

TITLE OF THE INVENTION

ELEVATOR DIAGNOSIS APPARATUS AND ELEVATOR DIAGNOSIS METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an elevator diagnosis apparatus using a magnetic sensor, and an elevator diagnosis method.

2. Description of the Related Art

An elevator diagnostic system described in W0 2020/031284 A1 is known as a conventional method of diagnosing the door operation of an elevator.

For example, the "Problems to be Solved by the Invention" column in W0 2020/031284 A1 describes that "In Patent Literature 1, since it is necessary to use the control signal of the elevator system to measure a landing position, the landing position cannot be measured and a landing error cannot be diagnosed when targeting an elevator system from which a meaning of control signal cannot be acquired, such as a relay-type elevator in which the control signal does not exist in the first place and an elevator manufactured by other company whose meaning of the control signal is unknown." and "Thus, the present invention aims to provide an elevator diagnostic system that can detect abnormality when a landing error is

extended due to deterioration over time, etc., even when an elevator system from which a meaningful control signal cannot be acquired is taken as a diagnosis target".

Then, as one aspect of the invention for solving this problem, claim 6 of WO 2020/031284 A1 states "An elevator diagnostic system that diagnoses an elevator system equipped with a car that goes up and down between multiple landings, the elevator diagnostic system comprising: an acceleration sensor installed on a car door of the car; a magnetic sensor installed on the car door; a running state detection unit that detects a running state of the car based on an output signal of the acceleration sensor; a car movement amount measuring unit that measures a movement amount of the car based on output signals of the acceleration sensor and the magnetic sensor; a car position detection unit that detects a current position of the car based on the output signals of the acceleration sensor and the magnetic sensor; a car door open/close detection unit that detects an open/closed state of the car door based on the output signals of the acceleration sensor and the magnetic sensor; and an error diagnosis unit that measures a landing error of the car based on output signals of the running state detection unit, the car movement amount measurement unit, the car position detection unit, and the car door open/close detection unit, and diagnoses as a

landing error when the landing error exceeds a predetermined threshold value".

As stated above, WO 2020/031284 A1 proposes a method of detecting the open/closed state of the car door based on the output signal of the magnetic sensor installed on the car door.

SUMMARY OF THE INVENTION

As described above, a diagnostic system of WO 2020/031284 A1 targets elevator systems from which a meaningful control signal cannot be acquired, such as relay-type elevators in which control signals do not exist and elevators manufactured by other companies whose meaning of the control signal is unknown. Even in these cases, an open/closed state of a car door is detected based on an output signal of a post-installed magnetic sensor on the car door, and abnormality of a landing position is determined.

Here, an elevator door opening/closing time needs to be set to an optimum time for a user to get on and off. Therefore, in general, it is possible to set an arbitrary door opening/closing time for each elevator. However, since an optimum door opening/closing time differs for each user, it has been difficult to set the optimum door opening/closing time after grasping usability of each user

by maintenance personnel and the like for each elevator and even for each floor.

As a method of grasping the usability of the user regarding the door opening/closing time, one method that can be considered is to monitor an operation of a door open/close button. For example, a user who feels that the opening/closing time is short tends to open the door for a long time using the open button when getting on and off. In this way, the usability of the user can be assumed from the operation of the open/close button. Therefore, to diagnose an elevator system from which an operation signal of the door open/close button cannot be directly acquired, it is very effective for estimating the optimum door opening/closing time for each elevator if the open/closed state of the door and the pressing state of the open/close button can be monitored based on an output signal of a post-installed magnetic sensor.

However, the diagnostic system of WO 2020/031284 A1 does not consider to monitor the operation state of the door open/close button based on the output signal of the post-installed magnetic sensor.

Therefore, it is an object of the present invention to provide an elevator diagnosis apparatus and an elevator diagnosis method capable of detecting a pressing of the door open/close button based on the output signal of the

post-installed magnetic sensor to give an inspection instruction or an adjustment instruction according to the number of pressings.

The elevator diagnosis apparatus of the present invention performs diagnosis based on a measurement value of the magnetic sensor installed on a landing side of a car, and includes a floor determination unit that determines a car stop floor based on the measurement value, an open/close button operation determination unit that determines an operation of an open button and a close button based on the measurement value, and a usage status recording unit that records the operation of the open button and the closed button on each floor.

