation is confirmed based on the signals from the sensor group 29 and the state of the safety circuit 30 (Step S3).

[0033] More specifically, for the determination made based on the signals from the sensor group 29, when it is determined, based on the signal from the door opening/closing detection sensor 22, that the car door is in an unclosed state, it is determined that the hoisting-machine rescue operation cannot be performed. In the case of a failure of the inverter 15 or the power supply device 14, the safety circuit 30 is interrupted. Therefore, it is determined, based on the interrupted state of the safety circuit, that the hoisting-machine rescue operation cannot be performed. Further, by comparing the multiplexed state signals of the same type with each other, whether or not the system including the sensor group 29 is in a state in which the hoisting-machine rescue operation can be performed is also determined.

[0034] When it is determined that the hoisting-machine rescue operation can be performed, the brake controller 18 drives the hoisting-machine motor 6 at a low speed through an intermediation of the operation controller 16 to perform the hoisting-machine rescue operation (Step S4). During the hoisting-machine rescue operation, the confirmation of the completion of the rescue (Step S5) and the confirmation of the possibility of the hoisting-machine rescue operation (Step S3) are repeated in a predetermined cycle.

[0035] The confirmation of the completion of the rescue is performed based on the signals from the sensor group 29 and the state of the safety circuit 30. Specifically, when an open state of the car door is detected based on, for example, the signal from the door opening/closing detection sensor 22, it is determined that the rescue operation is completed. For the determination as describe above, however, the car door needs to be configured openable only when the car 1 is located at the land-

ing floor.

[0036] Note that, if the rescue operation is not completed even after the elapse of a predetermined period of time, there is a possibility that the hoisting-machine rescue operation is not appropriately performed for some reason even when it is determined that the hoisting-machine rescue operation can be performed. Therefore, setting may be performed to change the determination so that it is determined that the hoisting-machine rescue operation cannot be performed in the above-mentioned case.

[0037] When it is determined that the hoisting-machine rescue operation is completed, the brake controller 18 then determines whether or not the normal operation can be performed (Step S6). Whether or not the normal operation can be performed is determined based on the signals from the sensor group 29 and the state of the safety circuit 30. Specifically, for example, when the signals from the sensor group 29 all indicate a normal state and in addition, the safety circuit 30 is not interrupted, it is determined that the normal operation can be performed.

[0038] When it is determined that the normal operation can be performed, the normal operation is directly restarted (Step S1). On the other hand, when it is determined that the normal operation cannot be performed, a notification is made to the maintenance center and recovery work is waited for (Step S7). After that, the recovery work is performed by the expert worker. After the safety is confirmed, the normal operation is restarted.

[0039] Next, when it is determined that the hoisting-machine rescue operation cannot be performed in the determination of the possibility of the hoisting-machine rescue operation (Step S3), the brake controller 18 confirms that the car 1 is held in a stopped state (Step S8) and then de-energizes the brake coils 10a and 10b to maintain a stationary state of the car 1 (Step S9). Moreover, the cutoff switch 17 is opened to cut off the electric power supply to the hoisting-machine motor 6 (Step S10).

[0040] The stopped state of the car 1 is confirmed before the de-energization of the brake coils 10a and 10b in the above-mentioned steps so as to prevent the car 1 from being unnecessarily suddenly stopped by the de-energization of the brake coils 10a and 10b while the car 1 is running in the case where the rescue command issued from the operation controller 16 is erroneous.

[0041] As a method of confirming the stop of the car 1, there is a method for confirming the stopped state of the car based on the signal from the hoisting-machine encoder 13 or the governor encoder 27. Specifically, when a pulse of the signal from the encoder 13 or 27 does not change or when the rotation speed calculated from the pulse is equal to or less than a predetermined value, it is determined that the car 1 is held in the stopped state. Moreover, it is also determined that the car 1 is held in the stopped state when it is determined, based on the signal from the accelerometer 21, that the acceleration of the car 1 is zero over a predetermined period of time or longer.

