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(54) **ELEVATOR DEVICE**

(57) Provided is an elevator device using magnetic-pole position estimating control, which is capable of realizing high landing accuracy even in a stopped state and in a super-low speed operation state. The elevator device using a magnetic-pole position estimating method, for estimating a magnetic-pole position by using an induced voltage generated by rotation of a motor of a hoisting machine (11) to perform running control on a car driven by the rotation of the hoisting machine, includes: a detector (32) provided outside the hoisting machine, for de-

tecting a position or a speed of the car; and a control section (20) for determining whether or not the car is in a switched running state according to a running speed of the car or a current position of the moving car, for performing the running control on the car by using the magnetic-pole position estimating control method when it is determined that the car is not in the switched running state, and for performing the running control on the car based on results of detection by the detector when it is determined that the car is in the switched running state.

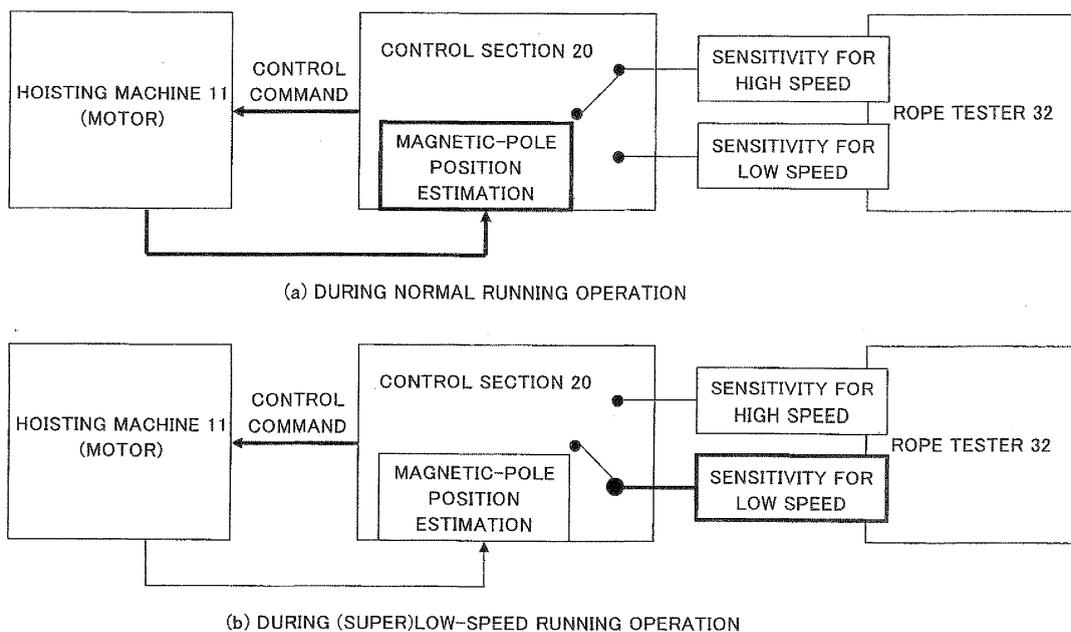


FIG. 4

Description

Technical Field

[0001] The present invention relates to an elevator device including a hoisting machine having a simple structure, which has improved landing accuracy.

Background Art

[0002] There exists an elevator device capable of controlling an electric motor and a braking mechanism to stably drive a sheave so as to perform a rescue operation even while a hoisting machine is being driven at a low speed (for example, Patent Literature 1). According to the conventional technology described in Patent Literature 1, when a failure occurs in an encoder, magnetic-pole position estimating control is performed so as to rescue a passenger(s).

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2008-230797 A

Summary of Invention

Technical Problem

[0004] However, the conventional technology has the following problem.

The conventional elevator device described in Patent Literature 1 has improved accuracy for a low speed by using a magnetic-pole position estimation method. However, in a stopped state or in a super-low speed operation state, an elevator device with high landing accuracy cannot be obtained only by the magnetic-pole position estimating method because the number of magnetic poles is limited.

