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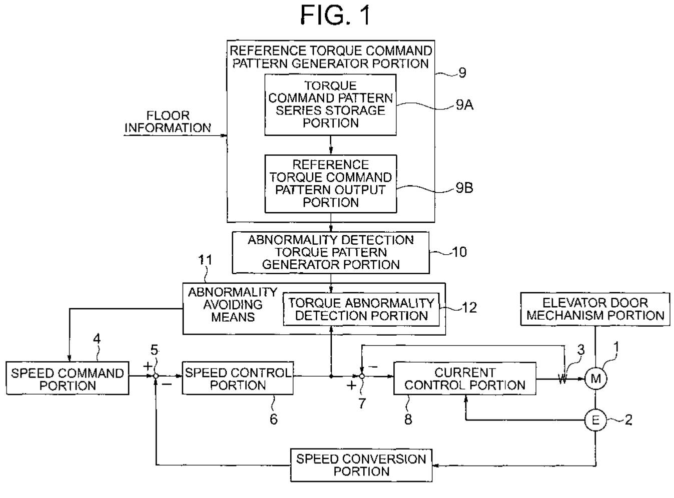
(54) ELEVATOR DOOR CONTROL DEVICE

(57) An elevator door control device is provided in which the precision of abnormality detection in door opening and closing operations is increased by appropriately detecting abnormalities in torque commands, so that there is little erroneous detection of abnormalities in door opening and closing operations. The elevator door control device has: a speed command portion that outputs a speed command; a speed control portion that outputs a torque command corresponding to a deviation between the speed command and a feedback speed; a reference torque command pattern storage portion that stores a plurality of torque command patterns that are formed by a plurality of the torque commands sampled according to door opening and closing operations, and stores a reference torque command pattern that is obtained based on the torque commands at each common sampling of the plurality of torque commands; an abnormality detection torque pattern generator portion that generates an abnormality detection torque pattern from the reference torque command pattern; and an abnormality avoiding unit that outputs an abnormality avoiding command to the speed command portion when the torque command exceeds the abnormality detection torque pattern.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an elevator door control device. More specifically, the present invention relates to an elevator door control device in which abnormal states during elevator door opening and closing operations are avoided by detecting the abnormal states with good precision.

Background Art

[0002] Conventional elevator door control devices detect whether or not an abnormality exists during elevator door opening and closing operations while monitoring increases in a motor current that accompany abnormal states in door opening and closing operations caused by an elevator user's body or finger getting caught in or pulled into a door portion. Door operation is reversed when an abnormality is detected.

[0003] Specifically, the focus is placed on the fact that there are differences between normal door operation and abnormal door operation as to how the motor current changes over time. The motor currents during normal door operation are successively measured at each floor according to the door operation over time, and then simply stored without performing any arithmetic processing. Motor current values during actual door opening and closing and motor current values for each corresponding floor (the stored data) are compared according to the door operation over time. An abnormality in the door is detected for cases where a difference between the two is equal to or greater than a prescribed value (refer to Patent Document 1, for example).

[0004] It should be noted that, it is clear that the conventional elevator door control devices described above are equivalent in operation to those in which abnormal states of the door are detected when the value of the motor current during actual door opening and closing exceeds a value obtained by adding a predetermined margin torque (prescribed value) to the value of the motor current during normal operation over time for the corresponding door, and the door is then made to operate in reverse.

[0005] Further, from the viewpoint of electrical machinery engineering, it is clear that the motor current described here can be considered to be a substitute for the motor torque. In addition, from the viewpoint of control engineering, it is clear that the motor torque and a motor torque command may be handled as equivalents in practice because it can be considered that normally a large numerical difference does not exist between a command and a control variable in a system implementing a feed back control. Accordingly, the motor current, the motor torque, and the motor torque command are treated as having equivalent meanings in the present specification.

[Patent Document 1] JP 54-120157 A (pages 4 and 5)

[0006] As described above, the conventional elevator door control devices perform door abnormality detection by adding a predetermined margin torque to a motor torque waveform (motor current waveform) or a torque command waveform that accompanies actual door opening and closing operations simply stored without performing arithmetic processing, and using the resultant waveform as an abnormality detection torque pattern for abnormal torque detection. In practice, the actual torque waveform and the torque command waveform changes with each door opening and closing operation due to disturbances attributable to changes over time, such as debris in the vicinity of the door and friction accompanying door opening and closing. Accordingly, there is a problem in that erroneous abnormality detection, not correct abnormality detection, occurs for cases where the added margin torque is too small, and where the torque waveform or the torque command waveform, which becomes a basis for the abnormality detection torque pattern, is inappropriate.

[0007] That is, the sensitivity for detecting torque abnormalities becomes higher if the margin torque added to the actual torque command pattern, which is simply stored without arithmetic processing, is made to be a small value. However, abnormalities are judged to have occurred for cases where the torque command increases due to torque fluctuations caused by debris in the vicinity of the door, friction, and the like which accompany door opening and closing. Unnecessary door reversal operations therefore repeatedly occur. Conversely, although the number of erroneous operations becomes fewer if the margin torque is increased, there is a problem in that the level of danger to the elevator user increases because the permissible values of the torque command become larger as a result of the abnormality detection torque pattern becoming larger.

[0008] The torque fluctuations that cause these problems depend upon long term torque fluctuations caused by changes over time, such as changes in the shape of door panels, in addition to short term torque fluctuations caused by debris in the vicinity of the door, friction, or the like.

[0009] The present invention has been made in order to solve problems like those described above. An object of the present invention is to provide an elevator door control device having a high abnormality detection precision, with few erroneous detentions of door opening and closing operation abnormalities, by creating an abnormality detection torque pattern for appropriately detecting torque abnormalities while taking into account long term fluctuations and short term fluctuations in an actual torque waveform (motor current waveform) and a torque command waveform.

[0010] It should be noted that, in the present invention, the term abnormality detection means detecting whether or not there is an abnormality in door opening and closing operations while monitoring increases in the motor current or increases in the motor torque command or in the motor torque, which accompany an abnormal state in door opening and closing operations such as an elevator user's body or finger getting caught in or pulled into a door portion during opening and closing operations of the elevator door. That is, the term abnormality detection means detecting abnormality states in door opening and closing operations by detecting abnormal motor current, motor torque commands, or motor torques.

Disclosure of the Invention

[0011] According to the present invention, there is provided an elevator door control device that outputs a torque command corresponding to a speed command to an elevator door driving unit to perform opening and closing control of the elevator door, the device including: a reference torque command pattern generator portion that generates a reference torque command pattern by collecting and arithmetically processing a plurality of patterns of the torque command; and a torque abnormality detection portion that detects abnormalities in the torque command based on the reference torque command pattern.

