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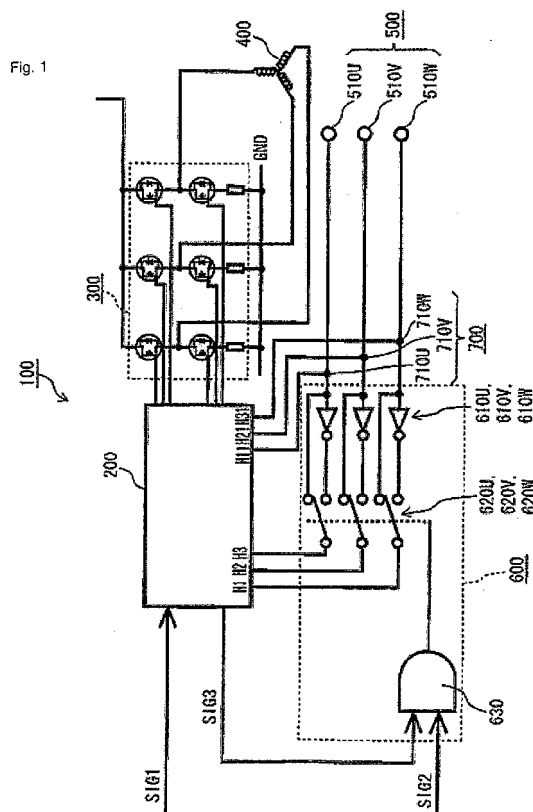
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(54) **DOOR CONTROL DEVICE FOR VEHICLES**

(57) Provided is a door control device for vehicles wherein the reliability of the control for opening and closing the door on a vehicle side can be maintained and improved. The door control device (100) for rail cars according to the present invention is constituted of a DC motor (400) that drives the opening and closing of the door; a drive unit (300) that drives the DC motor (400); and a control unit (200) that outputs a motor drive signal to the drive unit (300). The motor drive signal output from the control unit (200) is programmed so as to only be able to output a motor drive signal that matches a motor drive signal input into the drive unit (300) when the door is driven to close.



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Description

[Technical Field]

[0001] The present invention relates to a door control device for vehicles, for controlling the opening and closing of the side doors of a vehicle.

[Background Art]

[0002] General examples of vehicles having doors on the side of the vehicle include automobiles or rail cars. Of these, rail cars for conveying passengers are provided with a sliding door serving as a side door found on the side of the vehicle, in order to allow general passengers to board and disembark. Devices utilizing compressed air were conventionally used as a source of drive for such sliding doors, but in recent years it has become commonplace to use devices utilizing an electric motor controlled by a microcomputer (Patent Document 1). Lately, electric sliding doors have often been employed as side doors in automobiles.

[0003] The side door opening and closing device for rail cars recited in Patent Document 1 uses a brushless direct current motor as an electric motor in order to improve maintainability.

[Citation List]

[Patent Literature]

[0004]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2002-309849

[Summary of Invention]

[Technical Problem]

[0005] Thus, in order to ensure the safety of the passengers or the crew, the side door on the side opposite the platform will not open while the rail car is in transit, or even stalled, whenever a control device for the electric motor or the like experiences failure or is operated in error. The same is true of automobiles.

[0006] In order to prevent such unintentional opening of the door, when, for example, the electric motor is a brushed direct current motor, consideration is given to providing a relay for opening and closing based on signals from an upper system of the rail car or automobile, within the current pathway for rotating the brushed direct current motor in the direction for opening the door. Further, when the electric motor is a brushless direct current motor, consideration is given to causing a relay for selecting whether or not to supply current to the brushless direct current motor to open or close based on the signals from the upper system of the rail car or automobile.

[0007] However, in the former case, although the door will not open unintentionally whenever a control device for the electric motor or the like experiences failure or is operated in error, implementation is not possible without a brushed motor, and problems remain in terms of maintainability.

On the other hand, in the latter case, because the door can be moved in both the opening and closing direction when the relay is operated so as to feed current to the brushless direct current motor, it is assumed that the door may sometimes open unintentionally whenever a control device for the electric motor or the like experiences failure or is operated in error, even though the probability is very low, because the time required to operate the relay to feed current is short.

[0008] It is therefore an object of the present invention to provide a door control device for vehicles wherein the reliability of the control for opening and closing the side doors for a vehicle can be maintained and improved.

[Solution to Problem]

(1)

[0009] The door control device for vehicles according to the present invention includes a brushless motor that drives the opening and closing of a door; a motor encoder that detects the position of the brushless motor; a direction switching unit that either directly outputs a motor encoder signal or inverts the signal and then outputs the signal based on a signal from an upper system; and a control unit provided so as to be able to output only drive signals of a pattern that matches drive signals input to a drive unit when the door is driven to close, and configured so as to output drive signals based on the signals output by the direction switching unit, based on a signal from an upper system.

Note that an "upper system" signifies a door command control system provided to each rail car train, a centralized management system, or a primary control device governing the control of an entire automobile; the control unit is provided to each door of the vehicle.

[0010] As described above, the control unit is configured so as to be able to output only drive signals that match the drive signals input to the drive unit when the door is driven to close, and therefore the control unit is unable to drive to open the door whenever the control unit experiences a failure or is operated in error, unless the direction switching unit is switched - that is, unless the signal from the upper system is faulty. Therefore, an unintentional operation to open the door for the vehicle can be reliably prevented. As a result, the reliability of the control for opening and closing the door for the vehicle can be maintained and improved.

(2)

[0011] In a preferred configuration, the signals from

the upper system comprise a first signal that is input to the control unit, and a second signal that is input to the direction switching unit and is different from the first signal, and the direction switching unit is preferably configured to either directly output a motor encoder signal or invert the signal and then output the signal based on the signal that is output from the control unit, which is based on the first signal, as well as based on the second signal.

[0012] According to such a configuration, because the direction switching unit either directly outputs the motor encoder signal or inverts the signal and then outputs the signal based on the two different signals from the upper system (for example, the first signal is a transmission signal and the second signal is a contact signal), an unintentional operation to open the door for the vehicle can be more reliably prevented whenever one of the signals from the upper system is faulty.

(3)

[0013] The direction switching unit may be constituted of an exclusive OR circuit into which the signal output from the control unit and the second signal are input, and from which the input signals are output to the control unit.

[0014] According to such a configuration, because a failure due to a mechanical part will not occur, the failure rate can be reduced without incurring costs.

(4)

[0015] The direction switching unit is provided with an inverting circuit into which the motor encoder signal is input, and an electrical relay that is switched so as to output either the output signal of the inverting circuit or the motor encoder signal, and the electrical relay may be configured such that the output signal of the inverting circuit is output when the door is to be driven to open.

[0016] According to such a configuration, an unintentional operation to open the door for the vehicle can be more reliably prevented, because the drive to close the door is unaffected even when the inverting circuit fails. A contribution is further made to the on-time transit of the rail car, as well.

(5)

[0017] In a preferred configuration, the control unit is configured such that the motor encoder signal input into the direction switching unit can be input thereinto, a comparison then being made between the signal output by the direction switching unit and the input motor encoder signal.

[0018] According to such a configuration, the differences between the motor encoder signal input into the control unit and the signal output from the direction switching unit to the control unit are authenticated in consideration of signal from the upper system, by all the respective phases (for example, three phases) ; the situation is de-

termined to be normal when all the phases match, and the direction switching unit can be judged to have failed when even a part of the phases does not match. Therefore, an unintentional operation to open the door for the vehicle can be more reliably prevented.

(6)

[0019] The door control device for vehicles may be further provided with a handedness switching unit that sets the direction to close the door, in between the direction switching unit and the control unit.

[0020] In such a case, because the door control device for vehicles is further provided with the handedness switching unit that sets the direction to close the door, in between the direction switching unit and the control unit, it is possible to support the opposite handedness with a single type of door control device for vehicles. That is, in the case of a single opening door, whether or not the direction in which the door is closed is the direction to the front of the vehicle is determined according to the specification of the vehicle, but because the same can be set using the handedness switching unit, there is no need to manufacture or maintain etc., an opposite-handedness-door control device, and therefore the effort required for management in the factory can be reduced.

(7)

[0021] The handedness switching unit may comprise a switching switch and an exclusive OR circuit for switching the handedness direction.