[0005] The present invention has been made to solve the problem described above, and has an object to provide an elevator device using magnetic-pole position estimating control, which is capable of realizing high landing accuracy even in a stopped state and in a super-low speed operation state.

Solution to Problem

[0006] According to the present invention, there is provided an elevator device using a magnetic-pole position estimating method, for estimating a magnetic-pole position by using an induced voltage generated by rotation of a motor of a hoisting machine to perform running control on a car driven by the rotation of the hoisting machine, the elevator device including: a detector provided outside the hoisting machine, for detecting a position or a speed of the car; and a control section for determining whether or not the car is in a switched running state according to

a running speed of the car or a current position of the moving car, for performing the running control on the car by using the magnetic-pole position estimating control method when it is determined that the car is not in the switched running state, and for performing the running control on the car based on results of detection by the detector when it is determined that the car is in the switched running state.

10 Advantageous Effects of Invention

[0007] The elevator device according to the present invention includes the control section capable of performing switching between the running control using the magnetic-pole position estimating control method and the running control performed based on the results of the detection by the detector provided outside the hoisting machine according to the running speed of the car or the current position of the moving car. As a result, the elevator device using the magnetic-pole position estimating control, which is capable of realizing high landing accuracy even in a stopped state and in a super-low speed operation state, can be obtained.

25 Brief Description of Drawings

[0008]

[FIG. 1] A general view of an elevator device according to Embodiment 1 of the present invention.

[FIG. 2] A conceptual diagram illustrating a permanent-magnet type synchronous motor using magnetic-pole position estimating control according to Embodiment 1 of the present invention.

[FIG. 3] A conceptual diagram illustrating an induction-type rope tester used for the elevator device according to Embodiment 1 of the present invention.

[FIGS. 4] Explanatory views of a method of controlling the elevator device according to Embodiment 1 of the present invention.

[FIG. 5] A diagram illustrating another example of installation of the rope tester according to Embodiment 1 of the present invention.

[FIG. 6] An explanatory view illustrating control switching timing of the elevator device according to Embodiment 1 of the present invention.

Description of Embodiment

[0009] Hereinafter, an elevator device according to a preferred embodiment of the present invention is described with reference to the drawings.

Embodiment 1

[0010] FIG. 1 is a general view of an elevator device according to Embodiment 1 of the present invention. The elevator device of Embodiment 1 includes a driving

mechanism section 10 for driving a car of an elevator to raise and lower the car, a control section 20 for controlling the raising and lowering of the car, and a state detecting section 30 for generating a detection signal necessary for the control of the raising and lowering, which is performed by the control section 20.

[0011] The driving mechanism section 10 includes a hoisting machine 11, a car 12, a counterweight 13, a rope 14, a deflector sheave 15, and a governor 16. A motor of the hoisting machine 11 is a permanent-magnet type synchronous motor. Although the details are not illustrated, the hoisting machine 11 includes an electric motor, a sheave, a brake housing, and the like. A rope 14 having one end connected to the car 12 and the other end connected to the counterweight 13 is looped around the sheave. The deflector sheave 15 is located in the middle of a path of the rope 14 as needed. By driving the sheave by the electric motor, the car 12 performs a rising/falling operation. A brake applies a braking force to the sheave to stop the car 12 and releases the braking force to place the car 12 in a free state.

[0012] The state detecting section 30 includes an encoder 31 and a rope tester 32, each being for measuring a speed or a position of the car 12, a door-position detecting section 33 (not shown) for detecting a landing position of the car 12, and landing plates 34.

[0013] The encoder 31 is provided to the governor 16. The rope tester 32 can be provided in the middle of a hoistway as illustrated in FIG. 1 or can be provided to a sheave portion of the hoisting machine 11 as described below referring to FIG. 5. Although both the encoder 31 and the rope tester 32 are illustrated in FIG. 1 as detectors for measuring the speed or the position of the car 12 when running control using a magnetic-pole position estimating control method is not performed, the use of any one thereof is sufficient. Alternatively, another/other detector(s) can be used.