Brief description of the drawings

[0012]

Fig. 1 is a schematic diagram that shows an example of an elevator door control device according to Embodiment 1 of the present invention;
Fig. 2 is a diagram of a relationship between a torque command (reference torque command) and an abnormality detection torque pattern in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 3 is a diagram for explaining operation during torque abnormality detection in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 4 is a diagram that shows a torque command when door opening and door closing operations are repeated in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 5 is a diagram that shows time series data for a sampled torque command, and an example of a method for computing an arithmetic mean in order to generate a reference torque command pattern in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 6 is a diagram that shows time series data of a torque command for five times in a trial direction in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 7 is an explanatory diagram of a computational formula, showing a median process for the time series data of a torque command for five times in a trial direction in the elevator door control device according to Embodiment 1;
Fig. 8 is a flowchart that shows operation of a reference torque command pattern generator portion in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 9 is a flowchart that shows operation of an abnormality detection torque pattern generator portion and an abnormality avoiding unit in the elevator door control device according to Embodiment 1 of the present invention;
Fig. 10 is a schematic diagram that shows an example of an elevator door control device according to Embodiment 2 of the present invention; and
Fig. 11 is an explanatory diagram that shows operation during torque abnormality detection in the elevator door control device according to Embodiment 2 of the present invention.

Best Modes for carrying out the Invention

Embodiment 1

[0013] Fig. 1 is a schematic diagram that shows an example of an elevator door control device according to Embodiment 1 of the present invention. As shown in Fig. 1, a pulse generator 2 is connected directly to a motor shaft of a door driver motor 1 that drives an elevator door mechanism portion including an elevator door. The pulse generator 2 generates pulse information that shows positions of the door driver motor 1. Further, a current detector 3 detects a load current on the door driver motor 1. It should be noted that a vector control induction motor, a brushless DC motor, or the like is assumed to be used as the door driver motor 1.

[0014] A speed command portion 4 outputs a speed command according to a predetermined speed pattern. An adder portion 5 outputs a speed deviation between the speed command output by the speed command portion 4, and an actual motor speed (feedback speed) obtained from the pulse generator 2 through a speed conversion portion. A speed control portion 6 outputs a motor current command, which corresponds to a torque command, to the door driver motor 1 as a torque command corresponding to the output speed deviation, thus performing speed control.

[0015] More precisely, the adder portion 7 obtains a deviation in current from the load current, which is output by the current detector 3, with respect to the motor current command (torque command) that is output from the speed control portion 6. The motor current command is then output to a current control portion 8. The current control portion 8 generates the load current for driving the door driver motor 1 according to the input current deviation, thus performing speed control of the door driver motor 1. The current control portion 8 implements vector control based on phase information from the pulse generator 2, for example, when performing speed control.

[0016] Further, a reference torque command pattern generator portion 9 includes a torque command pattern series storage portion 9A and a reference torque command pattern output portion 9B. The torque command pattern series storage portion 9A stores a plurality of torque command patterns. The plurality of torque command patterns are formed by a plurality of torque commands sampled at each floor according to elapsed time, door position, and the like for door opening and closing operations at each floor based on floor information that is input from the outside.

[0017] Further, the reference torque command pattern output portion 9B generates and outputs a reference torque command pattern for each floor. The reference torque command pattern for each floor is obtained by computation based on the torque commands at each common sampling for a plurality of torque command patterns for each floor from among the plurality of torque command patterns that are stored in the torque command pattern series storage portion 9A.

[0018] The reference torque command patterns for each floor that are output from the reference torque command pattern output portion 9B are input to an abnormality detection torque pattern generator portion 10. The abnormality detection torque pattern generator portion 10 adds a predetermined margin torque to the input reference torque command patterns, generating an abnormality detection torque pattern that becomes a reference for detecting whether or not the torque commands output by the speed control portion 6 are abnormal.

[0019] Further, an abnormality avoiding unit 11 includes, in an inner portion thereof, a torque abnormality detection portion 12. The torque abnormality detection portion 12 inputs the torque command that is output from the speed control portion 6, and reads in the abnormality detection torque pattern generated by the abnormality detection torque pattern generator portion 10. The torque abnormality detection portion 12 detects that door opening and closing operations are abnormal when the torque command exceeds the abnormality detection torque pattern. Having detected abnormal door opening and closing, the torque abnormality detection portion 12 outputs an abnormality avoidance command to the speed command portion 4. Having received the abnormality avoidance command, the speed command portion 4 reduces the speed of the speed command to be output, outputting it as a new speed command (reverse operation speed command) for reversing operation of the elevator door.

[0020] That is, the abnormality avoiding unit 11 reduces the speed of the speed command, thus avoiding an abnormality state, for cases where the torque command exceeds the abnormality detection torque pattern. Alternatively, the abnormality avoiding unit 11 may reduce the speed of the speed command, and in addition, cause the elevator door to operate in reverse, thus avoiding an abnormality state.

[0021] Operation of the abnormality detection torque pattern generator portion 10 and the torque abnormality detection portion 12 in the elevator door control device according to Embodiment 1 are explained next. Fig. 2 is an explanatory diagram that shows a relationship between the reference torque command pattern and the abnormality detection torque pattern during door opening. Fig. 3 is an explanatory diagram that shows operation of the torque abnormality detection portion 12.

[0022] The reference torque command pattern generator portion 9 generates the reference torque command pattern shown in Fig. 2 from the torque command that is output each time the speed control portion 6 opens and closes the door at each floor. The reference torque command pattern is generated here by arithmetic processing, described below, such as median processing, simple mean processing, and additive averaging processing with a forgetting coefficient of the torque command data for cases where opening and closing is performed five times, for example. The abnormality detection torque pattern generator portion 10 adds a predetermined margin torque to the generated reference torque command pattern, thus generating the abnormality detection torque pattern.

[0023] Further, as shown in Fig. 3, the torque abnormality detection portion 12 detects that there is an abnormality when the torque command increases, exceeding the abnormality detection torque pattern, as a result of abnormal door opening and closing, and instructs the speed control portion 4 to operate the door in reverse.

[0024] It should be noted that Fig. 2 and Fig. 3 are examples, and show assumed door operations during door opening. It is not necessary to limit the present invention to only door operations during door opening. The configuration of the reference torque command pattern generator portion 10 and the torque abnormality detection portion 12 can also be similarly achieved for door operation during door closing.

[0025] With the elevator door control device of Embodiment 1, the torque command pattern is input by a plurality of door opening and closing trials (repeated opening and closing), as described below. A reference torque command pattern that is not excessively influenced, whether in the long-term or the short-term, by sudden disturbances is found by arithmetic processing of the input torque command. It should be noted that the most suitable reference torque command pattern is a representative value of the torque command pattern during normal operation, and is also referred to as a torque command pattern that does not cause the abnormality detection sensitivity to deviate. It is therefore understood that using a central value, that is, an average value, of fluctuations in the torque command pattern due to opening and closing the door a plurality of times is appropriate in order not to cause the abnormality detection sensitivity to deviate with respect to torque fluctuations caused by debris in the vicinity of the door accompanying door opening and closing, friction, and the like, as described above.

[0026] However, for cases where the average value of the torque command pattern is computed with respect to a repetition direction, it is necessary to pay attention to the fact that removing influence due to sudden disturbances during repetition counting, as discussed next, is a very important problem.

[0027] Fig. 4 is an explanatory diagram that shows a torque command when repeating door opening and door closing operations. In Fig. 4, a horizontal axis shows a count of pulses output from the pulse detector 2 (that is, door positions), while a vertical axis shows a torque command. Fig. 4 shows door opening and door closing operations repeated over an entire day and night on a two-dimensional diagram. Further, Fig. 4 is a waveform that includes mistakes (waveform distortions due to sudden disturbances) whereby an operator mistakenly touches the door during door opening and door closing operations performed over an entire day and night.