[0042] Further, the maintenance of the stationary state of the car 1 (Step S9) is performed before the cutoff switch 17 is opened because the car 1 is sometimes held in the stopped state by the driving force of the hoisting-machine motor 6. Specifically, in the case where the car 1 is held in the stopped state by the driving force of the hoisting-machine motor 6, the car 1 is moved due to imbalance between the car 1 and the counterweight 2 if the cutoff switch 17 is first opened. Therefore, the brake coils 10a and 10b are first de-energized to maintain the state of the car 1.

[0043] After the cutoff switch 17 is opened, the brake controller 18 notifies the maintenance center of the state in which the recovery work is required for the elevator apparatus (Step S11). When the operation controller 16 determines that the rescue operation is required even though the brake controller 18 determines that the rescue operation is not required, the brake controller 18 notifies the maintenance center of the occurrence of inconsistency in the determinations. More specifically, for example, when the rescue command from the operation controller 16 is transmitted to the brake controller 18 even though the car 1 is held in the stopped state at the position where the door can be opened, the brake controller 18 confirms the open state of the car door, and the brake controller 18 determines that the rescue operation is not required, the brake controller 18 notifies the maintenance center of the occurrence of the problem.

[0044] After the notification to the maintenance center, the brake controller 18 determines whether or not the brake rescue operation can be performed (Step S12). More specifically, when the voltages are applied to the brake coils 10a and 10b so that the energization of the brake coils 10a and 10b is confirmed by the current sensors 12a and 12b, the opening/closing operations of the brake linings 9a and 9b are confirmed by the brake switches 11a and 11b, and it is confirmed, based on the signal from the weighing device 20, that a difference in weight between the car 1 and the counterweight 2 is sufficiently large to move the car 1, it is determined that the brake rescue operation can be performed.

[0045] In this step, whether or not the difference in weight between the car 1 and the counterweight 2 is sufficiently large is determined in consideration of a difference in weight between the main ropes 3 and a control cable (not shown) on the car 1 side and those on the counterweight 2 side according to the stop position of the car 1. Then, when the difference in weight is larger than a resistance force due to a friction and an operation loss, which are generated at the time of movement of the car 1, it is determined that the difference in weight is sufficiently large.

[0046] Moreover, the brake controller 18 compares the multiplexed state signals of the same type with each other to determine whether or not the system including the sensor group 29 is in a state in which the brake rescue operation can be performed.

[0047] When it is determined that the brake rescue operation can be performed, the brake rescue operation is performed. In the brake rescue operation, the state of the car 1 is first confirmed (Step S13). For the confirmation of the state of the car 1, whether or not the car 1 is present at the floor position is confirmed and the car speed is detected.

[0048] Next, the voltages applied to the brake coils 10a and 10b are adjusted to adjust a brake torque so that the car speed follows a preset target speed (Step S14). In place of the method for controlling the car speed, a method which has a change in car position as a target, specifically, a method for controlling the car position so that the car position follows the target change in position may be used.

[0049] After that, based on the result of detection for the presence or absence of the car 1 at the floor position which is detected in advance, it is confirmed whether or not the car 1 is present at the position where the door can be opened (Step S15). When the car 1 is not present at the position where the door can be opened, the operation returns to the determination of the possibility of the brake rescue operation (Step S12). During the brake rescue operation, the operation of Steps S12 to S15 is repeated in a predetermined cycle.

[0050] When the car 1 reaches the position where the door can be opened, the stationary state of the car 1 is maintained (Step S16) and the car door and a landing door are held in an open state (Step S17). As a result, a passenger (s) can get off on the landing floor. After that, the recovery work is performed by the expert worker. After the safety is confirmed, the normal operation is restarted.

[0051] Based on the signal for transmitting the termination of control, which is generated from the operation controller 16 or the signals from the sensor group 29, the brake controller 18 can confirm the completion of the rescue operation. For example, by detecting the open state of the car door based on the signal from the door opening/closing detection sensor 22, it can be determined that the rescue operation is completed. For the determination described above, however, the car door needs to be configured openable only when the car 1 is present at the landing floor.

[0052] Note that, when the rescue operation is not completed even after the elapse of the predetermined period of time, there is a possibility that the brake rescue operation is not appropriately performed for some reason even though it is determined that the brake rescue operation can be performed. Therefore, the setting may be performed to change the determination so that it is determined that the brake rescue operation cannot be performed in the above-mentioned case.