[0022] In such a case, because the handedness switching unit comprises the switching switch and the exclusive OR circuit for switching the handedness direction, the configuration can be simplified and the door control device for vehicles can be rendered smaller.

[Brief Description of Drawings]

[0023] [

FIG. 1] A schematic structural diagram depicting an example of a door control device for rail cars according to a first embodiment.

[FIG. 2] A flowchart serving to describe an example of the operation of the control unit.

[FIG. 3] A schematic diagram depicting an example of the relationship between the encoder signal and the motor drive signal.

[FIG. 4] A schematic diagram depicting an example of the relationship between the encoder signal and the motor drive signal.

[FIG. 5] A schematic structural diagram depicting an example of a door control device for rail cars according to a second embodiment.

[FIG. 6] A schematic structural diagram depicting an example of a door control device for rail cars accord-

ing to a third embodiment.

[FIG. 7] A flowchart serving to describe an example of the operation of the control unit.

[FIG. 8] A schematic structural diagram depicting an example of a door control device for rail cars according to a fourth embodiment.

[Reference Sign List]

[0024]

100, 100a door control device for rail cars
200 control unit
300 drive unit
400 DC motor
500 motor encoder
600, 600a direction switcher
610U, 610V, 610W inverting circuit (direction switching unit) 620U, 620V, 620W relay
640U, 640V, 640W exclusive logical circuit (direction switching unit)
650U, 650V, 650W exclusive logical circuit (handedness switching unit)
660U, 660V, 660W inverting circuit (handedness switching unit) SIG1, SIG2, SIG3 control signal
800 handedness setting DIP switch (DIPSW) circuit
810 DIP switch

[Description of Embodiments]

[0025] The following is a description of embodiments according to the present invention. In the following embodiments, the door control device for vehicles is described taking the example of a door control device for a rail car having a sliding door provided for when general passengers are being conveyed. Note that the present invention is not to be limited to rail cars, and can also be applied to automobiles and other types of vehicles having doors.

(First Embodiment)

[0026] FIG. 1 is a schematic structural diagram depicting an example of a door control device 100 for a rail car according to a first embodiment of the present invention.

[0027] Each passenger embarkation port of the rail car is provided with the door control device 100 for rail cars. As depicted in FIG. 1, the door control device 100 for rail cars includes a control unit (a "local control unit", or "LCU") 200, a drive unit 300, a three-phase direct current brushless motor (hereinafter called a DC motor) 400, a motor encoder 500, a direction switcher 600, and an encoder monitor 700. Note that a door locking switch (DLS) is typically provided to the door control device; the lock is unlocked when the door is to be opened, and is locked when the door has been closed. In the embodiments below, a description of the door locking switch has been omitted.

[0028] The drive unit 300 is provided with a triplet of pairs of power devices (such as IGBTs or power MOSFETs) capable of supplying power from a power source corresponding to a U-phase, a V-phase, and a W-phase of the DC motor 400 in accordance with the signal from the control unit 200, each corresponding to a phase of the DC motor 400.

[0029] A power transmission device (not shown) capable of opening and closing the door for the rail car is connected to the DC motor 400. Examples of such power transmission devices include a rack-and-pinion mechanism, a ball screw mechanism, a belt mechanism, or the like. The rotation of the DC motor 400 in a given direction is able to perform the operation to open the door, and the rotation of the DC motor 400 in the opposite direction thereto is able to perform the operation to close the door.

[0030] Three Hall elements (a sensor 510U, a sensor 510V, and a sensor 510W) provided in order to detect the magnetic phase of the DC motor are used as the motor encoder 500. The rotation of the DC motor 400 can be detected by using the motor encoder 500.

[0031] Next, the direction switcher 600 includes inverting circuits 610U, 610V, and 601W; relays 620U, 620V, and 620W; and an AND circuit 630. A control signal SIG1, which is a transmission-format signal sent from the upper system by an RS-485 line, is passed to the AND circuit 630 via the control unit 200 as a control signal SIG3, which is a digital signal, and a control signal SIG2, which is a contact signal sent from the upper system, is further passed thereto. Also, the relays 620U, 620V, and 620W are of the two-point input and one-point output type. Herein, the "upper system" refers to a door command control system provided to each rail car train or to a system for governing the control information of a rail car train, which manages based on the operation of a conductor by sending commands to either open or close a door to the control unit 200 and by receiving the open/closed status of the door from the control unit 200.

[0032] Then, a signal line from the sensor 510U branches into two, each connecting to two inputs of the relay 620U. The inverting circuit 610U is inserted into one of these branched signal lines.

Similarly, the signal line from the sensor 510V branches into two, each connecting to two inputs of the relay 620V. The inverting circuit 610V being inserted into one of these branched signal lines, the signal line from the sensor 510W then branches into two, and each connects to two inputs of the relay 620W. The inverting circuit 610W is inserted into one of these branched signal lines. Below, a signal line into which an inverting circuit has been inserted is referred to as an inverter line, and a signal line into which an inverting circuit has not been inserted is referred to as a non-insertion signal line.

[0033] The relays 620U, 620V, and 620W are switched each so as to select any one of the branched inverter line and non-insertion signal line based on the output of the AND circuit 630. The output side of the relays 620U, 620V, and 620W are connected to the control unit 200.

Note that the configuration of this embodiment is such that a non-insertion signal line is selected when the operation is to close the door, and an inverter line is selected when the operation is to open the door.

[0034] Subsequently, the inside of the control unit 200 stores a control program that is capable of outputting only a motor drive signal that matches a motor drive signal input into the drive unit 300 when the operation is to close the door. An unintentional operation to open the door is therefore prevented even when the control unit 200 experiences a failure or is operated in error, because the door, as the control unit 200, is only able to output a motor drive signal in the direction for closing. Note that a more detailed description will be provided later for the relationship between the motor drive signal and the signal from the encoder input to the control unit 200.

[0035] Next, FIG. 2 is a flow chart serving to describe an example of the operation of the control unit 200.

[0036] As depicted in FIG. 2, the control unit 200 is on stand-by until an open command is received from the upper system (step S1). Herein, an "open command" refers to a transmission-format signal that is contained in the control signal SIG1, and instructs that the door is to be opened.

[0037] Next, when an open command is received (step S1: Yes), the control signal SIG3 for switching the direction switcher 600 to the door-opening direction is output from the control unit 200 (step S2). Herein, the control signal SIG3 is input into the AND circuit 630 of the direction switcher 600. A control signal SIG2 from the upper system is also directly input into the AND circuit 630. Herein, the control signal SIG2 includes a speed detection signal (5 km/h detection signal), an unlock-all signal, a permission-to-open signal, or the like.

[0038] Herein, the control signal SIG3 is an ON signal that indicates door opening; when the control signal SIG2 indicates the direction for opening the door, the AND circuit 630 selects the inverter line sides of the relays 620U, 620V, and 620W (see FIG. 1). In such a case, the sensors 510U, 510V, and 510W are inverted, and are input into the control unit 200 as corrected encoder input signals H1, H2, and H3.

[0039] On the other hand, when either one of the control signal SIG3 and the control signal SIG2 does not indicate door opening, the output of the AND circuit 630 is such that the non-insertion signal line sides of the relays 620U, 620V, and 620W are selected. In such a case, the sensors 510U, 510V, and 510W are directly input into the control unit 200 as corrected encoder input signals H1, H2, and H3.

[0040] In such a case, as will be described later, the control unit 200 controls the DC motor 400 so as to rotate in the direction in which the door is closed when the signals from the sensors 510U, 510V, and 510W are directly input as the corrected encoder input signals H1, H2, and H3. As a result, an unintentional operation to open the door is prevented whenever the control unit 200 experiences a failure or is operated in error, because the motor

drive signals for the door are output only in the closing direction.

[0041] Next, when both signals of the control signal SIG3 and the control signal SIG2 indicate door opening, the control unit 200 compares the corrected encoder input signals H1, H2, and H3 with the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W (step S3).

[0042] Herein, the control unit 200 returns to the process in step S1 without moving the door when even a part of the corrected encoder input signals H1, H2, and H3 do not match the inverted forms of the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W. Note that in such a case, the output of the control unit 200 may make it possible to visually confirm, from the exterior of the door control device 100 for rail cars, a signal in which any of the direction switcher 600, the sensors 510U, 510V, and 510W, or the encoder monitor 700 has failed. This failure signal may be transmitted to the upper system.