[0028] From these results it can be understood that it is necessary to compute an average value of the torque command by considering not only waveform fluctuation, but also the influence of sudden disturbances, in generating the reference torque command pattern that does not cause the abnormality detection sensitivity to deviate. It is necessary to collect a plurality of time series data, which is the waveform of the repeated torque command, in order to compute the average value.

[0029] Operation of the reference torque command pattern generator portion 9 that generates and stores the reference torque command pattern is explained next.

[0030] As shown in Fig. 5, in addition to a time direction during door opening and closing, a direction of the number of door openings and door closings is defined as a trial direction and explained. Two computation methods shown in Fig. 5, that is, (1) trial direction simple average processing and (2) trial direction additive average processing with a trial direction forgetting constant are used as average value computing methods in order to generate appropriate reference torque command patterns. Computation by the trial direction simple average process and the trial direction additive average process with a trial direction forgetting constant tend to receive excessive influence by sudden disturbances, however, because average computation with respect to the trial direction is performed with both methods by using a linear filter. It is necessary to take a very large number of averages for each, or it is necessary to make the forgetting coefficient extremely small, in order to reduce the influence of sudden disturbances. However, removing the influence of sudden disturbances is not very easy in these computations.

[0031] Median processing using a non-linear filter, called a median filter, that outputs a median value is used with the elevator door control device according to Embodiment 1. The median filter is one type of majority decision filter, known as a noise elimination method, used in image processing, and the medial filter is characterized by being able to easily eliminate the influence of sudden disturbances.

[0032] Operation of the median filter is explained in detail here. As shown in Fig. 6, torque commands A, B, C, D, and E appear with time series data for five times in a trial direction. For example, data is arranged in a time series such as a(1), a(2), a(3), a(4), a(5), a(6), and a(7), for example, with the first time series data A. That is, the numbers within parenthesis are sampling numbers.

[0033] Median processing for a case in which there is time series data of the torque command for five times in the test direction is computed by equations shown in Fig. 7. A number i within parenthesis means a sampling number here. "Median []" means an operator that performs a computation in which a value (median value) in a middle rank is extracted from results of sorting (arranged in ascending order) the data in [].

[0034] The influence of sudden disturbances that originally did not need to be considered door opening and closing abnormalities, for example a sudden disturbance due to an operator touching the door or the like, can easily be removed by this method. This is because the influence of disturbances appears in a maximum value and a minimum value. Accordingly, the influence of sudden disturbances that are not considered door opening and closing abnormalities can be excluded in the computation results by using the median value as the computation result of the average computation method of the torque command in order to generate an appropriate reference torque command pattern. The influence of sudden disturbances that are not considered to be door opening and closing abnormalities can thus be eliminated by computing the median value of the fluctuations in the torque command pattern. Therefore the reference torque command pattern generator portion 9 can thus generate an appropriate reference torque command pattern that does not cause the abnormality detection sensitivity to deviate.

[0035] That is, the reference torque command pattern generator portion 9 in the elevator door control device according to Embodiment 1 gets the reference torque command pattern by median processing of the torque command of each common sampling of the stored plurality of torque command patterns.

[0036] Further, the reference torque command pattern may also be found by using a simple averaging process or an additive averaging process with a forgetting coefficient as a substitute for median processing. However, when using these processes, it is necessary to take a very large number of averages, or to make the forgetting coefficient extremely small, respectively.

[0037] An example of specific operation for a case where median processing is used in the reference torque command pattern generator portion 9 is explained next. Fig. 8 is a flowchart that shows operation of the reference torque command pattern generator portion 9. The reference torque command pattern generator portion 9 performs floor recognition (step S1), smoothes the torque command waveform through filter processing by using a normal linear filter or the like on the torque command for door opening and closing (step S2), and divides positions from completely open to completely closed into 32 portions, for example, by motor angles, and buffers torque commands (a(1), a(2), ..., a (32)) at each of these points (step S3).

[0038] Next, the reference torque command pattern generator portion 9 confirms whether or not five sets of data in trial directions (independently for both door opening and door closing) have been acquired (step S4), finds a median value for five sets x 32 points of data by employing the median processing shown in Fig. 7 when the five sets of data that are shown in Fig. 6 have been acquired (step S5), and stores the reference torque command pattern found from the 32 points of data in an EEPROM (electrically erasable programmable read-only memory) (step S6).

[0039] The operation of reference torque command pattern generator portion that acquires five sets of data in the trial directions (independently for both door opening and door closing) and generates the reference torque command pattern has been explained here. Strictly speaking, however, it is necessary to be careful to apply the operations described here independently for each floor during operation of the elevator.

[0040] In addition, median processing may also be performed while updating the five sets of time series data in the test directions so as to include the most recent data, performing a moving average filter computation. A reference torque command pattern that is appropriate for counterbalancing short term and long term torque command fluctuations can thus be generated. As a result, it can be considered that short term torque command fluctuations are eliminated by taking the median value of the fluctuations, and further, long term fluctuations are taken in by taking the median value of the fluctuations. Further, median processing need not be performed for each data update. Updating of data may also be performed after acquiring five sets of data (updating once per five data sets, after 5, 10, 15 and the like).

[0041] Operation of the abnormality detection torque pattern generator portion 10 is explained next. It should be noted that values computed so as to have a constant force at door edges for each door opening and closing position may be used here as a margin torque that is added to the reference torque command pattern when finding the abnormality detection torque pattern.

[0042] Fig. 9 is a flowchart that shows an example of operation of the abnormality detection torque pattern generator portion 10 and the abnormality avoiding unit 11. The abnormality detection torque pattern generator portion 10 reads in the 32 points of the reference torque command pattern stored in the EEPROM in step S6 in Fig. 8 (step S10), adds a margin of torque (margin torque) corresponding to a 10 kgf portion at the door edge, for example, to each point of the reference torque command pattern (step S11), performs a process of employing the largest of three adjacent points in the 32 points of data, to which the margin torque has been added, as the data for that position (a step S12), and determines the abnormality detection torque pattern by linear interpolation between each point (step S13).

[0043] Next, the torque abnormality detection portion 12 of the abnormality avoiding unit 11 compares the torque command and the abnormality detection torque pattern (step S14), judges that the door opening and closing operations are abnormal when the torque command is equal to or greater than the abnormality detection pattern and performs door reversal operations (step S15). For cases where the torque command is less than the abnormality detection pattern, the torque abnormality detection portion 12 judges that the door operation is normal and continues the opening and closing operations.

[0044] According to the elevator door control device of Embodiment 1, the abnormality detection torque pattern can thus be generated based on the actual torque pattern in consideration of short term and long term torque command fluctuations, and in addition, the influence of sudden disturbances that are not considered to be door opening and closing abnormalities can be eliminated. The abnormality detection sensitivity therefore does not deviate, and it becomes unnecessary to make the predetermined torque excessively large when the abnormality detection torque pattern is generated. As a result, the door abnormality detection precision can be increased, and an elevator door having a high level of safety can be provided.