[0053] When the rescue operation is not completed even after the elapse of the predetermined period of time, the brake controller 18 may notify the maintenance center through the communication device 19. Then, if a command of the remote rescue operation is issued from the maintenance center in response to the notification, the brake rescue operation may be interrupted so as to perform the determination of the possibility of the remote rescue operation (Step S18).

[0054] Next, when it is determined that the brake rescue operation cannot be performed in the determination of the possibility of the brake rescue operation (Step S12), it is then determined whether or not the remote rescue operation can be performed (Step S18). In the determination of the possibility of the remote rescue operation, in case of a failure of any one of the sensors, when it is determined that the safety of the passenger(s) can be ensured through the communication from the maintenance center even though the failure occurs in the sensor, it is determined that the remote rescue operation can be performed.

[0055] For example, when the signal from the door opening/closing detection sensor 22 cannot be confirmed or the car door cannot be closed, the car 1 is moved to the landing floor by a remote operation so as to rescue the passenger (s) while the safety of the passenger (s) is ensured by the communication to the passenger (s) present inside the car 1 with an interphone device or by visually confirming an image, which is taken by a camera provided inside the car 1 or at the landing, at the maintenance center.

[0056] On the other hand, when the safety of the passenger (s) cannot be ensured in the remote rescue operation or the failure state is at such a degree that the remote rescue operation cannot be performed, it is determined that the remote rescue operation cannot be performed. As the case where the remote rescue operation cannot be performed, for example, the impossibility of energization of the brake coils 10a and 10b and a small difference in weight between the car 1 and the counterweight 2 are given.

[0057] When it is determined that the remote rescue operation can be performed, the maintenance center is notified of the result of determination (Step S19). After that, the remote rescue operation is performed according to the remote operation performed at the maintenance center (step S20). Even when the remote rescue operation is performed, the recovery work is performed by the expert worker after the completion of the rescue operation. After the safety is confirmed, the normal operation is restarted.

[0058] On the other hand, when it is determined that the remote rescue operation cannot be performed, the maintenance center is notified of the result of determination and the rescue is waited for (Step S21). In this case, the passenger(s) is rescued and the recovery work is performed by the expert worker. After the safety is confirmed, the normal operation is restarted.

[0059] In the elevator apparatus described above, at least a part of the sensors included in the sensor group 29 are multiplexed. The brake controller 18 compares the multiplexed signals of the same type, which are received from the sensors, to determine whether or not the

sensors function normally. Based on the result of determination, it is determined whether or not the brake rescue operation can be performed. Thus, the erroneous operation due to the failure of the sensor or erroneous detection can be prevented. Accordingly, the rescue operation can be performed more reliably and quickly. Specifically, at the time of the rescue operation, the car 1 can be prevented from passing through the door zone of the terminal landing to enter a terminal area of the hoistway, and the car speed can be prevented from reaching the overspeed.

[0060] The signals from the sensor group 29 are input to and the electric power is supplied to the brake controller 18 independently of the operation controller 16. Therefore, even when the car 1 cannot be moved by the operation controller 16, the brake rescue operation can be performed. As a result, the passenger (s) can be rescued more reliably and quickly.

[0061] Further, prior to the determination of the possibility of the brake rescue operation, the brake controller 18 confirms, based on the signals from the sensor group 29, that the car 1 is held in the stopped state. Then, the stationary state of the car 1 is maintained by the brake device 8, and then, the electric power supply to the hoisting-machine motor 6 is cut off. Therefore, an unnecessary sudden stop of the car 1 and the movement of the car 1, which is caused by the imbalance between the car 1 and the counterweight 2, can be more reliably prevented.

[0062] Still further, when determining that the brake rescue operation cannot be performed, the brake controller 18 notifies the remotely located maintenance center of the result of determination. Therefore, in the case where a large number of elevator apparatuses are simultaneously brought to an emergency stop due to an earthquake or the like, the maintenance center can easily identify the elevator apparatus for which the rescue operation cannot be automatically performed. Thus, the passenger (s) can be quickly rescued.