[0043] When the corrected encoder input signals H1, H2, and H3 completely match the inverted forms of the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W in all phases, the control unit 200 runs the aforementioned motor control program stored therein and outputs a motor drive signal to the drive unit 300 based on the corrected encoder input signals H1, H2, and H3. Further, the DC motor 400 being driven by the drive unit 300 and the encoder signal being detected by the motor encoder 500, the control unit 200 continues to control the drive unit 300 based on the corrected encoder signals (step S4).

[0044] Subsequently, the control unit 200 determines whether or not the door is in a completely open position (step S5). Herein, the control unit 200 repeats the process from step S4 when the determination is that the door is not in a completely open position.

[0045] On the other hand, when the determination is that the door is in a completely open position, the control unit 200 remains on stand-by until a close command is received from the upper system (step S6). Herein, a "close command" is a transmission-format signal that is contained in the control signal SIG1, which instructs that the door is to be closed.

[0046] Next, the control signal SIG3 for switching the direction switcher 600 to the door-closing direction is output from the control unit 200 (step S7).

Herein, when the control signal SIG3 is an OFF signal indicating door closing, or alternatively when the control signal SIG2 indicates the direction in which the door is closed, the AND circuit 630 selects the non-insertion signal line sides of the relays 620U, 620V, and 620W. The encoder signals from the sensors 510U, 510V, and 510W are thereby input into the control unit 200 as the corrected encoder input signals H1, H2, and H3, without being changed.

[0047] The control unit 200 runs the motor control program stored therein and outputs a motor drive signal to

the drive unit 300 based on the input corrected encoder input signals H1, H2, and H3. Further, the DC motor 400 being driven by the drive unit 300 and the encoder signal being detected by the motor encoder 500, the control unit 200 continuously controls the drive unit 300 based on the encoder signal (step S8).

[0048] Subsequently, the control unit 200 determines whether or not the door is in a completely close position (step S9). Herein, the control unit 200 repeats the process from step S8 when the determination is that the door is not in a completely close position.

[0049] On the other hand, the control unit 200 returns to step S1 when the determination is that the door is in a completely close position.

[0050] Note that in the above-described flow chart (FIG. 2), the process in step S3 may be inserted in between the process in step S7 and the process in step S8, to authenticate the failure or the like of the apparatus.

[0051] Next, FIGS. 3 and 4 are schematic diagrams depicting an example of the relationship between the motor drive signal and the encoder signal input to the control unit 200 - namely, the corrected encoder input signal. FIG. 3 depicts a corrected encoder input signal and motor drive signal for the door-opening direction, and FIG. 4 depicts a corrected encoder input signal and motor drive signal for the door-closing direction.

[0052] As depicted in FIG. 3(a1), the corrected encoder input signals H1, H2, and H3 repeat ON and OFF when the rotation is in the door-opening direction. Also, in FIG. 3(b1), the drive signals U, V, and W for the drive unit 300 repeat HIGH, OFF, LOW, and OFF.

[0053] On the other hand, as depicted in FIG. 4(a2), the corrected encoder input signals H1, H2, and H3 repeat ON and OFF when the rotation is in the door-opening direction. Also, in Fig. 4(b2), the drive signals U, V, and W for the drive unit 300 repeat HIGH, OFF, LOW, and OFF.

[0054] Herein, as depicted in FIGS. 3 and 4, from timing T1 to timing T2, when FIG. 3(a1) and FIG. 4(a2) are compared, inverting the ON and OFF timing of one matches the ON and OFF timing of the other.

Also, the HIGH, OFF, and LOW relationships in FIGS. 3 (b1) and 4(b2) from timing T1 to timing T2 match completely.

[0055] From the above, when the sensors 510U, 510V, and 510W are input directly as the corrected encoder input signals H1, H2, and H3, then the operation for closing the door is possible, and when the same are inverted and then input, the operation for opening the door is possible. As a result, there may only be one type of drive direction (drive signal pattern) for the drive phase of the drive unit 300 that drives the DC motor 400. Therefore, as described above, the control unit 200 stores a control program capable of outputting only a motor drive signal that matches the motor drive signal input into the drive unit 300 when the operation is to close the door (in other words, only one type of signal). Because the configuration is thus, whenever the control unit 200 experiences

a failure or is operated in error, an unintentional operation to open the door is prevented unless the direction switcher 600 is switched, because the door, serving as the control unit 200, can only output a motor drive signal in the closing direction. Moreover, reliability is high because the direction switcher 600 is not switched such that the operation opens the door until both of the control signals SIG1 and SIG2, which are in different formats, meet certain conditions.

(Second Embodiment)

[0056] Next, another example of the door control device 100 for rail cars according to the present invention will be described. The following is a description of the points of difference from the door control device 100 for rail cars depicted in FIG. 1.

[0057] FIG. 5 is a schematic structural diagram depicting an example of a door control device 100a for rail cars according to a second embodiment of the present invention.

[0058] As depicted in FIG. 5, the door control device 100a for rail cars includes a direction switcher 600a instead of the direction switcher 600 in FIG. 1.

[0059] The direction switcher 600a comprises exclusive logical circuits 640U, 640V, and 640W, and the AND circuit 630. The control signal SIG1 passed from the upper system is input to the AND circuit 630 via the control unit 200 as the control signal SIG3, and furthermore the control signal SIG2 from the upper system is also directly input thereto. The output from the AND circuit 630 is respectively input into the input of one of the exclusive logical circuits 640U, 640V, and 640W.

[0060] The signal line from the sensor 510U is input to another input of the exclusive logical circuit 640U. Similarly, the signal line from the sensor 510V is input to another input of the exclusive logical circuit 640V, and the signal line from the sensor 510W is input to another input of the exclusive logical circuit 640W. The output sides of the exclusive logical circuits 640U, 640V, and 640W are connected to the control unit 200, and the corrected encoder input signals H1, H2, and H3, which are the output of the exclusive logical circuits 640U, 640V, and 640W, are passed to the control unit 200.

[0061] In such a case, in the door control device 100a for rail cars, as in the door control device 100 for rail cars, the signals from the sensors 510U, 510V, and 510W are inverted and input to the control unit 200 as corrected encoder input signals H1, H2, and H3, unless all the output from the AND circuit 630 is ON. Accordingly, unless door-opening signals from the control signal SIG2 and the control signal SIG3 are entered into the AND circuit 630, the drive unit 300 will not be driven so as to open the door; rather, the drive unit 300 will be driven so as to close the door.

[0062] As described above, in the door control device 100a for rail cars according to the present invention, an unintentional operation to open the door can be reliably

prevented even when the control unit 200 experiences an abnormality or a failure, because as the control unit 200, motor drive signals can only be output in the closing direction.

[0063] Also, the direction switcher 600 in the door control device 100 for rail cars according to the first embodiment, being constituted of the inverting circuits 610U, 610V, and 610W and the relays 620U, 620V, and 620W, is therefore able to more reliably prevent an unintentional operation to open the door for the rail car, because the drive to close the door will not be affected even when a part of or all of the inverting circuits 610U, 610V, and 610W fails. A contribution is further made to the on-time transit of the rail car, as well. Also, the direction switcher 600a in the door control device 100a for rail cars according to the second embodiment, being constituted of the exclusive logical circuits 640U, 640V, and 640W, can therefore reduce the failure rate without incurring costs, because a failure due to a mechanical part will not occur.

[0064] Furthermore, disparities between the motor encoder signals H11, H21, and H31 detected by the encoder monitor 700 and the corrected encoder input signals H1, H2, and H3 are authenticated taking into account of the switched status of the direction switchers 600 and 600a, such that a determination can be made that the direction switchers 600 and 600a has failed when even a part does not match. Herein, "taking into account" signifies comparing the inverted signals of the signals H11, H21, and H31 with the corrected encoder input signals H1, H2, and H3 when the direction switchers 600 and 600a is switched to the side for operating to open the door, and signifies comparing the signals H11, H21, and H31 with the corrected encoder input signals H1, H2, and H3 when the direction switchers 600 and 600a is switched to the side for operating to close the door.