[0014] The door-position detecting section 33 (not shown) is provided to a side surface of the car 12. On the other hand, each of the landing plates 34 is provided at a position in the hoistway, which corresponds to a landing of each floor. The door-position detecting section 33 detects any one of the landing plates 34 along with the raising and lowering of the car 12. As a result, whether or not the car 12 is present at a position at which a door can be opened/closed, which corresponds to the landing of each floor, can be detected.

[0015] The control section 20 performs running control on the car 12 based on a detection signal from the state detecting section 30. More specifically, the "magnetic-pole position estimating control" described in Patent Literature 1 cited as the conventional technology is used for the elevator according to Embodiment 1. The running control by the "magnetic-pole position estimating control, uses an induced voltage, which is generated when the motor of the hoisting machine 11 rotates, to estimate a magnetic-pole position so as to control the rotation of the hoisting machine 11.

[0016] Next, the schema of the "magnetic-pole position estimating control" described in Patent Literature 1 is described. FIG. 2 is a conceptual diagram of the permanent-magnet type synchronous motor using the magnetic-pole position estimating control, according to Embodiment 1 of the present invention. There is provided a configuration which enables the running control without independently providing a magnetic-pole position detecting such as the encoder 31 by loading the induced voltage which can be detected at the time of driving into the control section 20.

[0017] As illustrated in FIG. 2, however, the induced voltage drops when the speed is lowered. Therefore, in a super-low speed operation state, it becomes difficult to detect the magnetic-pole position. Further, the number of magnetic poles of the synchronous motor is smaller than that of the encoder 31, and is therefore limited. Hence, the use of the magnetic-pole position estimating control lowers accuracy and reliability in some cases as compared with those obtained by using the encoder 31 even when improvement is achieved in terms of control. Therefore, even when the magnetic-pole position estimating control is used, full elimination of use of the encoder is difficult in practice.

[0018] Therefore, in the present invention, another running control using the detection section for detecting the speed or the position of the car is additionally used in a state in which the accuracy or the reliability obtained by the magnetic-pole position estimating control method becomes an issue in the elevator device employing the magnetic-pole position estimating control. In this manner, the running control with improved accuracy and reliability is realized. As an example of the detection section, the case where the rope tester 32 is used is first described below. As the rope tester 32, an induction-type rope tester, which is currently frequently used, is used.

[0019] FIG. 3 is a conceptual diagram of the induction-type rope tester used for the elevator device according to Embodiment 1 of the present invention. An induced voltage detected by the induction-type rope tester 32 illustrated in FIG. 3 has a peak when one of strands of a rope partially breaks. Therefore, by monitoring the case where the detected voltage becomes equal to or higher than a predetermined value, wire breaking can be detected.

[0020] In general, for the inspection of the rope, the rope tester 32 is mounted to a rope portion by a maintenance personnel at maintenance time to monitor the detected voltage so as to confirm whether or not the rope is normal. Normally, a sensitivity of the rope tester 32 is set so that the wire breaking can be clearly detected based on the detected voltage during a running operation performed at an inspection speed A shown in the lower right graph of FIG. 3.

[0021] Although the wire breaking can be clearly detected at the sensitivity suitable for the inspection speed A during the running operation, attention is not focused on the detection of each of peaks formed by the strands of the rope. The inspection speed A used in this case

corresponds to, for example, a normal running speed. Specifically, a pitch of each of the strands of the rope is extremely small, that is, in millimeter. Therefore, as the detected voltage at the sensitivity suitable for the inspection speed A, signals for peaks and valleys formed by the strands are measured as noise. Therefore, the detected voltage is not suitable for the detection of the position.