[0063] Further, the brake controller 18 can control the braking force of the brake device 8 to move the car 1 in response to the command issued from the maintenance center. Therefore, in some states of the elevator apparatus, the rescue operation can be remotely performed without sending the expert worker for the rescue. As a result, the passenger(s) can be quickly rescued.

[0064] Note that, a plurality of switches which are connected in series in a multiplexed manner may be used as the cutoff switch 17. In this case, an unintended operation of the hoisting-machine motor 6 can be more reliably prevented.

Although the traction-type elevator apparatus including the counterweight 2 is described in the above-mentioned example, the present invention is also applicable to a drum-type elevator apparatus without using the counterweight 2. In this case, it is not necessary to detect the imbalance between the car 1 and the counterweight 2 for the determination of the possibility of the brake rescue operation.

Further, the determination of the normality of the sensors may be performed at the time of the determination of the possibility of the rescue operation (in Steps S3, S12, and S18) or may be periodically performed independently of the determination of the possibility of the rescue operation.

Still further, the brake controller 18 may control the brake device 8 only at the time of the rescue operation. In this case, during the normal operation, the brake controller 8 is controlled by the operation controller 16.

Further, although the brake device 8 is provided to the hoisting machine 4 in the above-mentioned example, the brake device may be provided at another location. For example, the brake device may be a car brake mounted to the car 1 or a rope brake for gripping the main ropes 3 to brake the car 1.

Still further, as the suspension means, for example, a rope having a circular cross section or a belt having a flat cross sectional shape may be used.

Claims

1. An elevator apparatus, comprising:

a car;
a hoisting machine including a hoisting-machine motor to raise and lower the car;
an operation controller for controlling the hoisting-machine motor to control an operation of the car;
a brake device for braking running of the car;
a sensor group including a plurality of sensors, each for generating a signal based on a state of a device to be detected; and
a brake controller for performing a brake rescue operation for controlling a braking force of the brake device to move the car based on the signals from the sensor group when the car is stopped between floors, wherein
at least a part of the plurality of sensors are multiplexed, and
the brake controller compares multiplexed signals of the same type received from the plurality of sensors with each other to determine whether or not the plurality of sensors function normally, and determines, based on a result of determination, whether or not the brake rescue operation can be performed.

2. An elevator apparatus according to claim 1, wherein the signals from the sensor group are input to and electric power is supplied to the brake controller independently of the operation controller.

3. An elevator apparatus according to claim 1, wherein the brake controller confirms that the car is held in a

stopped state based on the signals from the sensor group prior to the determination of possibility of the brake rescue operation, maintains a stationary state of the car by the brake device, and cuts off electric power supply to the hoisting-machine motor.

4. An elevator apparatus according to claim 1, wherein, when determining that the brake rescue operation cannot be performed, the brake controller notifies a remotely located maintenance center of the determination.

5. An elevator apparatus according to claim 4, wherein the brake controller is capable of controlling the braking force of the brake device to move the car in response to a command from the maintenance center.

Amended claims under Art. 19.1 PCT

1. (Amended) An elevator apparatus, comprising:

a car;
a counterweight;
a hoisting machine including a hoisting-machine motor to raise and lower the car and the counterweight;
an operation controller for controlling the hoisting-machine motor to control an operation of the car;
a brake device for braking running of the car;
a sensor group including a plurality of sensors, each for generating a signal based on a state of a device to be detected; and
a brake controller for performing a brake rescue operation for controlling a braking force of the brake device to move the car based on the signals from the sensor group when the car is stopped between floors, wherein:

at least a part of the plurality of sensors are multiplexed; and
the brake controller compares multiplexed signals of the same type received from the plurality of sensors with each other to determine whether or not the plurality of sensors function normally and determines at least one of whether or not the braking force by the brake device can be controlled and whether or not a difference in weight between the car and the counterweight is sufficiently large to move the car, so as to determine, based on a result of determination, whether or not the brake rescue operation can be performed.