Embodiment 2

[0045] Fig. 10 is a schematic diagram that shows an example of an elevator door control device of Embodiment 2 of the present invention. Differing from Embodiment 1 shown in Fig. 1, an abnormality torque command correcting unit 13, which is a unit relating to computation of a torque command correction, is newly added as an abnormality avoiding unit 11A. Other elements are the same as, or equivalent to, the configuration of the elevator door control device of Embodiment 1 described above.

[0046] With the elevator door control device of Embodiment 2, the torque command and the abnormality detection torque pattern are compared in the torque abnormality detection portion 12 to detect torque abnormalities, similar to Embodiment 1. For cases where an abnormality of the torque command is detected, the abnormality avoiding unit 11A outputs an abnormality avoiding command for avoiding the abnormality to the speed control portion 4. The speed control portion 4 reduces the speed command, and in addition, outputs a new speed command for reversing the operation of the elevator door driving unit.

[0047] However, a considerable response delay until the changes of the speed command described above are actually reflected in the door control device is generated. Further, there is a problem in that the torque command may inadvertently exceed the abnormality detection torque pattern for cases where pulse shape noise is superimposed onto the torque command, making correct abnormality detection impossible. The elevator door control device of Embodiment 2 is an embodiment that takes this problem into consideration.

[0048] The abnormality torque command correcting unit 13 includes a correction torque command computation portion 13A that computes a correction torque command by a correction method described below based on a deviation between the torque command output by the speed control portion 6 and the abnormality detection torque pattern generated by the abnormality detection torque pattern generator portion 10. The abnormality torque command correcting unit 13 also includes an output torque command switching portion 13B that switches to output the correction torque command computed by the correction torque command computation portion 13A from the torque command that is output from the speed control portion 6 when the torque command is larger than the abnormality detection torque pattern, and on the other hand, switches to output the torque command that is output from the speed control portion 6 when the torque command is equal to or less than the abnormality detection torque pattern.

[0049] That is, a new torque command is generated in an inner portion of the abnormality avoiding unit 11A, specifically by the equations shown below. The new torque command is the correction torque command based on the size relationship between the abnormality torque pattern and the torque command, or the torque command that is output from the speed command portion 6.

(1) Abnormality present (abnormality detection torque pattern ≤ torque command):

correction torque command = abnormality detection torque pattern + (torque command - abnormality detection torque pattern) x coefficient (ε)

The torque command is the torque command before correction, the correction torque command is the torque command after correction, and the coefficient ε is defined by $0 \leq \varepsilon < 1$.

(2) Normal operation (abnormality detection torque pattern > torque command):

new torque command = torque command

[0050] That is, the coefficient ε possesses a meaning of a compression ratio for an exceeding amount when the torque command (torque command before correction) exceeds the abnormality detection torque pattern. Through use of the coefficient ε, suppression of the torque command while maintaining the size relationship between the abnormality detection torque pattern and the torque command (torque command before correction) within a period of time set in advance based on a time that corresponds to the response delay relating to an abnormality detection recognition time, elevator door reverse operation, or the like. It should be noted that it is necessary to determine a specific value for the coefficient ε while taking the size of the maximum permissible torque and the size of the torque fluctuations into account.

[0051] Further, the abnormality detection torque pattern within the period of time set in advance based on the time of the response delay relating to the abnormality detection recognition time, reverse operation of the elevator door, or the like may also be controlled to be spread across the torque command, for example. This case corresponds to setting the coefficient $\varepsilon = 0$.

[0052] Next, Fig. 11 is a diagram for explaining operation of the elevator door control device of Embodiment 2. Fig. 11 is a diagram showing that the torque command pattern during abnormality generation becomes the corrected torque command that is compressed by correction computation of the torque command value in the inner portion of the abnormality avoiding unit 11A within an abnormality detection confirmation time T (or within an amount of time set in advance corresponding to the response delays relating to elevator door reversal operations or the like).

[0053] Further, Fig. 11 is a diagram that shows that the door operation switches to reverse operation, which is abnormality avoiding operation, after an abnormality is first judged for a case where the torque command before correction continues to exceed the abnormality detection torque pattern within the abnormality detection confirmation time, which is a certain predetermined period of time.

[0054] That is, the abnormality avoiding unit 11A in the elevator door control device according to Embodiment 2 can prevent inadvertent abnormality avoidance operations that accompany erroneous detection due to the influence of noise and the like, and further, can prevent the torque command from becoming excessively large. The abnormality avoiding unit 11A does so by suppressing the torque command to an order that just exceeds the abnormality detection torque pattern within the certain predetermined period of time for cases where the torque command exceeds the abnormality detection torque pattern.

[0055] According to the elevator door control device of Embodiment 2, the torque command can be suppressed to an order that just exceeds the abnormality detection torque pattern, and sudden door opening and closing operations due to the generation of an excessively large torque can be suppressed by the abnormality avoiding unit 11A for cases in which the abnormality detection torque pattern exceeds the torque command.

[0056] Further, a problem existed in that the torque command inadvertently exceeds the abnormality detection torque pattern when pulse shape noise exists superimposed onto the torque command. With the elevator door control device according to Embodiment 2, however, even if pulse shape noise exists superimposed onto the torque command, reliable abnormality detection becomes possible by setting the abnormality detection confirmation time, where an abnormality in the door opening and closing operations is first detected when the torque command exceeds the abnormality detection torque pattern for a certain predetermined period of time (abnormality detection confirmation time), for example. In addition, excessively large torque generation can be suppressed during the abnormality detection confirmation time until the abnormality avoiding unit 11A operates. Abnormalities during door opening and closing can thus be reliably detected with good precision, and door safety with a high likelihood of avoiding abnormalities can be achieved.

Industrial Applicability

[0057] According to the present invention as described above, dispersion in an abnormality detection torque pattern is eliminated, and it becomes unnecessary to make an added predetermined margin torque excessively large when setting a reference torque command pattern. As a result, an elevator door control device having a high degree of safety, in which door abnormality detection precision can be increased and erroneous detection of door opening and closing operation abnormalities are reduced, can be provided.

Claims

1. An elevator door control device that outputs a torque command corresponding to a speed command to an elevator door driving means to perform opening and closing control of the elevator door, **characterized by** comprising:

    a reference torque command pattern generator portion that generates a reference torque command pattern by collecting and arithmetically processing a plurality of patterns of the torque command; and
    a torque abnormality detection portion that detects abnormalities in the torque command based on the reference torque command pattern.

2. The elevator door control device according to claim 1, **characterized in that**:

    the reference torque command pattern generator portion generates the reference torque command pattern corresponding to an elevator door on each floor; and
    the torque abnormality detection portion detects abnormalities in the torque command for the elevator door on each floor based on the reference torque command pattern of each floor.

3. The elevator door control device according to claim 1, further comprising an abnormality detection torque pattern generator portion that generates an abnormality detection torque pattern for detecting abnormalities in the torque command by adding a predetermined margin torque to the reference torque command pattern,
    characterized in that the torque abnormality detection portion detects abnormalities when the torque command exceeds the abnormality detection torque pattern.

4. The elevator door control device according to claim 1, **characterized in that** the reference torque command pattern generator portion generates the reference torque command pattern by storing the plurality of torque command patterns that are sampled according to the elevator door opening and closing operations, and performing arithmetic processing based on the torque commands at each common sampling for the plurality of torque command patterns.