According to the elevator diagnosis apparatus or the elevator diagnosis method of the present invention, the usage status can be identified by detecting the operation of the door open/close button, using the post-installed magnetic sensor. Accordingly, door opening/closing time is adjustable quickly.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing a configuration of an elevator diagnosis apparatus according to an embodiment;

Figs. 2A and 2B are diagrams showing a device layout around a door according to the embodiment;

Fig. 3 is a time chart showing measurement values of a magnetic sensor at stopping at each floor according to the embodiment;

Fig. 4 is a flowchart showing an overall process according to the embodiment;

Fig. 5 is a flowchart showing an initial value registration process by a floor determination unit according to the embodiment;

Fig. 6 is a flowchart showing a floor detection process by the floor determination unit according to the embodiment;

Figs. 7A1 to 7D3 are time charts showing door operations and measurement values of the magnetic sensor;

Fig. 8 is a flowchart showing an overall process of initial value registration;

Fig. 9 is a flowchart showing a door opening operation initial value registration process;

Fig. 10 is a flowchart showing a door closing operation initial value registration process;

Fig. 11 is a flowchart showing a door opening time initial value registration process;

Fig. 12 is a flowchart showing an open/close button detection process;

Fig. 13 is a time chart showing measurement values of the magnetic sensor when a door peripheral device in a

hoistway is damaged; and

Fig. 14 is a time chart showing measurement values of the magnetic sensor when a door peripheral device in a car is damaged.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a diagnosis apparatus 1 for elevators according to an embodiment of the present invention will be described with reference to the drawings.

First, an outline of the diagnosis apparatus 1 of the embodiment and an elevator to be diagnosed will be described with reference to Fig. 1.

The elevator illustrated here is installed in a building with seven floors or more, and is equipped with a car 21 that ascends and descends in a hoistway 20 and a landing door 22 on each floor. A magnetic sensor 2 that measures a magnetic flux density on the landing side is installed on the front side (landing side) of the upper surface of the car 21, and the magnetic flux density measured by the magnetic sensor 2 (hereinafter referred to as "magnetic measurement value M") is transmitted to the diagnosis apparatus 1 by wireless communication. Inside the car 21, an open button 21a and a close button 21b for opening and closing the door are provided, and in a vicinity of the landing door 22, a landing button 22a for

calling the car 21 to the landing is provided. Operations of the open button 21a, the close button 21b, and the landing button 22a are input to an elevator control device (not shown) via a tail code (not shown) or the like, and are reflected in the ascending and descending control of the car 21 and the opening/closing control of the door. However, the operations are not input to the diagnosis apparatus 1.

The diagnosis apparatus 1 includes a sensor receiving unit 1a, a floor determination unit 1b, an open/close button operation determination unit 1c, a usage status recording unit 1d, a device failure determination unit 1e, and a notification unit 1f. The sensor receiving unit 1a receives the magnetic measurement value M from the magnetic sensor 2 and transmits it to the floor determination unit 1b, the open/close button operation determination unit 1c, and the device failure determination unit 1e. The floor determination unit 1b determines a car stop floor based on the magnetic measurement value M from the sensor receiving unit 1a. The open/close button operation determination unit 1c determines the operation of the open button 21a or the close button 21b based on the magnetic measurement value M from the sensor receiving unit 1a. The usage status recording unit 1d records the number of times the open/close button is operated on each floor

based on information from the floor determination unit 1b and the open/close button operation determination unit 1c. The device failure determination unit 1e determines whether or not there is a failure in devices around the door based on the information from the sensor receiving unit 1a and the floor determination unit 1b. The notification unit 1f transmits the usage status received from the usage status recording unit 1d to a control center 3. Further, when the device failure determination unit 1e determines that a failure has occurred, the notification unit 1f transmits failure information to the control center 3. Based on the notification content received from the notification unit 1f, the control center 3 confirms the usage status and contacts an on-site maintenance staff to give inspection instructions and adjustment instructions. Details of each part of the diagnosis apparatus 1 will be described later.