2. (Amended) An elevator apparatus, comprising:

a car;
a hoisting machine including a hoisting-machine motor to raise and lower the car;
an operation controller for controlling the hoisting-machine motor to control an operation of the car;
a brake device for braking running of the car;
a sensor group including a plurality of sensors, each for generating a signal based on a state of a device to be detected; and
a brake controller for performing a brake rescue operation for controlling a braking force of the brake device to move the car based on the signals from the sensor group when the car is stopped between floors, wherein:

at least a part of the plurality of sensors are multiplexed;
the brake controller compares multiplexed signals of the same type received from the plurality of sensors with each other to determine whether or not the plurality of sensors function normally and determines, based on a result of determination, whether or not the brake rescue operation can be performed;
the sensor group includes a door opening/closing detection sensor for detecting an open/closed state of a door of the car as one of the plurality of sensors; and
the brake controller detects that the door of the car is opened based on a signal from the door opening/closing detection sensor to determine that the brake rescue operation is completed.

3. (Amended) An elevator apparatus according to claim 1 or 2, wherein the signals from the sensor group are input to and electric power is supplied to the brake controller independently of the operation controller.

4. (Amended) An elevator apparatus according to claim 1 or 2, wherein the brake controller confirms that the car is held in a stopped state based on the signals from the sensor group prior to the determination of possibility of the brake rescue operation, maintains a stationary state of the car by the brake device, and cuts off electric power supply to the hoisting-machine motor.

5. (Amended) An elevator apparatus according to claim 1 or 2, wherein, when determining that the brake rescue operation cannot be performed, the brake controller notifies a remotely located maintenance center of the determination.

6. (Addition) An elevator apparatus according to

claim 5, wherein the brake controller is capable of controlling the braking force of the brake device to move the car in response to a command from the maintenance center.