[0065] Note that this embodiment has been described taking the example of the three-phase direct current brushless motor 400, but there is no limitation thereto, and the motor having any other desired number of phases may be used. Further, in the first embodiment, the motor encoder signals H11, H21, and H31 are made to pass through the inverting circuits 610U, 610V, and 610W when the operation is to open the door, but there is no limitation thereto, and the configuration may be such that the same pass therethrough when the operation is to close the door. Also, although there are two signals from the upper system - the control signal SIG1 and the control signal SIG2 - there is no limitation thereto, and the configuration may be one of one or three or more. Further, the electrical relay can use a contactless relay in addition to a contact relay. In addition, although the control signal SIG1 is of the transmission format and the control signal SIG2 is a contact signal, there is no limitation thereto, and both the control signal SIG1 and the control signal SIG2 may be contact signals, or both may be of the transmission format.

(Third embodiment)

[0066] Next, a description will be provided for yet another example of the door control device 100 for rail cars according to the present invention. In a door control device 100b for rail cars in the third embodiment, the description provided is for the door control device 100b that is capable of supporting an opposite handedness of a rail car side door - that is, a door that is closed in different directions. The following is a description of the points of difference from the door control device 100 for rail cars and the door control device 100a for rail cars depicted in FIGS. 1 to 5.

[0067] FIG. 6 is a schematic structural diagram depicting an example of the door control device 100b for rail cars according to the third embodiment of the present invention.

[0068] As depicted in FIG. 6, the door control device 100b for rail cars includes a direction switcher 600b instead of the direction switchers 600 and 600a; the direction switcher 600b comprises the inverting circuits 610U, 610V, and 610W, and the relays 620U, 620V, and 620W, the And circuit 630, as well as exclusive OR circuits 650U, 650V, and 650W.

[0069] The door control device 100b for rail cars further includes a handedness setting DIP switch (DIPSW) circuit 800. The handedness setting DIP switch circuit 800 has a DIP switch 810, and is intended to set the direction in which the door is closed. The DIP switch 810 is set to one of either ON (+24V) or OFF (0V), and then the corresponding handedness signal KSIG is passed on to the control unit 200. The corresponding handedness signal KSIG is also then passed on to the exclusive OR circuits 650U, 650V, and 650W by the control unit 200.

[0070] The control signal SIG1, which is a transmission-format signal that has been sent from the upper system by the RS-485 line, is passed to the AND circuit 630 via the control unit 200 as the control signal SIG3, which is a digital signal; the control signal SIG2, which is a contact signal sent from the upper system, is also passed thereto. The relays 620U, 620V, and 620W, are of the two-point input and one-point output type. The exclusive OR circuits 650U, 650V, and 650W comprise two-input and one-output exclusive OR circuits.

[0071] As depicted in FIG. 6, the signal line from the sensor 510U branches into two, each connecting to the two inputs of the relay 620U. The inverting circuit 610U is then inserted into one of these branched signal lines. Similarly, the signal line from the sensor 510V branches into two, each connecting to the two inputs of the relay 620V. The inverting circuit 610V is inserted into one of these branched signal lines; the signal line from the sensor 510W branches into two, each connecting to the two inputs of the relay 620W. The inverting circuit 610W is inserted into one of these branched signal lines. Below, equivalent to FIG. 1, a signal line into which an inverting circuit has been inserted is referred to as an inverter line, and a signal line into which an inverting circuit has not

been inserted is referred to as a non-insertion signal line.

[0072] The relays 620U, 620V, and 620W are each switched so as to select any one of the branched inverter line and non-insertion signal line based on the output of the AND circuit 630. The output sides of the relays 620U, 620V, and 620W are connected to one of the two inputs of the exclusive OR circuits 650U, 650V, and 650W.

The handedness signal is also connected to one of the two inputs of the exclusive OR circuits 650U, 650V, and 650W. The exclusive OR circuits 650U, 650V, and 650W input the corrected encoder input signals H1, H2, and H3 into the control unit 200 based on the handedness signal KSIG and the relays 620U, 620V, and 620W.

[0073] That is, in the door control device 100b for rail cars, the direction of movement of the door (handedness direction) can be changed using the handedness signal KSIG, and therefore the management man-hours in the factory and the like of the door control device can be reduced without necessitating the manufacture or management of an opposite-handedness-door control device - that is, two different kinds of control devices.

[0074] Next, FIG. 7 is a flow chart serving to describe an example of the operation of the control unit 200 according to the third embodiment.

[0075] As depicted in FIG. 7, the control unit reads out the content of the handedness setting DIP switch (DIPSW) circuit 800 (step S11). A handedness signal (KSIG) is then output based on the content that has been read out (step S12). In particular, it is possible to control either one of left or right door opening by switching the DIP switch 810 of the handedness setting DIP switch (DIPSW) circuit 800.

[0076] Subsequently, the control unit 200 remains on stand-by until an open command is received from the upper system (step S21). Herein, an "open command" refers to a transmission-format signal that is contained in the control signal SIG1, and which instructs to open the door.

[0077] Next, when an open command is received (step S21: Yes), the control signal SIG3 for switching the direction switcher 600 to the door-opening direction is output from the control unit 200 (step S22). Herein, the control signal SIG3 is input into the AND circuit 630 of the direction switcher 600. The control signal SIG2 is also directly input from the upper system to the AND circuit 630. Herein, the control signal SIG2 includes a speed detection signal (5 km/h detection signal), an unlock-all signal, a permission-to-open signal, or the like.

[0078] Herein, when the control signal SIG3 is an ON signal indicating door opening and the control signal SIG2 indicates the direction for opening the door, the AND circuit 630 selects the inverter line sides of the relays 620U, 620V, and 620W (see FIG. 6). In such a case, the sensors 510U, 510V, and 510W are inverted and passed to the exclusive OR circuits 650U, 650V, and 650W; the handedness signal KSIG is also passed to the exclusive OR circuits 650U, 650V, and 650W, and the output of the exclusive OR circuits 650U, 650V, and 650W is input

to the control unit 200 as the corrected encoder input signals H1, H2, and H3.

[0079] On the other hand, when the control signal SIG3 and the control signal SIG2 do not indicate door opening, the output of the AND circuit 630 is such that the non-insertion signal line sides of the relays 620U, 620V, and 620W are selected. In such a case, the sensors 510U, 510V, and 510W are input via the exclusive OR circuits 650U, 650V, and 650W to the control unit 200 as the corrected encoder input signals H1, H2, and H3.

[0080] In such a case, as will be described later, when the signals from the sensors 510U, 510V, and 510W are input as the corrected encoder input signals H1, H2, and H3, the control unit 200 controls the DC motor 400 to rotate in the direction in which the door is closed.

[0081] Next, when all the signals of the control signal SIG3 and the control signal SIG2 indicate door opening, the control unit 200 compares the corrected encoder input signals H1, H2, and H3 with the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W (step S23).

[0082] Herein, when even a part of the corrected encoder input signals H1, H2, and H3 does not match the inverted forms of the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W, the control unit 200 returns to the process in step S21 without moving the door. Note that in such a case, the output of the control unit 200 may be made to report to the exterior of the door control device 100b a signal that any of the direction switcher 600, the sensors 510U, 510V, and 510W, or the encoder monitor 700 have failed.

[0083] When the corrected encoder input signals H1, H2, and H3 completely match the inverted forms of the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W in all phases, the control unit 200 runs the aforementioned motor control program stored therein, and outputs a motor drive signal to the drive unit 300 based on the corrected encoder input signals H1, H2, and H3. Further, the DC motor 400 being driven by the drive unit 300 and the encoder signal being detected by the motor encoder 500, the control unit 200 continuously controls the drive unit 300 based on the corrected encoder signal (step S24). Note that herein, when the setting status of the handedness signal KSIG is Low, the object is a comparison with the inverted forms of the signals H11, H21, and H31 from the encoder monitors 710U, 710V, and 710W, but when the setting status of the handedness signal KSIG is High, the configuration is that the comparison is performed without any inversion.

[0084] Subsequently, the control unit 200 determines whether or not the door is in a completely open position (step S25). Herein, the control unit 200 repeats the process from step S24 when the determination is that the door is not in a completely open position.

[0085] On the other hand, when the determination is that the door is in a completely open position, the control unit 200 remains on stand-by until a close command is received from the upper system (step S26). Herein, a

"close command" refers to a transmission-format signal that is contained in the control signal SIG1 and instructs that the door is to be closed.

[0086] Next, the control signal SIG3 for switching the direction switcher 600 to the door-closing direction is output from the control unit 200 (step S27). Herein, when the control signal SIG3 is an OFF signal indicating door closing, or alternatively when the control signal SIG2 indicates the direction in which the door is closed, the AND circuit 630 selects the non-insertion signal line sides of the relays 620U, 620V, and 620W. The encoder signals of the sensors 510U, 510V, and 510W are thereby input via the exclusive OR circuits 650U, 650V, and 650W to the control unit 200 as corrected encoder input signals H1, H2, and H3.