Specifically, the diagnosis apparatus 1 is a computer provided with hardware including a computing device such as a CPU, a main storage device such as a semiconductor memory, an auxiliary storage device, and a communication device. The computing device executes a program loaded from the auxiliary storage device to the main storage device, so as to realize each of the above functions. Hereinafter, description of such well-known techniques in the computer is omitted below as appropriate.

<Relationship between metal arrangement around landing door and measurement value M of magnetic sensor>

Next, with reference to Figs. 2A, 2B, and 3, the metal arrangement around the landing door 22 on each floor and a change in the measurement value M of the magnetic sensor 2 by a difference in the metal arrangement will be described.

Figs. 2A and 2B are diagrams showing a state in which the landing door 22 in Fig. 1 is viewed from the hoistway 20. Fig. 2A is, for example, the landing door 22 on the first floor, and Fig. 2B is, for example, the landing door 22 on the second floor. As shown in the drawings, a laying state of metal parts differs on each floor depending on the presence or absence of a vision glass 22b of the landing door 22 and the presence or absence of a wiring 23 in the hoistway. An arrangement of iron pillars 24 and the like above the door also differs, depending on a height of the floor and a building structure. Therefore, a degree of influence on the magnetic sensor 2 of the metal arrangement around the landing door 22 is different in each floor.

Fig. 3 is a time chart illustrating the magnetic measurement value M measured by the magnetic sensor 2 when the car 21 ascends while stopping each floor from the first to seventh floors. Since the landing door 22 opens and

closes while stopping at each floor, the magnetic measurement value M fluctuates greatly in conjunction with the opening and closing of the door.

When the car 21 is stopped at the first floor and the landing door 22 on the first floor is closed, the magnetic measurement value M measured by the magnetic sensor 2 is defined as M_1 . In the same way, when the car 21 is stopped at the n th floor and the landing door 22 on the n th floor is closed, the magnetic measurement value M measured is defined as M_n .

As described above, since the metal arrangement around the landing door 22 is different in each floor, magnetic measurement values M_1 to M_7 measured in each floor are different. Therefore, a stop floor of the car 21 can be determined based on a magnitude of the magnetic measurement value M measured when the car 21 is stopped. When some floors have very similar magnetic measurement values M , it is possible to intentionally make the magnetic measurement value M in each floor different by adding an appropriate metal near any of the landing doors 22.

<Overall process of diagnosis apparatus>

Fig. 4 is a flow showing the overall process of the diagnosis apparatus 1. As shown in the flow, the diagnosis apparatus 1 performs a general initial process (S1) of the elevator, and then performs unique processes of the present

invention, which are an initial value registration process for floor detection (S2), an initial value registration process for open/close button operation detection (S3), a floor detection process (S4), and an open/close button operation detection process (S5). Hereinafter, the details of each process will be described with reference to the drawings.

<S2: Initial value registration process for floor detection>

Fig. 5 is a flow showing the initial value registration process for floor detection. In this process, the initial value of the magnetic measurement value M in each floor used for determining the floor on which the car 21 is stopped is registered in the floor determination unit 1b. The maintenance staff performs registration at the time of installing the diagnosis apparatus 1 and the magnetic sensor 2.

First, in S21, the maintenance staff sets the initial value of a floor registration variable n to 1. Note that $n = 1$ indicates the lowest floor. When the lowest floor is the second basement floor, the second basement floor is the floor corresponding to $n = 1$. However, for the sake of simplicity below, it is assumed that the first floor above ground is the lowest floor, as shown in Fig. 1 and Fig. 3.

Next, in S22, the maintenance staff moves the car 21 to the lowest floor (first floor). Then, in S23, the floor determination unit 1b acquires the magnetic measurement value M_1 of the lowest floor (first floor). After that, in S24, the floor determination unit 1b registers the magnetic measurement value M_1 acquired in S23 as the initial value for the lowest floor (first floor).

Next, in S25, the maintenance staff confirms whether the stop floor of the car 21 is the top floor. When the stop floor is not the top floor (No in S25), the maintenance staff moves the car 21 to one floor above in S26. Then, in S27, 1 is added to the floor registration variable n , and the process from S23 is performed again.