FIG. 1

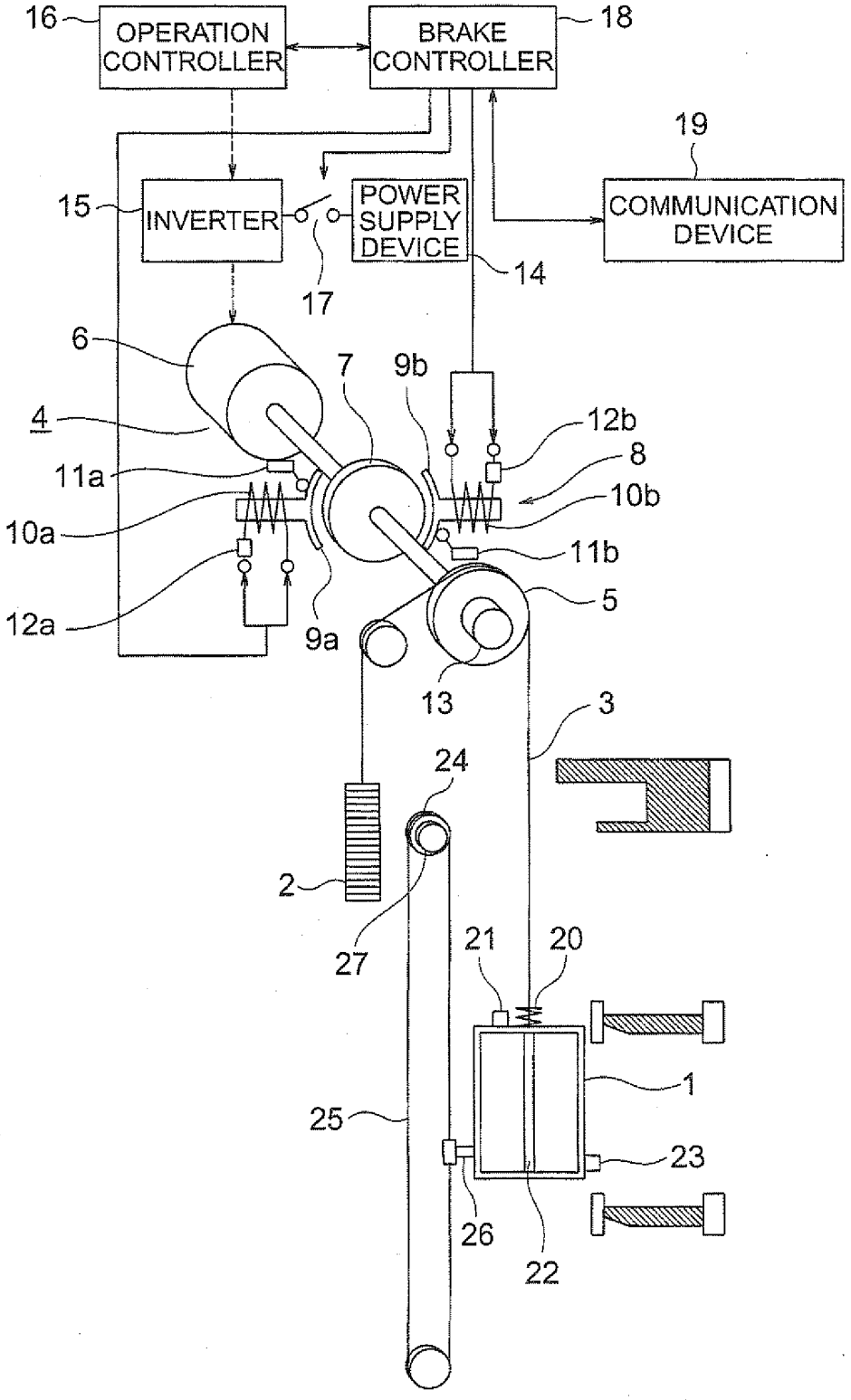

16
OPERATION CONTROLLER
BRAKE CONTROLLER
18
19
15
INVERTER
POWER SUPPLY DEVICE
COMMUNICATION DEVICE
17
14
6
7
9b
4
12b
8
11a
10b
10a
11b
5
12a
9a
13
3
24
2
27
21
20
1
25
23
26
22