[0087] The control unit 200 runs the motor control program stored therein and outputs a motor drive signal to the drive unit 300 based on the input corrected encoder input signals H1, H2, and H3. Also, the DC motor 400 being driven by the drive unit 300 and the encoder signal being detected by the motor encoder 500, the control unit 200 continuously controls the drive unit 300 based on the encoder signal (step S28). Note that herein, the setting status of the handedness signal KSIG has been recited as being Low, but when the setting status is High, the corrected encoder input signals H1, H2, and H3 are inverted and then input.

[0088] Subsequently, the control unit 200 determines whether or not the door is in a completely close position (step S29). Herein, when the determination is that the door is not in a completely close position, the control unit 200 repeats the process from step S28.

[0089] On the other hand, when the determination is that the door is in a completely close position, the control unit 200 returns to step S21.

[0090] Note that in the flow chart described above (FIG. 7), the process in step S23 may be inserted in between the process in step S27 and the process in step S28, to authenticate the failure or the like of the apparatus.

(Fourth embodiment)

[0091] Next, yet another example of the door control device 100 for rail cars according to the present invention will be described. The following is a description of the points of difference from the door control devices 100, 100a, and 100b for rail cars depicted in FIGS. 1 to 7.

[0092] FIG. 8 is a schematic structural diagram depicting an example of a door control device 100c for rail cars according to the fourth embodiment of the present invention.

[0093] As depicted in FIG. 8, the door control device 100c for rail cars includes a direction switcher 600c instead of the direction switchers 600, 600a, and 600b; the direction switcher 600c comprises the inverting circuits 610U, 610V, and 610W; the relays 620U, 620V, and 620W; the AND circuit 630; inverting circuits 660U, 660V,

and 660W; and relays 670U, 670V, and 670W.

[0094] The door control device 100c for rail cars further includes a handedness setting DIP switch (DIPSW) circuit 800c. The handedness setting DIP switch circuit 800c has a DIP switch and is intended to set the direction in which the door is closed. In this embodiment, the handedness signal KSIG can be passed on without passing via the control unit 200. As a result, there will not be any effect from a failure or the like of the control unit 200.

[0095] Because the handedness setting DIP switch (DIPSW) circuit 800 is additionally provided, it is possible to support the opposite handedness. That is, in the case of two opening doors, this operation is performed by having the pair of doors moving in opposite directions for the opening operations and the closing operations, and therefore the same can be set using the handedness setting DIP switch (DIPSW) circuit 800. Furthermore, by providing the handedness setting DIP switch (DIPSW) circuit 800, a signal of the motor encoder 500 is output either directly or inverted and then output even when the control unit 200 is operated in error in the doors having different closing directions - for example, when the microcomputer erroneously recognizes an open command, and thus even when one of the signals SIG1 and SIG2 from the upper system is faulty, an unintentional operation to open the doors of the vehicle can be more reliably prevented, and the door will not open unintentionally while in transit, nor will the door of the oppose side from the platform open. Therefore, an unintentional operation to open the door of the vehicle can be reliably prevented. As a result, the reliability of the control for opening and closing the doors of the vehicle can be maintained and improved. Additionally, because there is no need to manufacture separate door control devices for each of a pair of doors, the effort required for management time during manufacture can be reduced.

[0096] In the embodiments of the present invention, the door control devices 100, 100a, 100b, and 100c for rail cars correspond to the door control device for vehicles; the DC motor 400 corresponds to the brushless motor; the drive unit 300 corresponds to the drive unit; the motor encoder 500 corresponds to the motor encoder; the control signal SIG1 and the control signal SIG2 correspond to the signals from the upper system; the control unit 200 corresponds to the control unit; the control signal SIG1 corresponds to the first signal; the control signal SIG2 corresponds to the second signal; the direction switchers 600, 600a, 600b, and 600c correspond to the direction switching unit; the relays 620U, 620V, and 620W and the relays 670U, 670V, and 670W correspond to the electrical relay; the exclusive logical circuits 640U, 640V, and 640W correspond to the exclusive logical circuits of the direction switching unit; the exclusive logical circuits 650U, 650V, and 650W correspond to the exclusive OR circuit of the handedness switching unit; the handedness setting DIP switch (DIPSW) circuit 800 corresponds to the handedness switching unit; the DIP switch 810 corresponds to the switching switch; the in-

verting circuits 610U, 610V, and 610W correspond to the inverting circuits of the direction switching unit; and the inverting circuits 660U, 660V, and 660W correspond to the inverting circuits of the handedness switching unit.

[0097] A preferred embodiment of the present invention is as described above, but the present invention is not to be limited only thereto. It will be understood that there are various additional possible embodiments that will not depart from the gist and scope of the present invention. Further, operations and effects from the configuration of the present invention are described in these embodiments, but these operations and effects are an example and are not meant to limit the present invention.

Claims

1. A door control device for vehicles for controlling the opening and closing of a vehicle door, the device comprising:

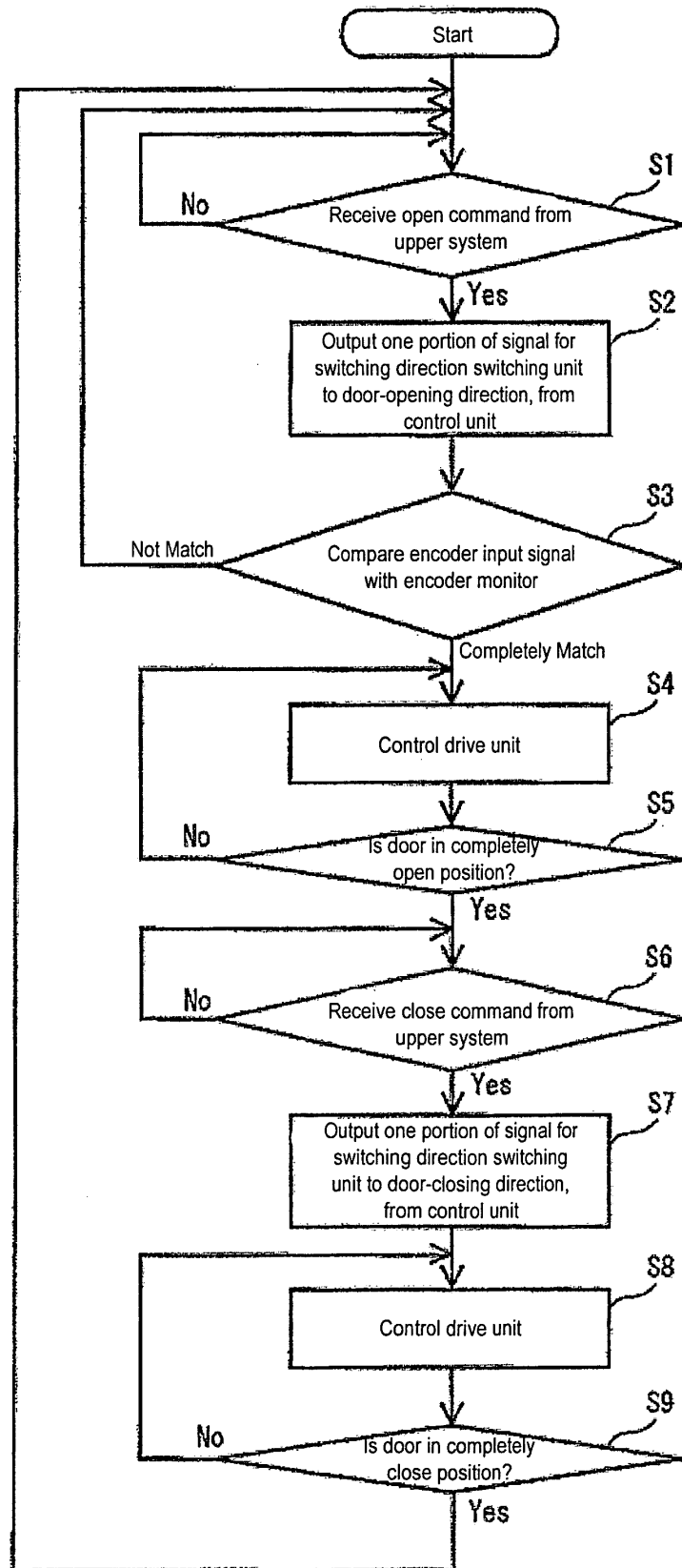
a brushless motor that drives the opening and closing of said door;
 a drive unit that drives said brushless motor;
 a motor encoder that detects the position of said brushless motor;
 a direction switching unit that either directly outputs a signal of said motor encoder or inverts the signal and then outputs the signal based on a signal from an upper system; and
 a control unit, which is provided so as to be able to output only a drive signal having a pattern that matches a pattern of a drive signal input to said drive unit when said door is driven to close, and which outputs said drive signal based on a signal output by said direction switching unit in accordance with the signal from said upper system.