5. The elevator door control device according to claim 4, **characterized in that** the reference torque command pattern generator portion generates the reference torque command pattern by performing median processing based on the torque commands at each common sampling for the plurality of stored torque command patterns.

6. The elevator door control device according to claim 1, **characterized by** further comprising an abnormality avoiding means for decreasing a speed of the speed command based on abnormality detection by the torque abnormality detection portion.

7. The elevator door control device according to claim 6, **characterized in that**, after reducing the speed of the speed command, the abnormality avoiding means additionally changes the speed command into a reverse speed command that causes the elevator door to operate in reverse.

8. The elevator door control device according to any one of claims 3 to 7, **characterized by** further com-

prising an abnormality torque command correction portion that corrects the torque command based on the abnormality detection torque pattern during a period while abnormalities are detected by the torque abnormality detection portion.

FIG. 1

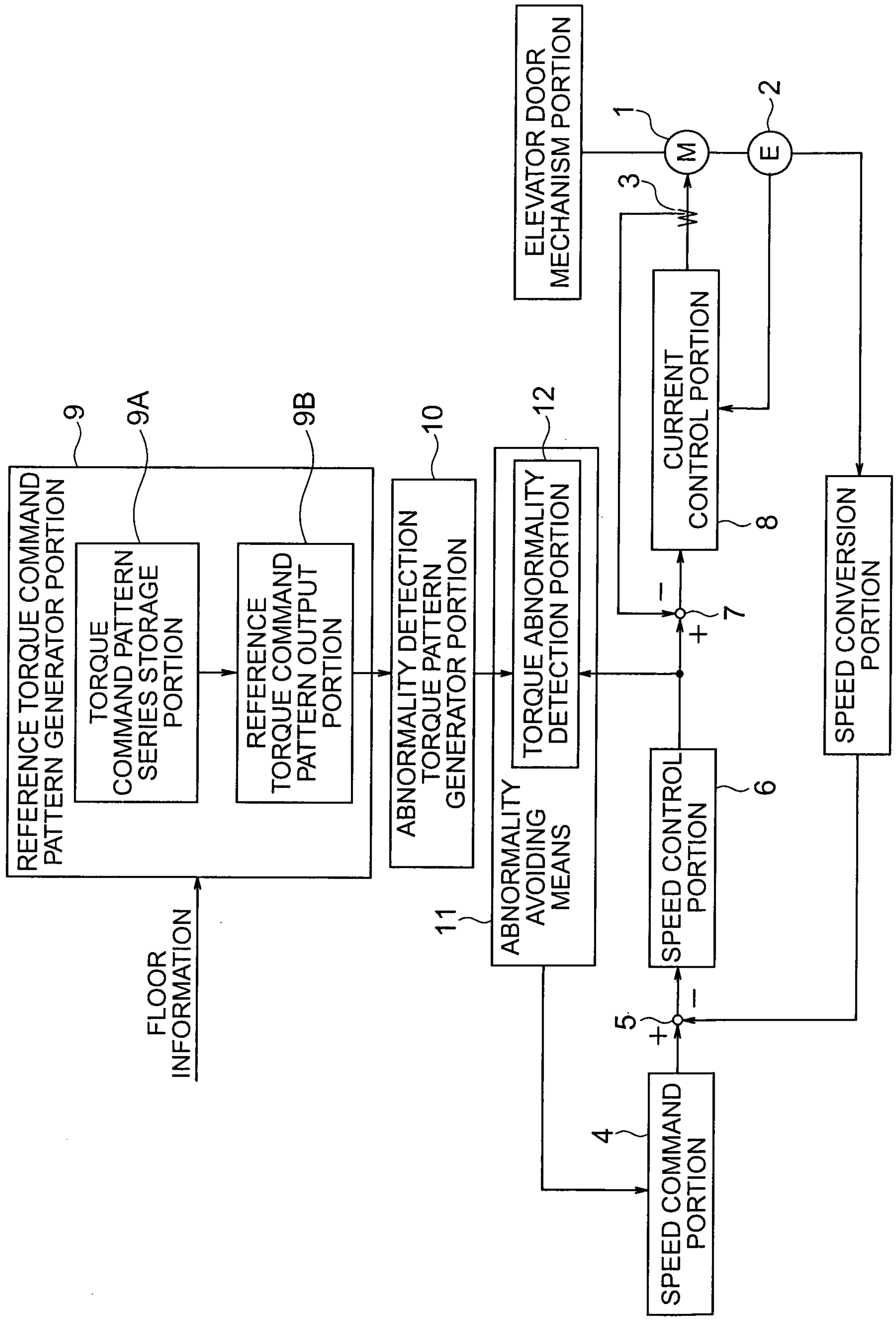

REFERENCE TORQUE COMMAND PATTERN GENERATOR PORTION
9
TORQUE COMMAND PATTERN SERIES STORAGE PORTION
9A
REFERENCE TORQUE COMMAND PATTERN OUTPUT PORTION
9B
FLOOR INFORMATION
ABNORMALITY DETECTION TORQUE PATTERN GENERATOR PORTION
10
TORQUE ABNORMALITY DETECTION PORTION
12
ABNORMALITY AVOIDING MEANS
11
SPEED COMMAND PORTION
4
5
+
−
SPEED CONTROL PORTION
6
7
+
−
CURRENT CONTROL PORTION
8
3
M
1
E
2
ELEVATOR DOOR MECHANISM PORTION
SPEED CONVERSION PORTION

FIG. 2

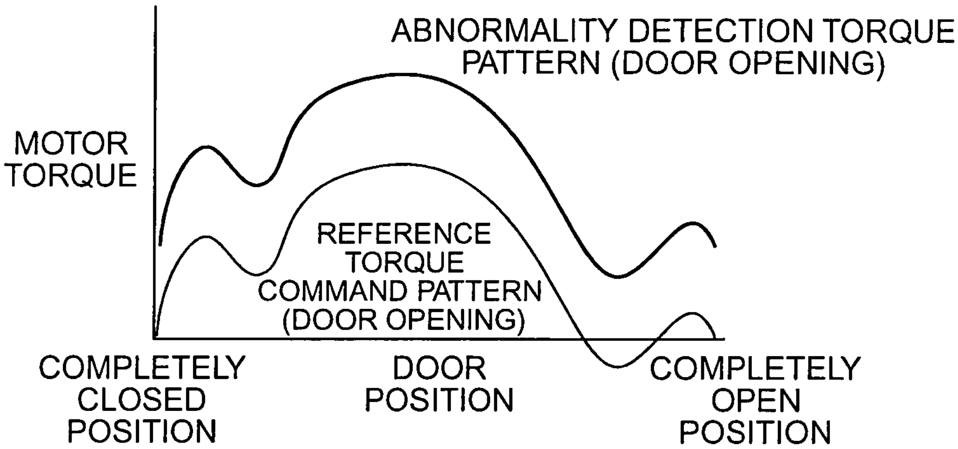

ABNORMALITY DETECTION TORQUE
PATTERN (DOOR OPENING)
MOTOR
TORQUE
REFERENCE
TORQUE
COMMAND PATTERN
(DOOR OPENING)
COMPLETELY
CLOSED
POSITION
DOOR
POSITION
COMPLETELY
OPEN
POSITION