FIG. 2

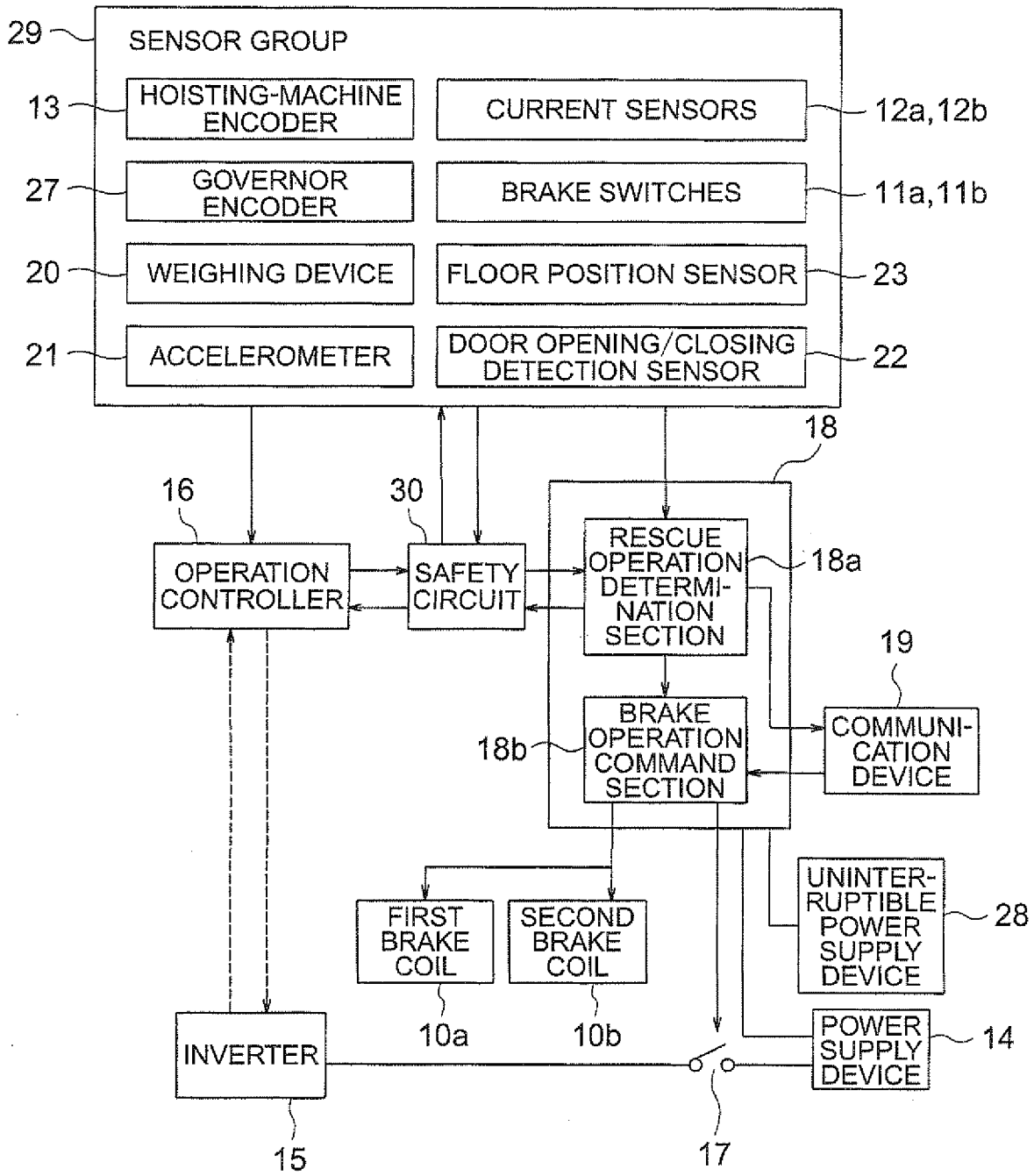
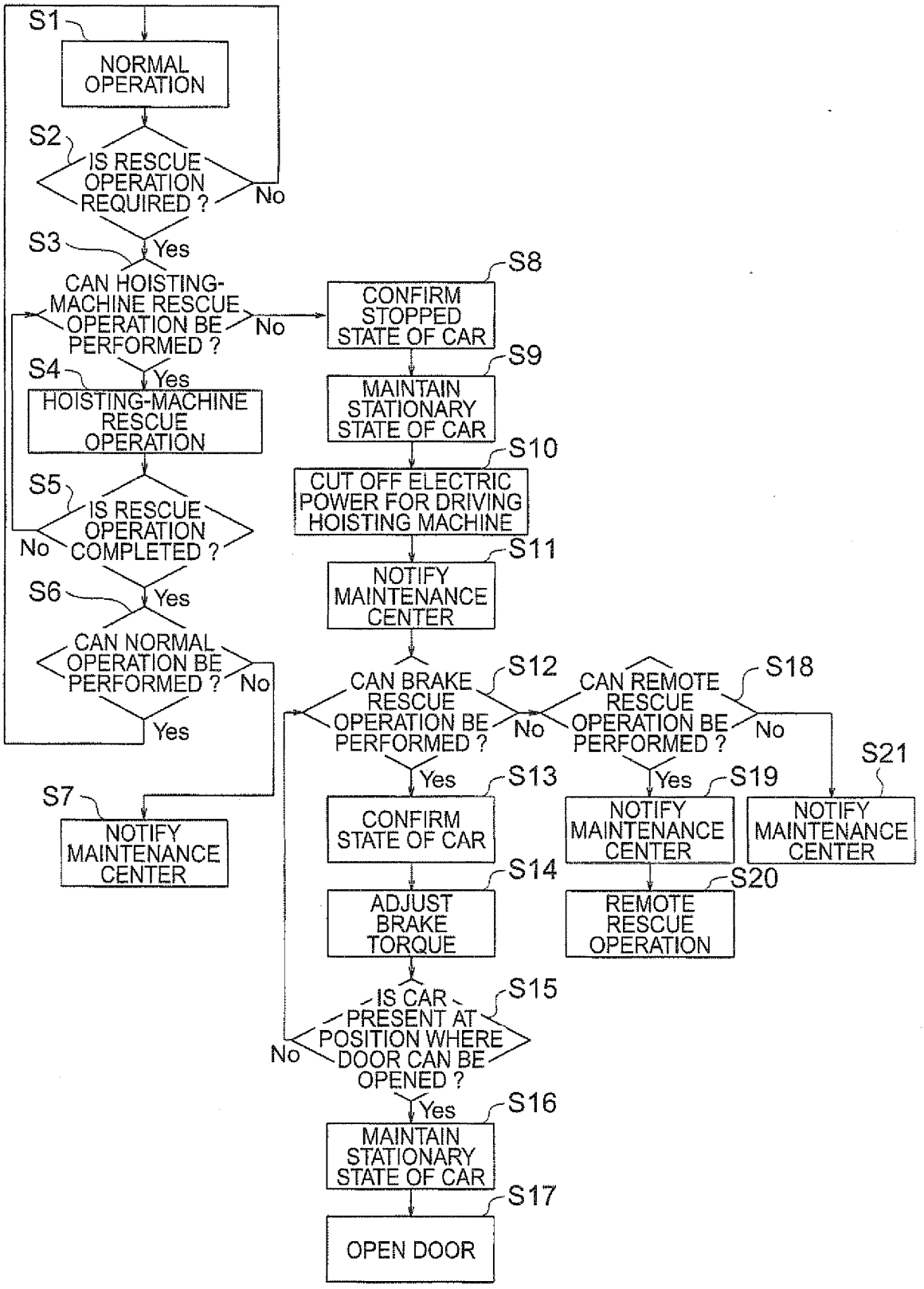