2. The door control device for vehicles according to claim 1, wherein
 the signal from said upper system comprises a first signal input to said control unit, and a second signal that is different from said first signal and is input to said direction switching unit, and
 said direction switching unit is configured so as to either directly output a signal of said motor encoder or invert the signal and then output the signal based on a signal output from said control unit based on said first signal and said second signal.

3. The door control device for vehicles according to claim 2, wherein said direction switching unit is constituted of an exclusive OR circuit into which said second signal and the signal that is output from said control unit are input, and from which the input signals are output to said control unit.

4. The door control device for vehicles according to claim 1, wherein said direction switching unit comprises an inverting circuit into which said motor encoder signal is input, and an electrical relay that switches so as to output either of the output signal of said inverting circuit and said motor encoder signal;
 and said electrical relay is configured such that the output signal from said inverting circuit is output when said door is to be driven to open.
5. The door control device for vehicles according to any one of claims 1 to 4, wherein said control unit is configured such that said motor encoder signal input to said direction switching unit can be input, and is configured so as to compare the signal output by said direction switching unit with said input motor encoder signal, taking into account of the signal from said upper system.
6. The door control device for vehicles according to any one of claims 1 to 5, further comprising a handedness switching unit that sets a direction in which said door is closed, between said direction switching unit and said control unit.
7. The door control device for vehicles according to claim 6, wherein said handedness switching unit is constituted of an exclusive OR circuit and a switching switch for switching the handedness direction.