By repeating this operation, initial values for the lowest to top floors are registered in the floor determination unit 1b. Then, when the initial value registration for the top floor is completed (Yes in S25), the process S2 ends.

<S3: Floor detection process>

Fig. 6 is a flow showing details of the floor detection process continuously performed by the floor determination unit 1b while the elevator is in operation.

First, in S31, the floor determination unit 1b acquires the magnetic measurement value M measured by the magnetic sensor 2.

Next, in S32, the floor determination unit 1b confirms whether a previous value of the magnetic measurement value M has been saved. When the previous value has not been saved (No in S32), the process proceeds to S33. The floor determination unit 1b saves a current value of the magnetic measurement value M acquired in S31 as a previous value for the next process, and the process S3 ends.

On the other hand, when the previous value has been saved (Yes in S32), the floor determination unit 1b confirms whether the car 21 is stopped. Specifically, first, in S34, a difference between the previous value and the current value of the magnetic measurement value M is calculated. Next, in S35, whether the difference is equal to or less than a threshold value is determined. Then, when the difference is equal to or less than the threshold value (Yes in S35), it is determined that the car 21 may be stopped. The threshold value is determined from an amount of fluctuation at the time of stopping in consideration of a detection error of the magnetic sensor 2.

Further, to reliably determine a stop state, the floor determination unit 1b determines whether a predetermined time has elapsed while the difference remains equal to or less than the threshold value. Specifically, first, in S36, a stop detection timer starts counting up.

Next, in S37, whether or not the stop detection timer has reached the predetermined time is determined. Here, for example, it is confirmed that the state in which the difference is equal to or less than the threshold value continues for 1 second. When the difference is larger than the threshold value in S35 (No in S35), it is determined that the car 21 is moving between floors, and the stop detection timer is reset in S3c.

On the other hand, when the predetermined time has not elapsed in S37 (No in S37), the process S3 ends after performing S33.

When the stop detection timer exceeds the predetermined time period (Yes in S37), the floor determination unit 1b determines that the car 21 is stopped, and performs a process of identifying the stop floor. Specifically, first, in S38, 1 is selected as a floor n . Next, in S39, the magnetic measurement value M_1 which is the initial value for the first floor, and the current value of the magnetic measurement value M acquired in S31 are compared. Then, when the difference between the two values is equal to or less than the threshold value (Yes in S39), the car stop floor is determined to be the first floor (S3a).

On the other hand, when the difference is larger than the threshold value in S39 (No in S39), it is

determined that the car stop floor is not the first floor, and in S3b, 1 is added to floor $n = 1$, and in S39, the magnetic measurement value M_2 , which is the initial value for the second floor, and the current value of the magnetic measurement value M acquired in S31 are compared. By repeating the processes in S39 and S3b in this way, the car stop floor can be determined. When the current value of the magnetic measurement value does not match any of the initial values for all floors in S39, it may be determined as abnormal and notified to the control center 3.

<Relationship between door open/closed state and magnetic measurement value M >

Here, before explaining a process of detecting the operation of the open button 21a and the close button 21b by the open/close button operation determination unit 1c, the relationship between the open/closed state of the landing door 22 and the magnetic measurement value M will be described in relation to the button operations, using the time chart in Figs. 7A1 to 7D3.

Generally, the landing door 22 is controlled to open when the car 21 arrives at the landing and then close after a certain time period passes. A time period from the start of the opening operation to the completion of the closing operation can be arbitrarily set, and can also be changed by the maintenance staff or the like upon a request of the

user.

Figs. 7A1 and 7A2 are time charts showing the relationship between the door open/closed state and the magnetic measurement value M when the open button 21a (or the landing button 22) and the close button 21b are not operated. Immediately after the car 21 stops at the landing, the landing door 22 is closed. At this point, the magnetic measurement value M is also substantially constant within a measurement error range of the initial value M_n for each floor registered in S2. After that, when the landing door 22 is opened, the magnetic measurement value M also decreases as the door opens, and the magnetic measurement value M becomes substantially constant while the door is open. After that, when the set time period elapses, the landing door 22 closes, and the magnetic measurement value M also rises as the door is closed. When the user does not operate the open button 21a (or the landing button 22) or the close button 21b, a standard time t_s required from the start of the opening operation to the completion of the closing operation of the landing door 22 is always constant.