29
SENSOR GROUP
13
HOISTING-MACHINE ENCODER
CURRENT SENSORS
12a,12b
27
GOVERNOR ENCODER
BRAKE SWITCHES
11a,11b
20
WEIGHING DEVICE
FLOOR POSITION SENSOR
23
21
ACCELEROMETER
DOOR OPENING/CLOSING DETECTION SENSOR
22
18
16
30
OPERATION CONTROLLER
SAFETY CIRCUIT
RESCUE OPERATION DETERMI-NATION SECTION
18a
19
18b
BRAKE OPERATION COMMAND SECTION
COMMUNI-CATION DEVICE
UNINTER-RUPTIBLE POWER SUPPLY DEVICE
28
FIRST BRAKE COIL
SECOND BRAKE COIL
10a
10b
INVERTER
POWER SUPPLY DEVICE
14
15
17

FIG. 3


S1
NORMAL OPERATION
S2
IS RESCUE OPERATION REQUIRED ?
No
Yes
S3
CAN HOISTING-MACHINE RESCUE OPERATION BE PERFORMED ?
No
Yes
S4
HOISTING-MACHINE RESCUE OPERATION
S5
IS RESCUE OPERATION COMPLETED ?
No
Yes
S6
CAN NORMAL OPERATION BE PERFORMED ?
No
Yes
S7
NOTIFY MAINTENANCE CENTER
S8
CONFIRM STOPPED STATE OF CAR
S9
MAINTAIN STATIONARY STATE OF CAR
S10
CUT OFF ELECTRIC POWER FOR DRIVING HOISTING MACHINE
S11
NOTIFY MAINTENANCE CENTER
S12
CAN BRAKE RESCUE OPERATION BE PERFORMED ?
No
Yes
S13
CONFIRM STATE OF CAR
S14
ADJUST BRAKE TORQUE
S15
IS CAR PRESENT AT POSITION WHERE DOOR CAN BE OPENED ?
No
Yes
S16
MAINTAIN STATIONARY STATE OF CAR
S17
OPEN DOOR
S18
CAN REMOTE RESCUE OPERATION BE PERFORMED ?
No
Yes
S19
NOTIFY MAINTENANCE CENTER
S20
REMOTE RESCUE OPERATION
S21
NOTIFY MAINTENANCE CENTER

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/070933

A. CLASSIFICATION OF SUBJECT MATTER
B66B5/02(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

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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	JP 2000-247558 A (Hitachi, Ltd.), 12 September, 2000 (12.09.00), Full text; all drawings (Family: none)	1-5
Y	WO 2007/060733 A1 (Mitsubishi Electric Corp.), 31 May, 2007 (31.05.07), Par. Nos. [0015] to [0031]; Figs. 1 to 4 & EP 1958909 A1 & CN 101312898 A	1-5
Y	JP 2002-326776 A (Mitsubishi Electric Building	4-5
A	Techno-Service Co., Ltd.), 12 November, 2002 (12.11.02), Par. Nos. [0025] to [0036]; Figs. 1 to 3 (Family: none)	1-3

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 April, 2009 (15.04.09)	28 April, 2009 (28.04.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000247558 A **[0003]**