FIG. 3

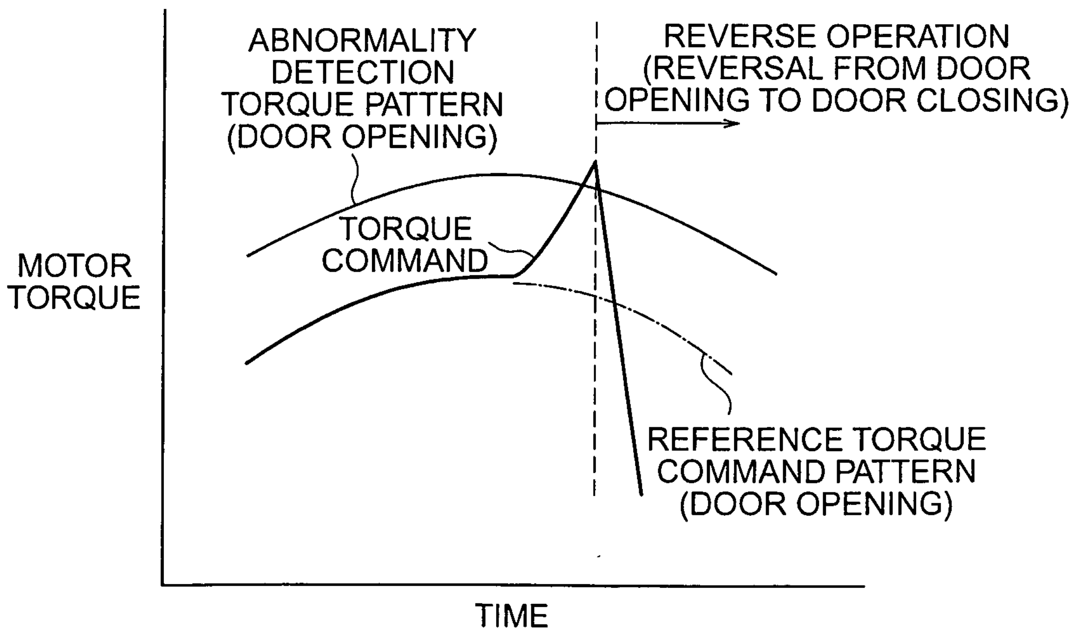

ABNORMALITY
DETECTION
TORQUE PATTERN
(DOOR OPENING)
REVERSE OPERATION
(REVERSAL FROM DOOR
OPENING TO DOOR CLOSING)
TORQUE
COMMAND
MOTOR
TORQUE
REFERENCE TORQUE
COMMAND PATTERN
(DOOR OPENING)
TIME

FIG. 4

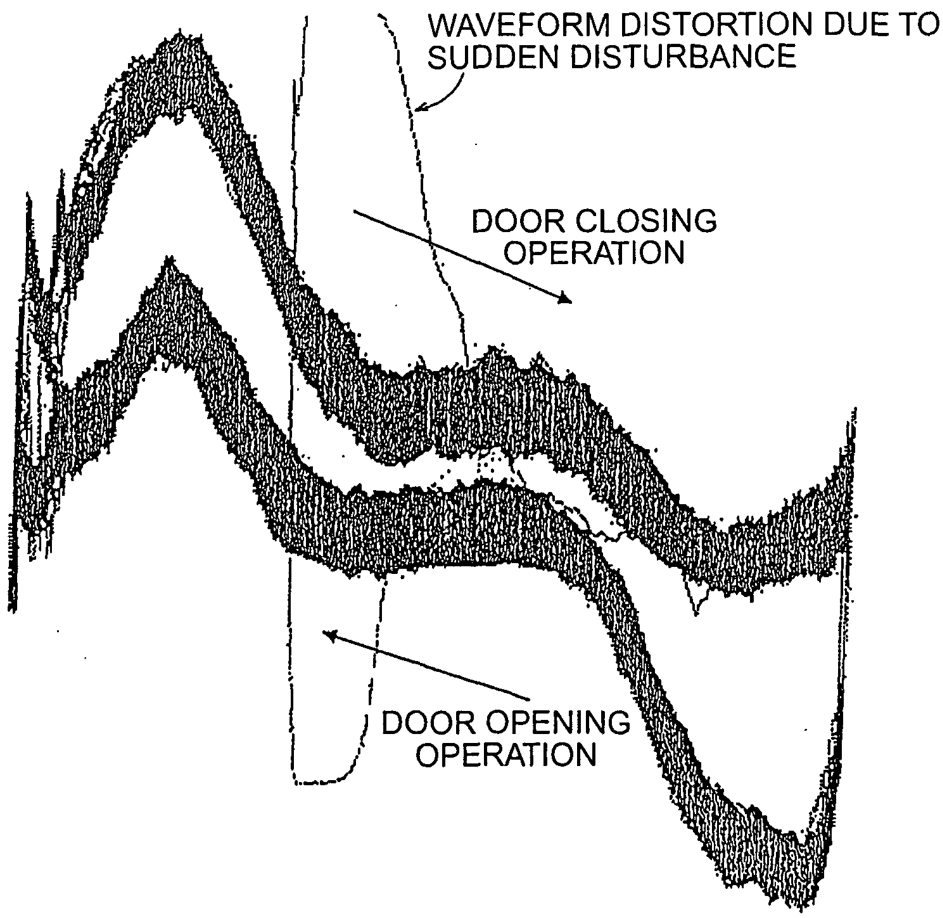

WAVEFORM DISTORTION DUE TO SUDDEN DISTURBANCE
DOOR CLOSING OPERATION
DOOR OPENING OPERATION

FIG. 5

● TRIAL DIRECTION TIME SERIES DATA

TIME SERIES DATA A:a(1),a(2),a(3),a(4),a(5),a(6),a(7),.....
TIME SERIES DATA B:b(1),b(2),b(3),b(4),b(5),b(6),b(7),.....
TIME SERIES DATA C:c(1),c(2),c(3),c(4),c(5),c(6),c(7),.....
TIME SERIES DATA D:d(1),d(2),d(3),d(4),d(5),d(6),d(7),.....
TIME SERIES DATA E:e(1),e(2),e(3),e(4),e(5),e(6),e(7),.....
TIME SERIES DATA F:f(1),f(2),f(3),f(4),f(5),f(6),f(7),.....
TIME SERIES DATA G:g(1),g(2),g(3),g(4),g(5),g(6),g(7),.....
TIME SERIES DATA H:h(1),h(2),h(3),h(4),h(5),h(6),h(7),.....

TIME DIRECTION

TRIAL DIRECTION

● TRIAL DIRECTION SIMPLE AVERGING

SIMPLE AVERAGE AFTER FIRST TRIAL:a(1),a(2),a(3),a(4),a(5),a(6),a(7),.....

SIMPLE AVERAGE AFTER SECOND TRIAL:(a(1)+b(1))/2,(a(2)+b(2))/2,(a(3)+b(3))/2,(a(4)+b(4))/2,(a(5)+b(5))/2,.....

SIMPLE AVERAGE AFTER THIRD TRIAL:(a(1)+b(1)+c(1))/3,(a(2)+b(2)+c(2))/3,(a(3)+b(3)+c(3))/3,(a(4)+b(4)+c(4))/3,(a(5)+b(5)+c(5))/3,.....