Figs. 7B1 to 7B3 are time charts showing the door open/closed state and the magnetic measurement value M when the user presses the close button 21b to close the landing door 22 while the door is open. When the user presses the

close button 21b at the timing indicated by a dotted line in Fig. 7B3, the closing operation of the landing door 22 starts. Therefore, a time t_c required from the start of the opening operation of the landing door 22 to the completion of the closing operation becomes shorter than the standard time t_s . When this condition occurs frequently, it can be assumed that the standard time t_s is long for the user, and the maintenance staff may set the standard time t_s shorter.

Figs. 7C1 to 7C3 are time charts showing the door open/closed state and the magnetic measurement value M when the user presses the open button 21a (or the landing button 22) while the door is open to extend the open state of the landing door 22. When the user presses the open button 21a (or the landing button 22) at the timing indicated by a solid line in Fig. 7C3, the open state of the landing door 22 is extended. Therefore, a time t_o required from the start of the opening operation of the landing door 22 to the completion of the closing operation becomes longer than the standard time t_s . When this condition occurs frequently, it can be assumed that the standard time t_s is short for the user, and the maintenance staff may set the standard time t_s longer.

Figs. 7D1 to 7D3 are time charts showing the door open/closed state and the magnetic measurement value M when

the user presses the open button 21a (or the landing button 22) to reopen the landing door 22 while the door is in the closing operation. When the user presses the open button 21a (or the landing button 22) at the timing during the closing operation indicated by a solid line in Fig. 7D3, the landing door 22 in the closing operation is switched to the opening operation. In this case, a pulsed magnetic measurement value M is measured, as shown in Fig. 7D2. Therefore, the reverse operation of the door can be detected based on the pulsed magnetic measurement value M . Also, when the door operation is frequently reversed, the maintenance staff may set the standard time t_s longer because it can be estimated that the standard time t_s is short for the user. Also, when the door operation is switched to the opening operation as a result of the user touching the door during the closing operation, it may be considered as the open button 21a (or the landing button 22) has been pressed.

In this way, it is possible to determine whether or not the open button 21a (or the landing button 22) or the close button 21b is operated and the operation timing based on the length of the opening/closing time of the landing door 22 and the behavior of the magnetic detection value M . The open/close button operation determination unit 1c determines the button operation by the following method,

using the above values.

<S4: Initial value registration process for open/close button operation detection>

Fig. 8 is a flow showing the initial value registration process for open/close button operation detection. In this process, the initial values for the door opening operation, the door closing operation, and the door opening time used when detecting the operations of the open button 21a (or the landing button 22) and the close button 21b are registered to the open/close button operation determination unit 1c. The maintenance staff performs registration at the time of installing the diagnosis apparatus 1 and the magnetic sensor 2.

First, in S4a, the maintenance staff stops the car 21 at one of the landings. After that, the door opening operation initial value registration process in S4b, the door closing operation initial value registration process in S4c, and the door opening time initial value registration process in S4d are sequentially performed. Hereinafter, S4b to S4d will be described in detail with reference to Figs. 9 to 11.

<S4b: Door opening operation initial value registration process>

Fig. 9 is a flow showing details of the door opening operation initial value registration process. First, in

S4b1, the open/close button operation determination unit 1c acquires a magnetic measurement value M_i in a state that the door is closed. Next, in S4b2, the maintenance staff opens the door. After that, in S4b3, the open/close button operation determination unit 1c acquires a magnetic measurement value M_i' in a state that the door is open.

Next, in S4b4, the open/close button operation determination unit 1c compares the magnetic measurement values M_i and M_i' . When a change is equal to or greater than a threshold value (Yes in S4b4), a magnetism change direction is stored in S4b5. Specifically, as shown in Equation 1, when an amount of change exceeds the threshold value, it is determined that the magnetism has changed related to the door opening operation, and a positive or negative change direction is stored in Equation 2.