[0022] On the other hand, with the detected voltage in the super-low speed operation, the extremely small pitch of the strand is more visible. Therefore, during the super-low speed operation, the sensitivity is switched to a sensitivity suitable for the detection of each of the peaks formed by the strands of the rope without focusing attention on the wire breaking. In this manner, the peaks and valleys of the strands can be detected, as illustrated in the lower left graph of FIG. 3.

[0023] It is considered to switch the sensitivity of the rope tester 32 according to the running speed by using the above-mentioned characteristics. FIGS. 4(a) and 4(b) are explanatory views of a method of controlling the elevator device according to Embodiment 1 of the present invention. FIG. 4(a) corresponds to the normal running operation, whereas FIG. 4(b) corresponds to the low speed/super-low speed running operation.

[0024] As illustrated in FIG. 4(a), during the normal running operation (in the case of a high speed), the elevator control is performed by using the magnetic-pole position estimating control. In addition, the rope tester 32 constantly performs monitoring for an abnormality of the rope at the sensitivity for the detection of the wire breaking (sensitivity for high speed). The monitoring of the rope may be omitted.

[0025] On the other hand, as illustrated in FIG. 4(b), when the speed of the elevator is low or super low, the sensitivity of the rope tester 32 is switched to the sensitivity for low speed, at which the peaks and valleys formed by the strands are more visible and there is no fear of erroneous detection of the wire breaking. At this time, the running control on the elevator is switched from the magnetic-pole position estimating control to the control using the signal of the rope tester 32.

[0026] The detection method used by the rope tester 32 may also be an optical one. When an optical method is used, the peaks and valleys formed by the strands are identified by the positions. Therefore, the peaks and valleys can be detected more precisely as the speed becomes lower. As a result, the accuracy of the position control using the signal of the rope tester 32 can be enhanced. Besides the optical method, other methods may be used as long as the shape of the strand can be detected. Further, in the case where the wire breaking can be detected at a single sensitivity by single signal processing at a speed varying from low to high and the strand can be detected, it is not necessary to switch the sensitivity.

[0027] In FIG. 1, the case where the rope tester 32 is provided in the middle of the hoistway is exemplified.

However, the location at which the rope tester 32 is provided is not limited thereto. FIG. 5 is a view illustrating another example of the installation of the rope tester according to Embodiment 1 of the present invention. As illustrated in FIG. 5, the rope tester 32 may be provided to the sheave portion of the hoisting machine 11. In this case, a configuration in which the rope tester 32 is nearly integrated with the hoisting machine 11 can be obtained. As a result, a space can be reduced. In addition, the rope tester 32 can be used in place of a rope retainer.

[0028] Next, timing of switching between the case where the running control is performed using the magnetic-pole position estimating control as illustrated in FIG. 4(a) and the case where the running control is performed using the rope tester signal as illustrated in FIG. 4(b) is described. FIG. 6 is an explanatory view illustrating the control switching timing for the elevator device according to Embodiment 1 of the present invention.

[0029] As first switching timing, a point at which the speed is switched to the super-low speed immediately before landing is considered. Specifically, a zone in which the speed is equal to or lower than the super-low speed immediately before landing corresponds to a "switched running state" in which the running control using the signal of the detection section is performed. In the case where the switching control described above is performed, a speed zone in which the signal of the rope tester 32 is used for the running control is limited to a zone in which the speed is equal to or lower than the super-low speed. Therefore, the sensitivity of the rope tester 32 can be easily set optimally as two sensitivities, that is, a first detection sensitivity suitable for the detection of the wire breaking of the rope in the case where the speed exceeds the super-low speed and a second detection sensitivity suitable for the detection of the pitch of the strand in the case where the speed is equal to or lower than the super-low speed. As a result, a high-quality signal can be obtained from the rope tester 32.

[0030] On the other hand, as second switching timing, a point at which the speed control is switched to the position control as a result of the movement of the elevator toward the landing is considered. Specifically, a zone in which the position control is performed corresponds to a "switched running state" in which the running control using the signal of the detection signal is performed. In the case where the switching control described above is performed, the magnetic-pole position estimating control is used only for the speed control, whereas the running control using the signal of the rope tester 32 is used only for the position control. As a result, a control system is simplified to obtain an easily realizable control configuration.