(2)TRIAL DIRECTION ADDITIVE AVERAGING WITH A FORGETTING COEFFICIENT

IT SHOULD BE NOTED THAT THE FORGETTING COEFFICIENT r IS GENERALLY SET SUCH THAT r<1.
THE EXAMPLE BELOW IS FOR A CASE OF AN r THAT ESTABLISHES AN INEQUALITY r^7 >> r^8, r^8 BEING NEARLY EQUAL TO 0 (THAT IS, THERE ARE 8 ELEMENTS ON A NON-FORGETTING SECTION)
(THE SYMBOL ^ INDICATES EXPONENT, AND THE SYMBOL >> MEANS SUFFICIENTLY SMALLER THAN)

EXAMPLE OF ADDITIVE AVERAGING WITH A FORGETTING COEFFICIENT

Y(i)=(h(i)+r・g(i)+r^2・f(i)+.....+r^7・a(i))/(1+r+r^2+...+r^7)

NON-FORGETTING SECTION, 8 ELEMENT PORTION

FIG. 6

TIME SERIES DATA A:a(1),a(2),a(3),a(4),a(5),a(6),a(7),.....
TIME SERIES DATA B:b(1),b(2),b(3),b(4),b(5),b(6),b(7),.....
TIME SERIES DATA C:c(1),c(2),c(3),c(4),c(5),c(6),c(7),.....
TIME SERIES DATA D:d(1),d(2),d(3),d(4),d(5),d(6),d(7),.....
TIME SERIES DATA E:e(1),e(2),e(3),e(4),e(5),e(6),e(7),.....
TIME SERIES DATA F:f(1),f(2),f(3),f(4),f(5),f(6),f(7),.....
TIME SERIES DATA G:g(1),g(2),g(3),g(4),g(5),g(6),g(7),.....
TIME SERIES DATA H:h(1),h(2),h(3),h(4),h(5),h(6),h(7),.....

FIG. 7

MEDIAN FILTER OUTPUT:o(i)
=median[a(i),b(i),c(i),d(i),e(i)]

FIG. 8

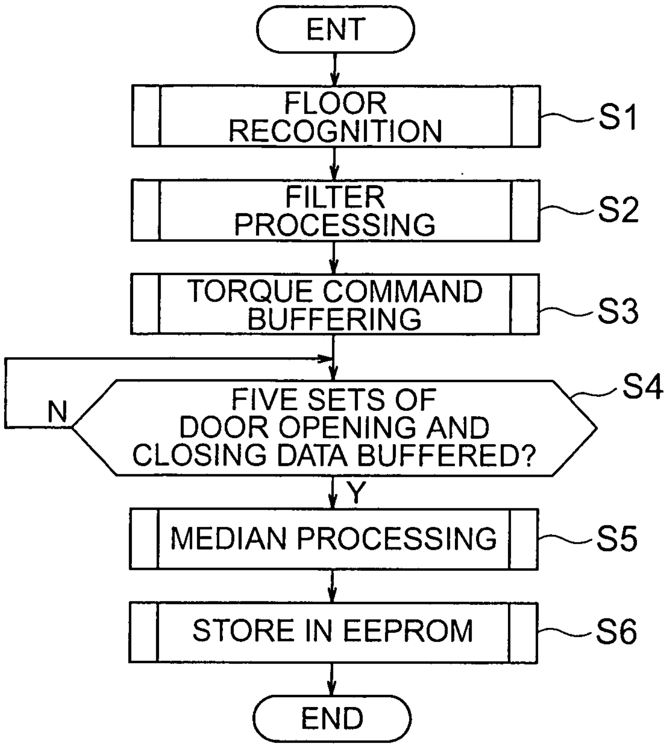

ENT
FLOOR RECOGNITION
S1
FILTER PROCESSING
S2
TORQUE COMMAND BUFFERING
S3
FIVE SETS OF DOOR OPENING AND CLOSING DATA BUFFERED?
S4
N
Y
MEDIAN PROCESSING
S5
STORE IN EEPROM
S6
END

FIG. 9

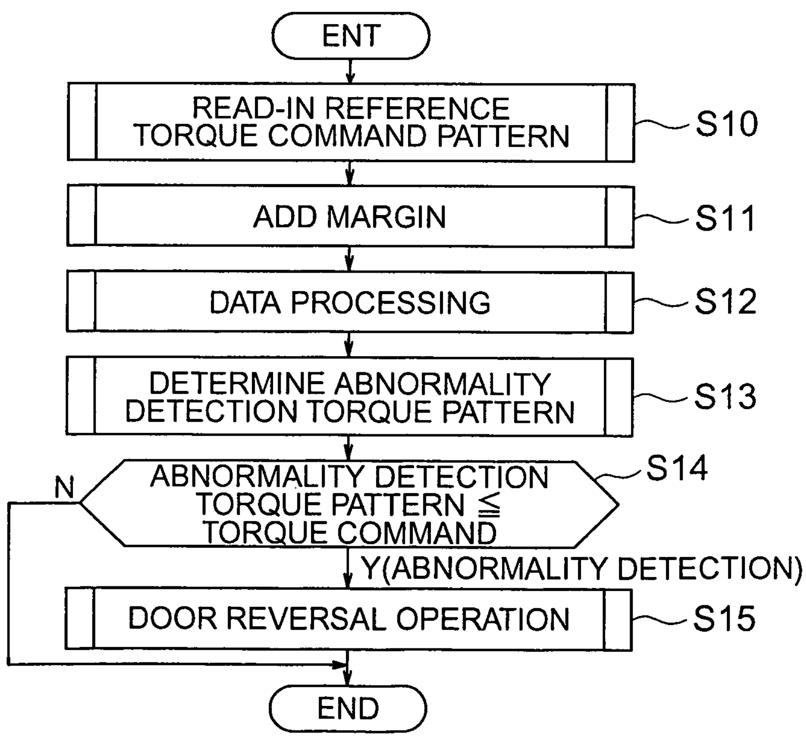

ENT
READ-IN REFERENCE TORQUE COMMAND PATTERN
S10
ADD MARGIN
S11
DATA PROCESSING
S12
DETERMINE ABNORMALITY DETECTION TORQUE PATTERN
S13
ABNORMALITY DETECTION TORQUE PATTERN ≦ TORQUE COMMAND
S14
N
Y(ABNORMALITY DETECTION)
DOOR REVERSAL OPERATION
S15
END