Equation 1

$$|M_i' - M_i| > \text{THRESHOLD} \quad \dots \quad \text{FORMULA (1)}$$

Equation 2

$$\text{CHANGE DIRECTION} = \frac{M_i' - M_i}{|M_i' - M_i|} \quad \dots \quad \text{FORMULA (2)}$$

Finally, in S4b6, the open/close button operation determination unit 1c records the magnetism change direction stored in S4b5 as the door opening operation initial value.

<S4c: Door closing operation initial value

registration process>

Fig. 10 is a flow showing details of the door closing operation initial value registration process. First, in S4c1, the open/close button operation determination unit 1c acquires a magnetic measurement value M_j in a state that the door is open. Next, in S4c2, the maintenance staff closes the door. After that, in S4c3, the open/close button operation determination unit 1c acquires a magnetic measurement value M_j' in a state that the door is closed.

Next, in S4c4, the open/close button operation determination unit 1c compares the magnetic measurement values M_j and M_j' . When a change is equal to or greater than a threshold value (Yes in S4c4), a magnetism change direction is stored in S4c5. Specifically, as shown in Equation 3, when an amount of change exceeds the threshold value, it is determined that the magnetism has changed related to the door closing operation, and the positive or negative change direction is stored in Equation 4.

Equation 3

$$|M_j' - M_j| > \text{THRESHOLD} \quad \dots \text{ FORMULA (3)}$$

Equation 4

$$\text{CHANGE DIRECTION} = \frac{M_j' - M_j}{|M_j' - M_j|} \quad \dots \text{ FORMULA (4)}$$

Finally, in S4c6, the open/close button operation

determination unit 1c records the magnetism change direction stored in S4c5 as the door closing operation initial value.

<S4d: Door opening time initial value registration process>

Fig. 11 is a flow showing details of the door opening time initial value registration process. First, in S4d1, the maintenance staff opens the door. Next, in S4d2, the open/close button operation determination unit 1c acquires a magnetic measurement value Mt. When there is a magnetism change registered as the door opening operation initial value (Yes in S4d3) related to the door opening operation, the open/close button operation determination unit 1c starts counting up the door opening time timer in S4d4. On the other hand, when there is no magnetism change registered as the door opening operation initial value (No in S4d3), the open/close button operation determination unit 1c repeats S4d2.

After starting the count-up, the open/close button operation determination unit 1c acquires a magnetic measurement value Mt' in S4d5, and waits in S4d6 until the landing door 22 is automatically closed. In other words, the open/close button operation determination unit 1c waits until there is a magnetism change of door closing operation registered as the door closing operation initial value, and

the count-up in S4d4 continues when there is no magnetism change (No in S4d7).

Then, when the magnetism change of door closing operation is detected (Yes in S4d6), the open/close button operation determination unit 1c records the current count time as an initial value t_d for the door opening time in S4d7. The initial value t_d for the door opening time registered here corresponds to the standard time t_s in Fig. 7A1.

<S5: Open/close button operation detection process>

Fig. 12 is a flow showing details of the open/close button operation detection process continuously performed by the floor determination unit 1b, the open/close button operation determination unit 1c, and the usage status recording unit 1d while the elevator is in operation.

First, in S51, the floor determination unit 1b determines whether a floor on which the car 21 is currently stopped is confirmed. When the current floor is confirmed (Yes in S51), the process proceeds to S52. When the floor is not confirmed (No in S51), the car 21 may be moving. Therefore, the process in S5 ends without detecting the open/close button operation.

Next, in S52, the open/close button operation determination unit 1c determines whether or not there is a magnetism change of the door opening operation. When there

is a magnetism change of the door opening operation (Yes in S52), the door opening time timer starts counting up in S53. After that, in S54, whether there is a magnetism change of door closing operation is determined. When there is a magnetism change of door closing operation (Yes in S53), the door opening time timer stops counting in S55. A measurement value td' of the timer at this point is the actual door opening/closing time while the customer is in use.

Next, in S56, the open/close button operation determination unit 1c compares the initial value td registered in S4d with the measurement value td' acquired in S55. When the measurement value td' is smaller than the initial value td (Yes in S56), it can be determined that the user has operated the close button 21b because the door has closed earlier than the automatic closing (see Fig. 7B). Therefore, the open/close button operation determination unit 1c determines in S57 that the close button 21b has been operated.