[0031] In the case where the switching control is performed at the second switching timing, the sensitivity of the rope tester 32 are set optimally as two sensitivities, that is, a first detection sensitivity suitable for the detection of the wire breaking of the rope at the time when the speed control is performed and a second detection speed suitable for the detection of the pitch of the strand at the

time when the position control is performed.

[0032] The case where the rope tester 32 is used is described above as an example of the detection section for detecting the speed or the position of the car in the control zone in which the accuracy or reliability obtained by the magnetic-pole position estimating control is insufficient in the elevator device using the magnetic-pole position estimating control. On the other hand, when the encoder 31 is used as the detection section, the rope tester 32 is not required although the wire breaking cannot be detected. Therefore, the space can be reduced. In addition, cost can be reduced as compared with the case where the rope tester 32 is used. The encoder described above can be provided to the governor 6 or can be provided to the outer side of the hoisting machine 11 as a contact type one.

[0033] In Embodiment 1 described above, the case where the control is switched from the running control using the magnetic-pole position estimating control method to the running control performed based on the results of detection by the detector in the predetermined switched running state has been described. Even during the execution of the running control using one of the methods, however, the speed or the position can be detected by the other method. Therefore, during the execution of the control using any of the methods, the control section 20 constantly monitors a difference between the results of detection (difference in detected speed or difference in detected position) respectively obtained by the control methods. When the difference becomes equal to or larger than a predetermined allowable difference, the occurrence of a control abnormality can be determined.

[0034] As described above, according to Embodiment 1, the control section for determining whether or not the car is in the switched running state according to the running speed of the car or the current position of the moving car to perform switching between the running control using the magnetic-pole position estimating control method and the running control performed based on the results of detection by the detector provided outside the hoisting machine is provided. In the super-low speed operation state or the like in which high landing accuracy cannot be obtained only by the magnetic-pole position estimating method, the control is switched to the running control using the detector. As a result, high landing accuracy can be obtained. Accordingly, the elevator device using the magnetic-pole position estimating control, which is capable of realizing high landing accuracy even in the super-low speed operation state or the like, can be realized.

Reference Signs List

[0035] 10 driving mechanism section, 11 hoisting machine, 12 car, 13 counterweight, 14 rope, 15 deflector sheave, 16 governor, 20 control section, 30 state detecting section, 31 encoder, 32 rope tester, 33 door-position detecting section, 34 landing plate

Claims

1. An elevator device using a magnetic-pole position estimating method, for estimating a magnetic-pole position by using an induced voltage generated by rotation of a motor of a hoisting machine to perform running control on a car driven by the rotation of the hoisting machine, the elevator device comprising:
 - a detector provided outside the hoisting machine, for detecting a position or a speed of the car; and
 - a control section for determining whether or not the car is in a switched running state according to a running speed of the car or a current position of the moving car, for performing the running control on the car by using the magnetic-pole position estimating control method when it is determined that the car is not in the switched running state, and for performing the running control on the car based on results of detection by the detector when it is determined that the car is in the switched running state.
2. An elevator device according to claim 1, wherein the control section compares a detected position and a detected speed used for the running control using the magnetic-pole position estimating control method and a detected position and a detected speed used for the running control performed based on the results of the detection by the detector with each other regardless of an employed control method, and detects a control abnormality when a difference in detected position and a difference in detected speed exceed a predetermined allowable position difference and a predetermined allowable speed difference, respectively.
3. An elevator device according to claim 1 or 2, wherein the control section determines that the car is not in the switched running state to perform the running control using the magnetic-pole position estimating method when the running control on the car is in a speed control state and determines that the car is in the switched running state to perform the running control performed based on the results of the detection by the detector when the running control on the car is in a position control state.
4. An elevator device according to claim 1 or 2, wherein the control section determines that the car is not in the switched running state to perform the running control using the magnetic-pole position estimating control method when the running speed of the car exceeds a predetermined super-low speed and determines that the car is in the switched running state to perform the running control based on the results of the detection by the detector when the running

speed of the car is equal to or lower than the predetermined super-low speed.