Fig. 2



Rotation in door-opening direction

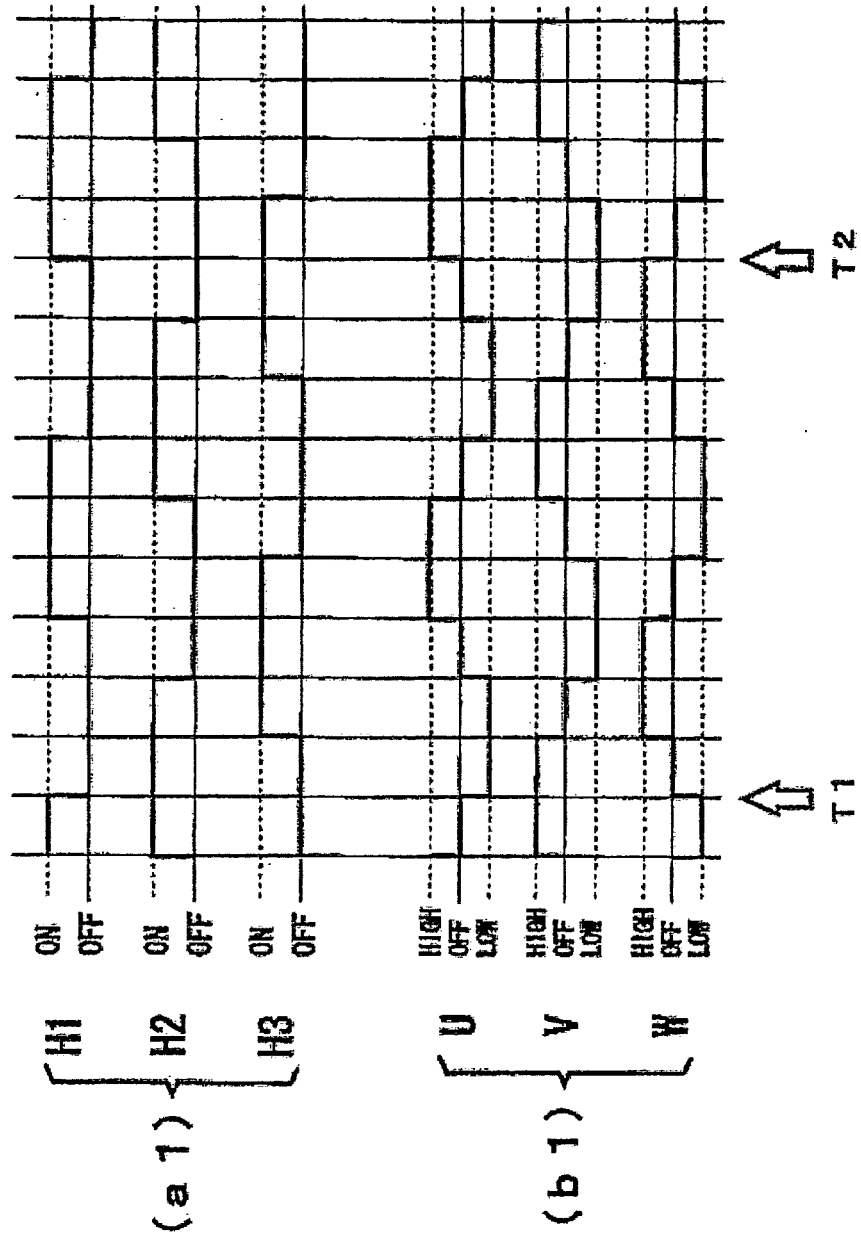


Fig. 3

Fig. 4

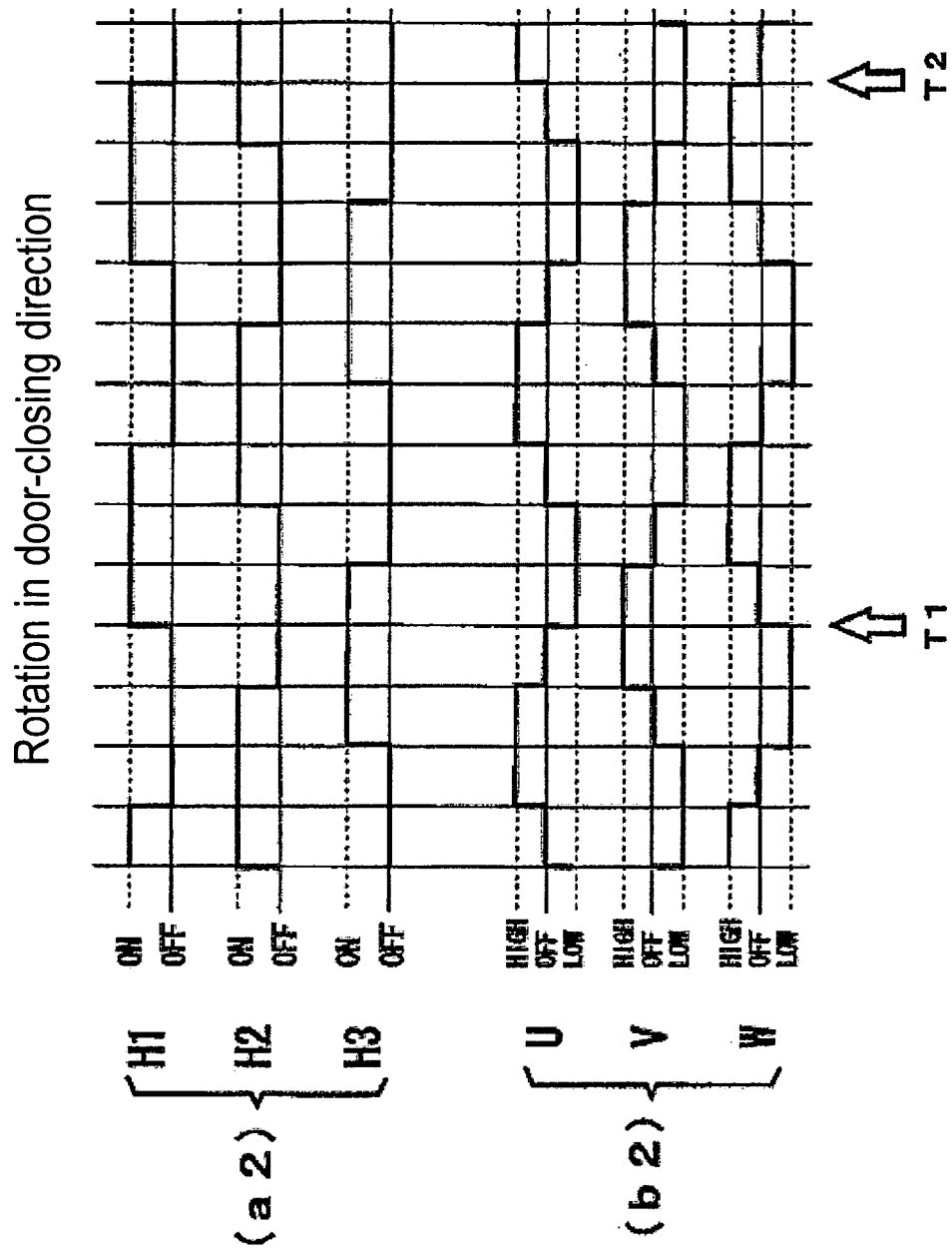


Fig. 5

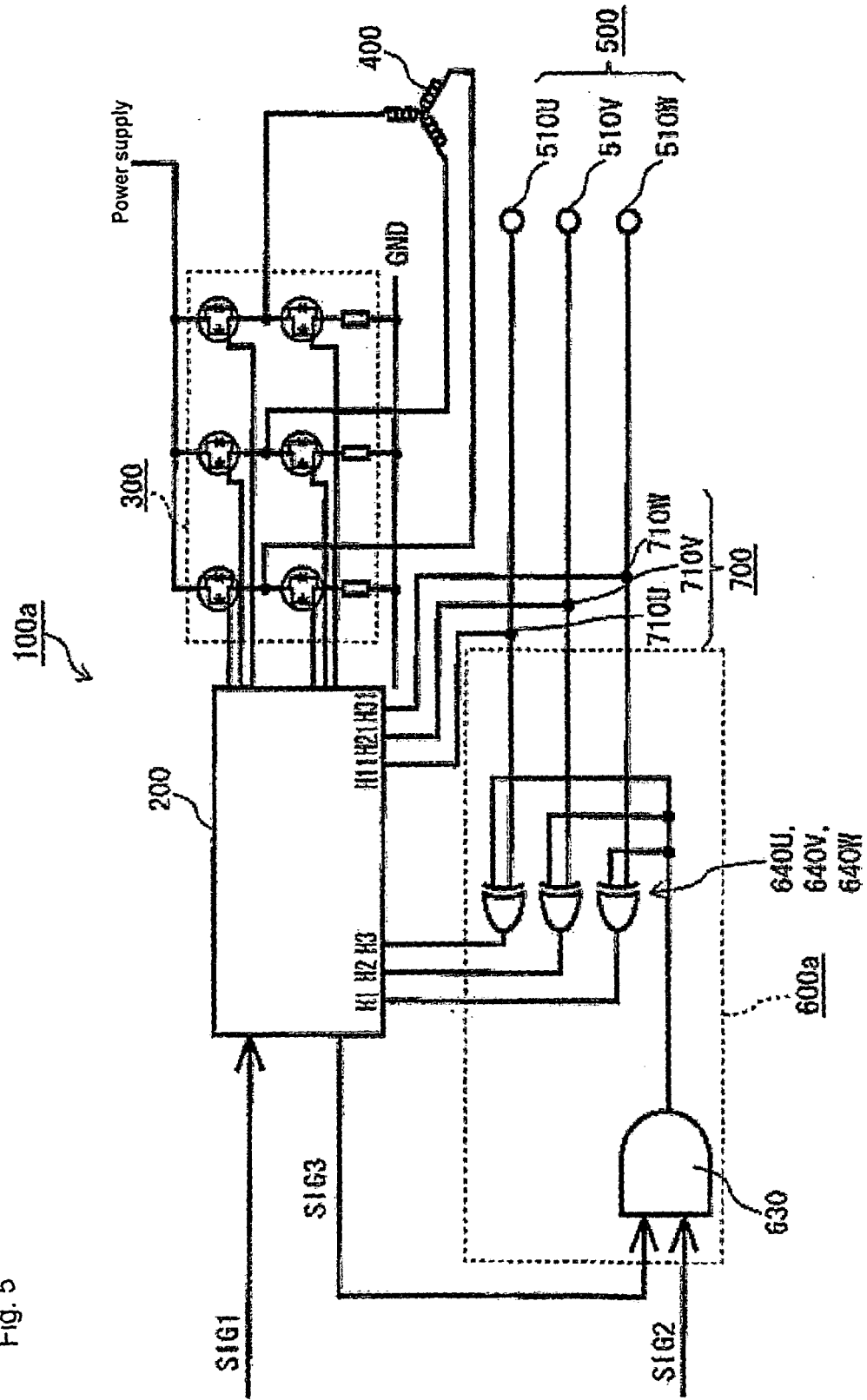


Fig. 6

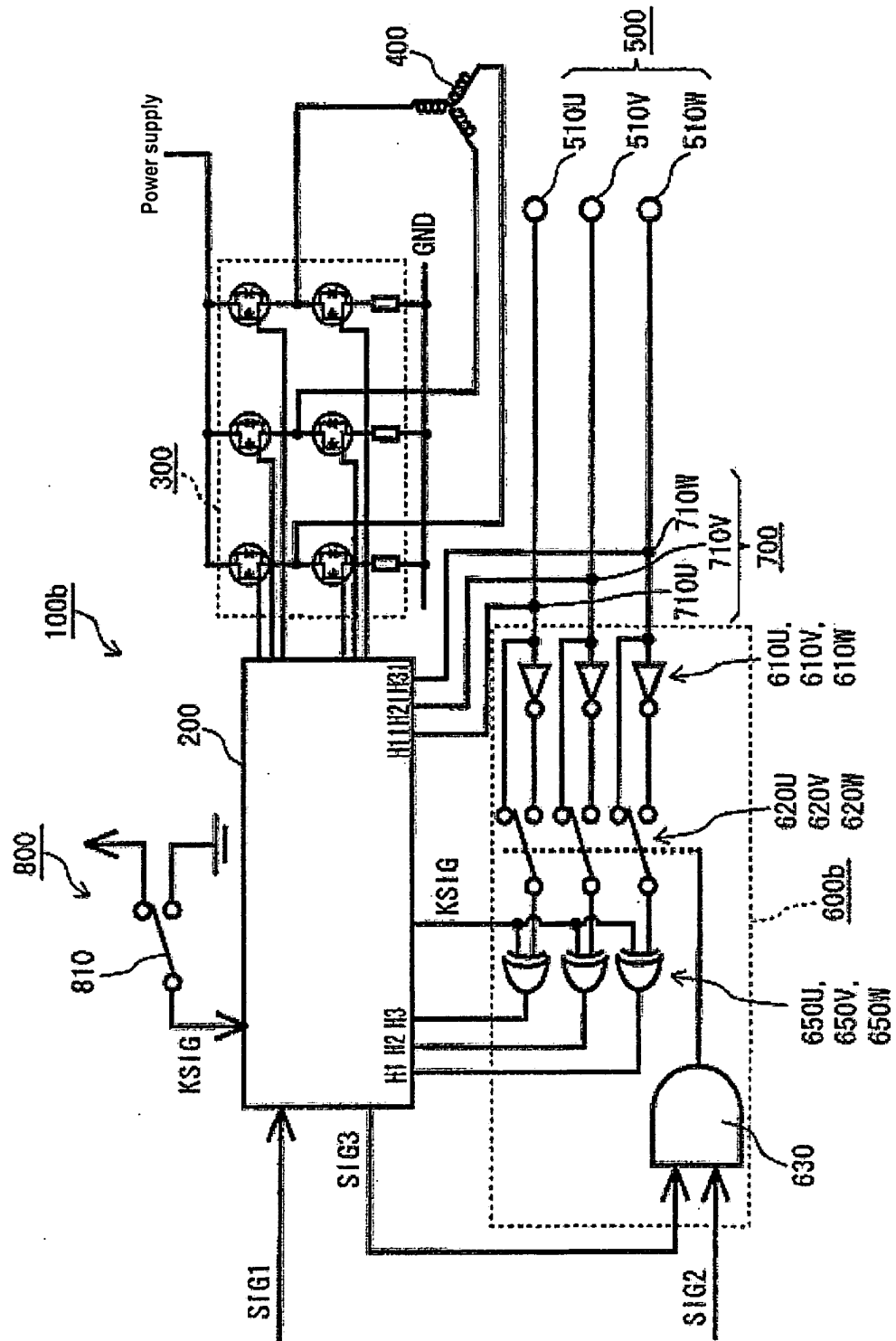


Fig. 7

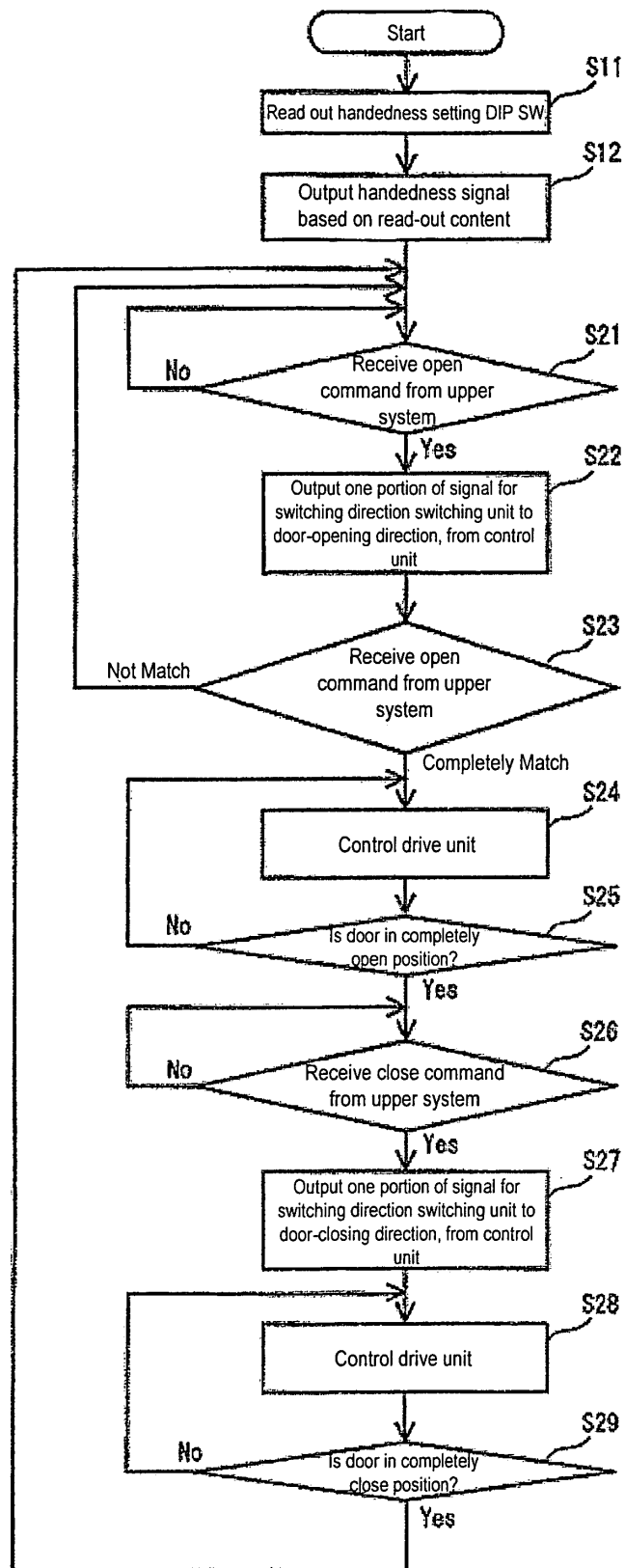
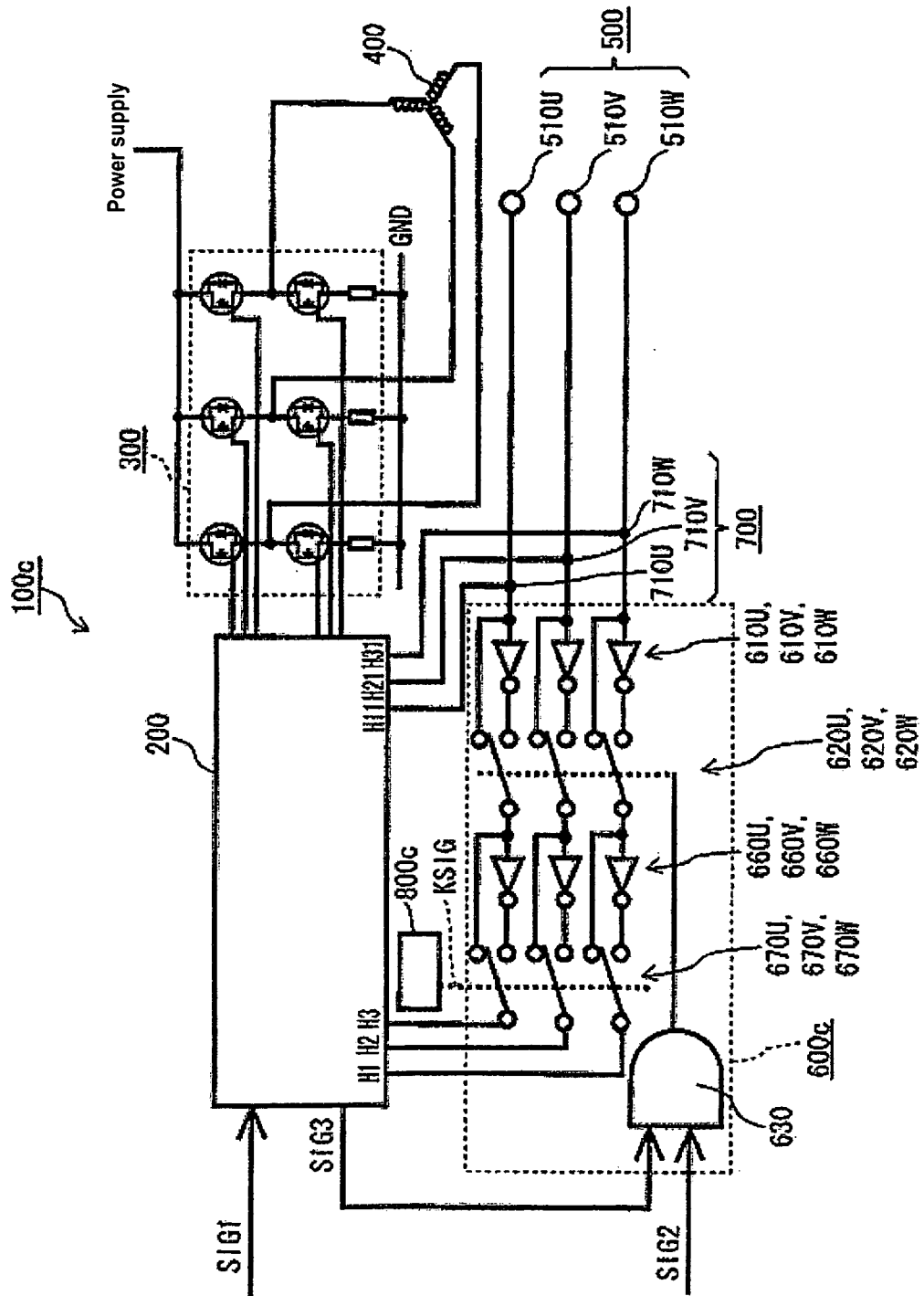


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/003823

A. CLASSIFICATION OF SUBJECT MATTER

E05F15/10(2006.01)i, B61D19/02(2006.01)i, E05F15/20(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)

E05F15/10, B61D19/02, E05F15/20

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2005-330703 A (Asmo Co., Ltd.), 02 December 2005 (02.12.2005), entire text; all drawings (Family: none)	1 2-7
Y A	JP 2005-336804 A (Nabtesco Corp.), 08 December 2005 (08.12.2005), entire text; all drawings (Family: none)	1 2-7
Y A	JP 2005-048356 A (YKK Corp.) 24 February 2005 (24.02.2005) entire text; all drawings (Family: none)	1 2-7

☐ 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
07 September, 2010 (07.09.10)Date of mailing of the international search report
28 September, 2010 (28.09.10)Name and mailing address of the ISA/
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