On the other hand, when the measurement value td' is equal to or greater than the initial value td (No in S56) and the measurement value td' is also greater than the initial value td (Yes in S5b), it can be determined that the user has operated the open button 21a because the door has been open longer than the automatic closing (see Figs.

7C and 7D). Therefore, the open/close button operation determination unit 1c determines in S5c that the door open button has been operated.

Still more, when the measurement value td' is equal to or greater than the initial value td (No in S56) and the measurement time td' is equivalent to the initial value td (No in S5b), it can be determined as the automatic opening/closing (see Fig. 7A). Therefore, the open/close button operation determination unit 1c determines in S5f that the open/close button has not been operated.

During the operation of the elevator, for example, when there is a person who gets in while the door is closing, the user in the car may operate the open button 21a to open the door (see Fig. 7D). In this case, the opening operation is performed during the door closing operation. In other words, the reverse operation is performed.

When the closing operation is detected in S54 and then a magnetism change of the door opening operation is detected again in S58 (Yes in S58), it can be determined that the open button 21a has been operated during the door closing operation to reverse the door operation. Therefore, the open/close button operation determination unit 1c determines that the open button operation is performed in S59, and determines that door reverse

operation is performed in S5g.

In the case where the door is opened after it is completely closed, time from the closing operation detection in S54 to the opening operation detection in S58 may be counted, in order to distinguish from the case where the user gets in from the waiting floor after the car moves and stays in the standby state. When the counted time is less than a predetermined time, it may be determined as the reverse operation, and when the counted time is equal to or greater than a predetermined time, it may be determined as the opening/closing operation without reverse operation.

Alternatively, the process on and after S53 may be performed again after S58 to determine again the open/close button operation after reversal and the presence of reverse operation.

Then, in S5a, the usage status recording unit 1d records, for each floor determined in S51, the operation of the open/close button and the number of reverse operations determined by the open/close button operation determination unit 1c.

In the case where the closing operation after the door opens is not detected in S54 (No in S54), i.e., in the case where the door continues to be open, it is determined as a door failure in S5e when the door opening time in S5d significantly exceeds (for example, 10 minutes) the

predetermined time such as assumed door opening time in S5b (Yes in S5d). On the other hand, when the door opening time is within the predetermined time (No in S5d), the process returns to S53 and the door opening time timer continues counting.

When the door opening operation is not detected in S52 (No in S52), the door opening time timer is cleared in S5h until the door opening operation is performed.

By the above-mentioned open/close button operation detection process, the measured number of door open/close button operations and the number of reverse operations are transmitted from the notification unit 1f to the control center 3 so that the maintenance staff can grasp the usage status.

When the close button 21b is operated many times, there is a high possibility of the user feeling that the door opening/closing time is long. Therefore, a proposal is made to shorten the door opening/closing time setting. When the open button 21a is operated many times, there is a high possibility of the user feeling that the door opening/closing time is short. Therefore, a proposal is made to extend the door opening/closing time setting.

In addition, when the reverse operation is performed many times, it is possible to inspect and improve the door before a failure occurs. Further, by using the floor

information, it is possible to immediately respond to a failure of the landing door 22 on a specific floor when the reverse operation is performed only in the specific floor.

In addition, when a door failure is determined in S5e, the notification unit 1f notifies the failure to the control center 3 so that the maintenance staff can be informed to take on-site action promptly.

<Damage detection method by device failure determination unit 1e>

Next, a method of detecting a damage to a door peripheral device and a method of detecting a damage to the device on the car by the device failure determination unit 1e will be described.

As explained in Fig. 3, the magnetic measurement value M_n in each stop floor is different, but in general, the position of the metal does not change in the hoistway because cables and brackets are fixed. However, a damage or positional deviation due to deterioration over time or contact during movement may occur. When left as it is, contact during movement may cause emergency stop of the elevator. Therefore, it is necessary to grasp condition of devices in the hoistway even when they are not affecting the movement.