5. An elevator device according to any one of claims 1 to 4, wherein the detector comprises a detector for detecting a strand of a rope. 5

6. An elevator device according to claim 5, wherein:

the detector has a function of individually setting a first detection sensitivity suitable for detection of wire breaking of the rope and a second detection sensitivity suitable for detection of a pitch of the strand; and 10

the control section detects the wire breaking of the rope based on the first detection sensitivity when the running control using the magnetic-pole position estimating control method is performed and performs the running control based on the second detection sensitivity when the running control based on the results of the detection by the detector is performed. 15
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7. An elevator device according to any one of claims 1 to 4, wherein the detector comprises an encoder provided to a governor. 25

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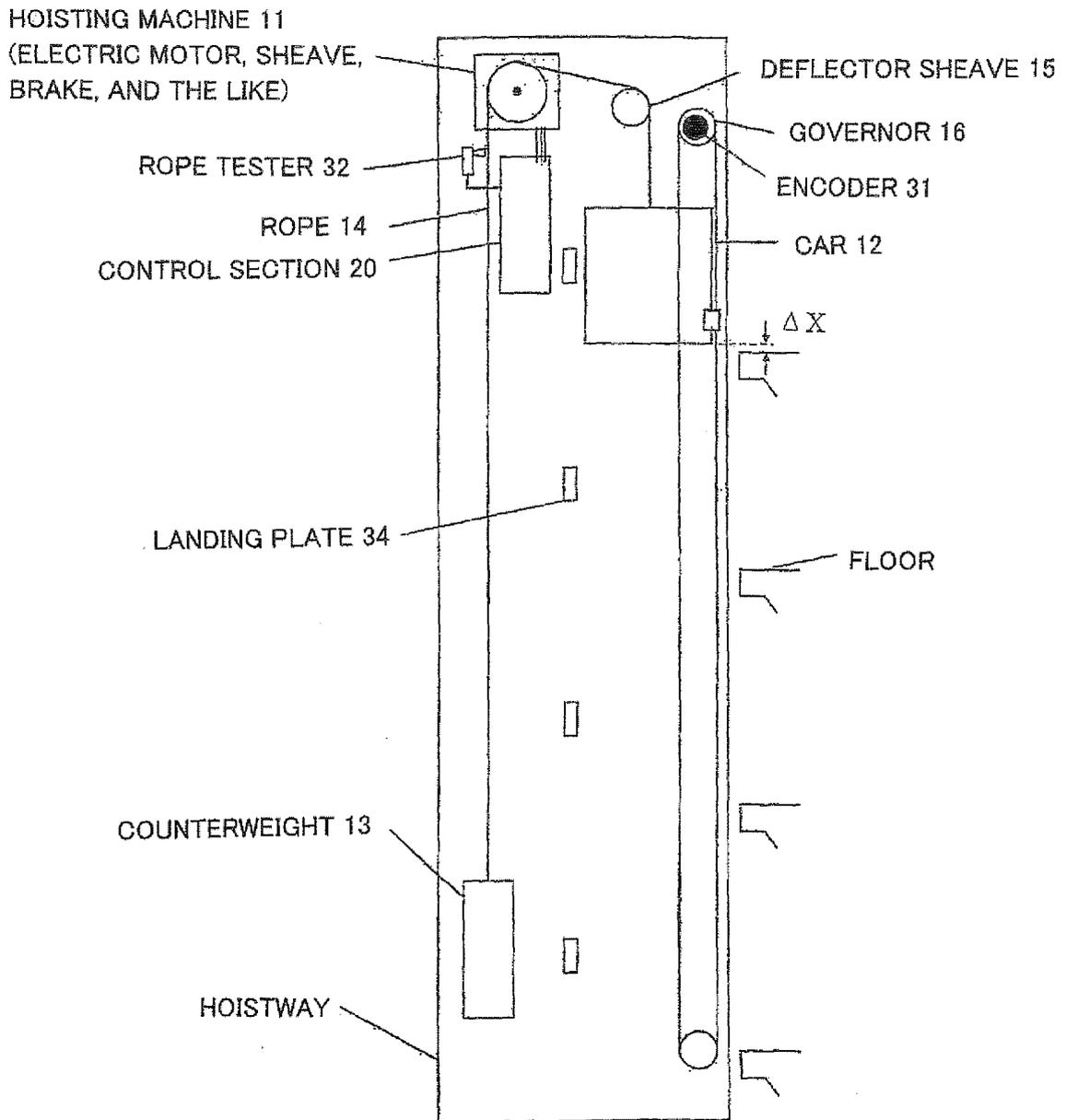