FIG. 10

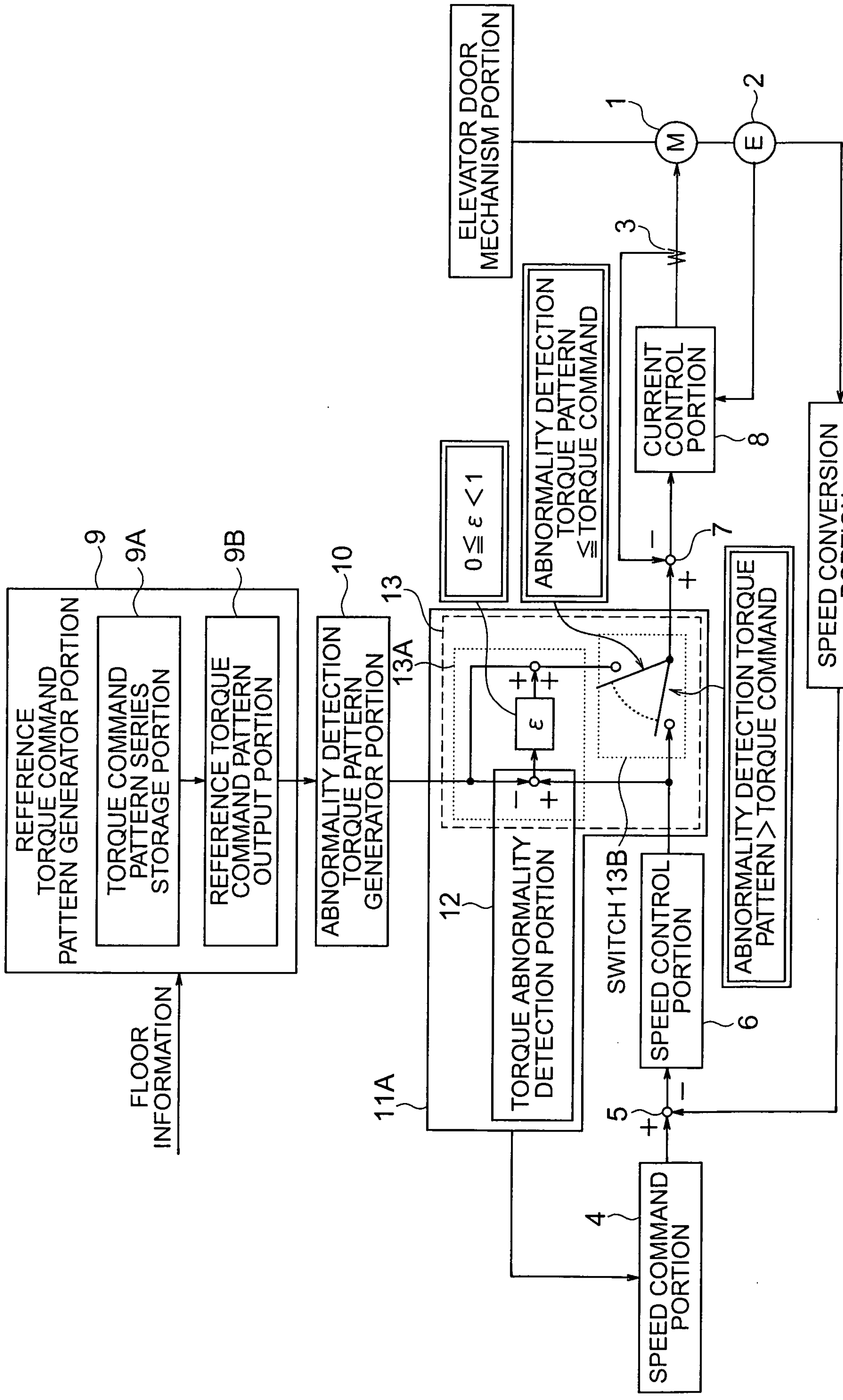
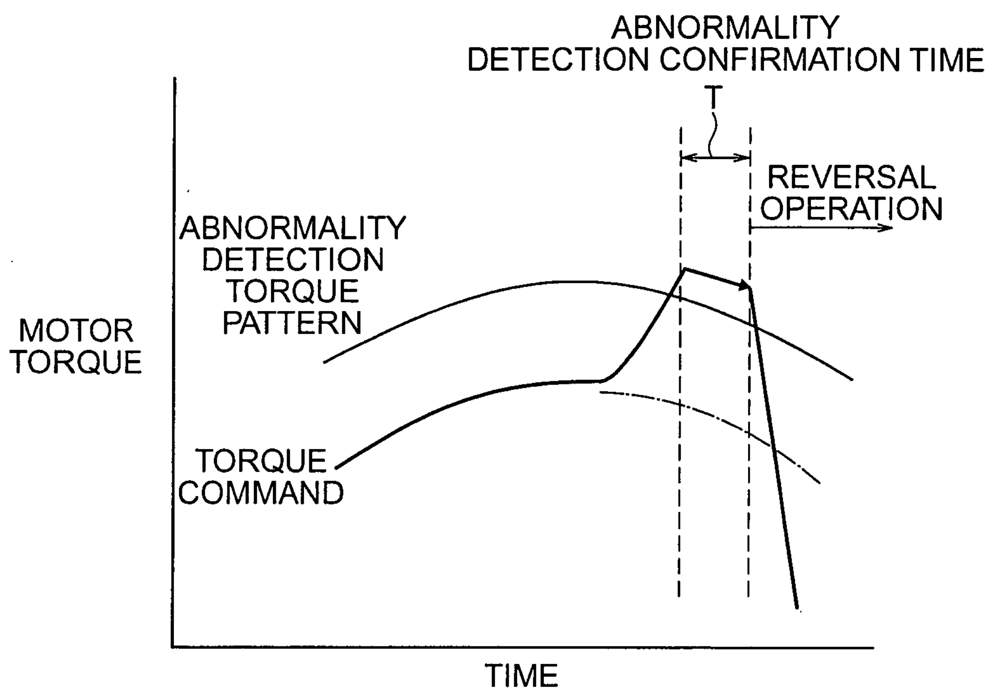

REFERENCE TORQUE COMMAND PATTERN GENERATOR PORTION
9
TORQUE COMMAND PATTERN SERIES STORAGE PORTION
9A
REFERENCE TORQUE COMMAND PATTERN OUTPUT PORTION
9B
FLOOR INFORMATION
ABNORMALITY DETECTION TORQUE PATTERN GENERATOR PORTION
10
13
13A
0≦ε<1
ε
ABNORMALITY DETECTION TORQUE PATTERN ≦TORQUE COMMAND
ABNORMALITY DETECTION TORQUE PATTERN>TORQUE COMMAND
SWITCH 13B
12
TORQUE ABNORMALITY DETECTION PORTION
11A
SPEED CONTROL PORTION
6
5
4
SPEED COMMAND PORTION
7
CURRENT CONTROL PORTION
8
3
ELEVATOR DOOR MECHANISM PORTION
1
M
2
E
SPEED CONVERSION PORTION

FIG. 11


ABNORMALITY
DETECTION CONFIRMATION TIME
T
REVERSAL
OPERATION
ABNORMALITY
DETECTION
TORQUE
PATTERN
MOTOR
TORQUE
TORQUE
COMMAND
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/12155

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B13/14

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B66B13/00-B66B13/30

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	1996-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Toroku Jitsuyo Shinan Koho	1994-2004

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.
X Y A	JP 9-323877 A (MITSUBISHI DENKI KABUSHIKI KAISHA), 16 December, 1997 (16.12.97), Par. Nos. [0016] to [0021], [0038] to [0056] (Family: none)	1-5 6-7 8
Y	US 5144101 A (MITSUBISHI DENKI KABUSHIKI KAISHA), 01 September, 1992 (01.09.92), & CN 1057038 A & JP 4-32487 A & KR 9408974 B	6-7
A	JP 8-259154 A (Fujitec Co., Ltd.), 08 October, 1996 (08.10.96), (Family: none)	1-3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 09 January, 2004 (09.01.04)	Date of mailing of the international search report 27 January, 2004 (27.01.04)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)