Fig. 13 is a time chart showing measurement values of the magnetic sensor 2 when the car stops at each floor

under the condition that a door peripheral device in the second floor is damaged. A dotted line in the second floor is the initial magnetic measurement value M , and a solid line is the magnetic measurement value M after the door peripheral device is damaged. For example, when a bracket above the door on the second floor is missing, the magnetic measurement value M will also change due to a change in the metal arrangement. In the floor detection process in S3, when there is an initial value corresponding to the magnetic measurement value M when the car stops at a floor other than the second floor, and there is no initial value corresponding to the magnetic measurement value M only when the car stops at the second floor, the device failure determination unit 1e determines that the door peripheral device on the second floor may have been damaged, and notifies the control center 3 via the notification unit 1f. Then, the maintenance staff can take action before a failure occurs. To identify that the stop floor of the car 21 is the second floor, it is necessary to refer to which floor is the previous floor, or to use information such as from an acceleration sensor or a barometric pressure sensor (not shown).

Further, Fig. 14 is a time chart showing measurement values of the magnetic sensor 2 when the car stops at each floor while the device above the car is damaged. The

dotted line is the magnetic measurement value M at the time of initial setting, and the solid line is the magnetic measurement value M after the device on the car is damaged. For example, when a cover of a door control box on the car comes off, the magnetic measurement value M also changes due to a change in the metal arrangement around the magnetic sensor 2. In the floor detection process in S3, when there is a similar deviation from the initial value on all floors, the notification unit 1f notifies the control center 3 that the device on the car may have been damaged. Then, the maintenance personnel can take action before a failure occurs.

As described above, according to the diagnosis apparatus or the diagnosis method of the embodiment, the user's operation status of the door open/close button and a failure of the landing door peripheral devices and devices above the car can be detected, based on the output signal of the post-installed magnetic sensor.

What is claimed is:

1. An elevator diagnosis apparatus that performs a diagnosis based on a measurement value of a magnetic sensor installed on a landing side of a car, the elevator diagnosis apparatus comprising:

a floor determination unit that determines a car stop floor based on the measurement value;

an open/close button operation determination unit that determines an operation of an open button and a close button based on the measurement value; and

a usage status recording unit that records the operation of the open button and the close button in each floor.

2. The elevator diagnosis apparatus according to claim 1, wherein

the open/close button operation determination unit detects a door opening operation or a door closing operation based on a change direction of the measurement value, and the close button is determined to be operated when a time spent from a start of the door opening operation to a completion of the door closing operation is shorter than a predetermined standard time.

3. The elevator diagnosis apparatus according to claim 1, wherein

the open/close button operation determination unit detects a door opening operation or a door closing operation based on a change direction of the measurement value, and the open button is determined to be operated when a time spent from a start of the door opening operation to a completion of the door closing operation is longer than a predetermined standard time.

4. The elevator diagnosis apparatus according to claim 1, wherein

the open/close button operation determination unit detects a door opening operation or a door closing operation based on a change direction of the measurement value, and a movement of the door is determined to be reversed when the change direction of the measurement value is switched before a completion of the door closing operation.

5. The elevator diagnosis apparatus according to claim 1, wherein

the floor determination unit stores for each floor an initial value of the measurement value at closing the door, and a current car stop floor is determined by comparing the measurement value at present and the initial value for each floor.

6. The elevator diagnosis apparatus according to claim 1, further comprising a notification unit that

transmits a usage status recorded in the usage status recording unit to an external control center.

7. An elevator diagnosis apparatus that performs a diagnosis based on a measurement value of a magnetic sensor installed on a landing side of a car, the elevator diagnosis apparatus comprising:

- a floor determination unit that determines a car stop floor based on the measurement value; and

- a failure determination unit that determines a failure based on the measurement value, wherein

- the failure determination unit determines that

- when the measurement value with abnormality is found only in a specific floor, a failure exists in a device in a hoistway near a landing door of the specific floor, and

- when the measurement value with abnormality is found in all floors, a failure exists in a device installed in the car.

8. An elevator diagnosis method of performing a diagnosis based on a measurement value of a magnetic sensor installed on a landing side of a car, the elevator diagnosis method comprising:

- determining a stop floor of the car based on the measurement value;

- determining an operation of an open button and a close button based on the measurement value; and

transmitting the operation of the open button and the close button in each floor to a control center.