FIG. 1

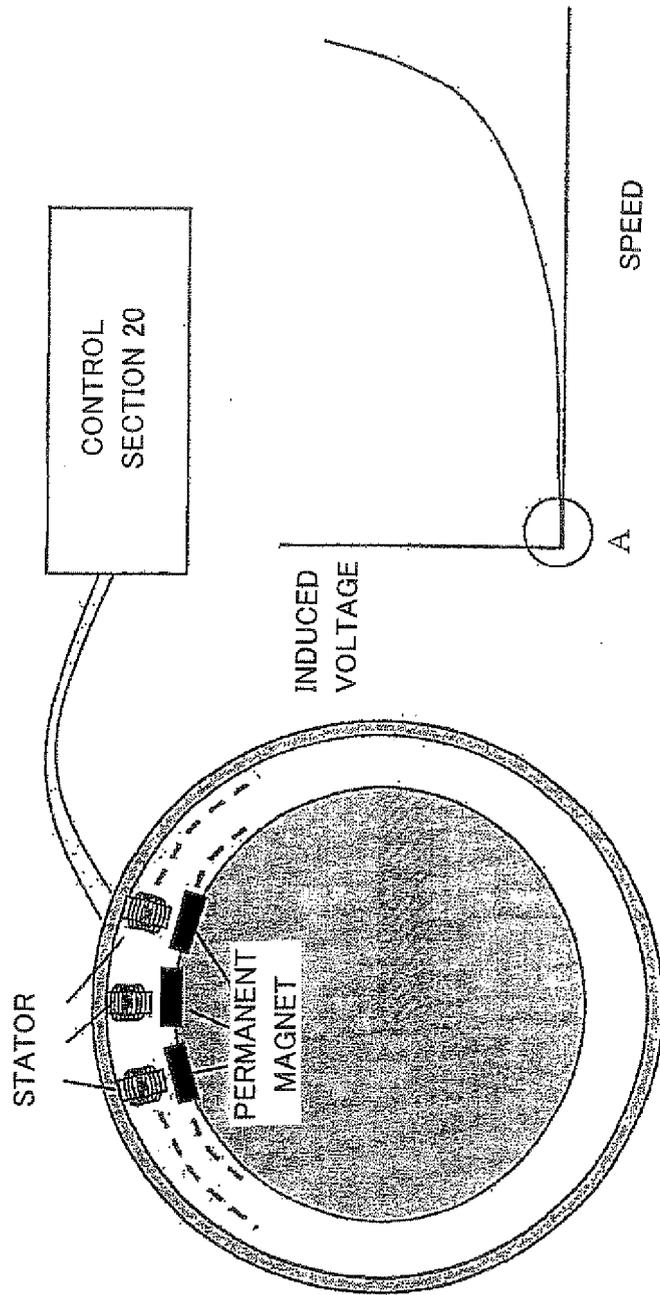


FIG. 2

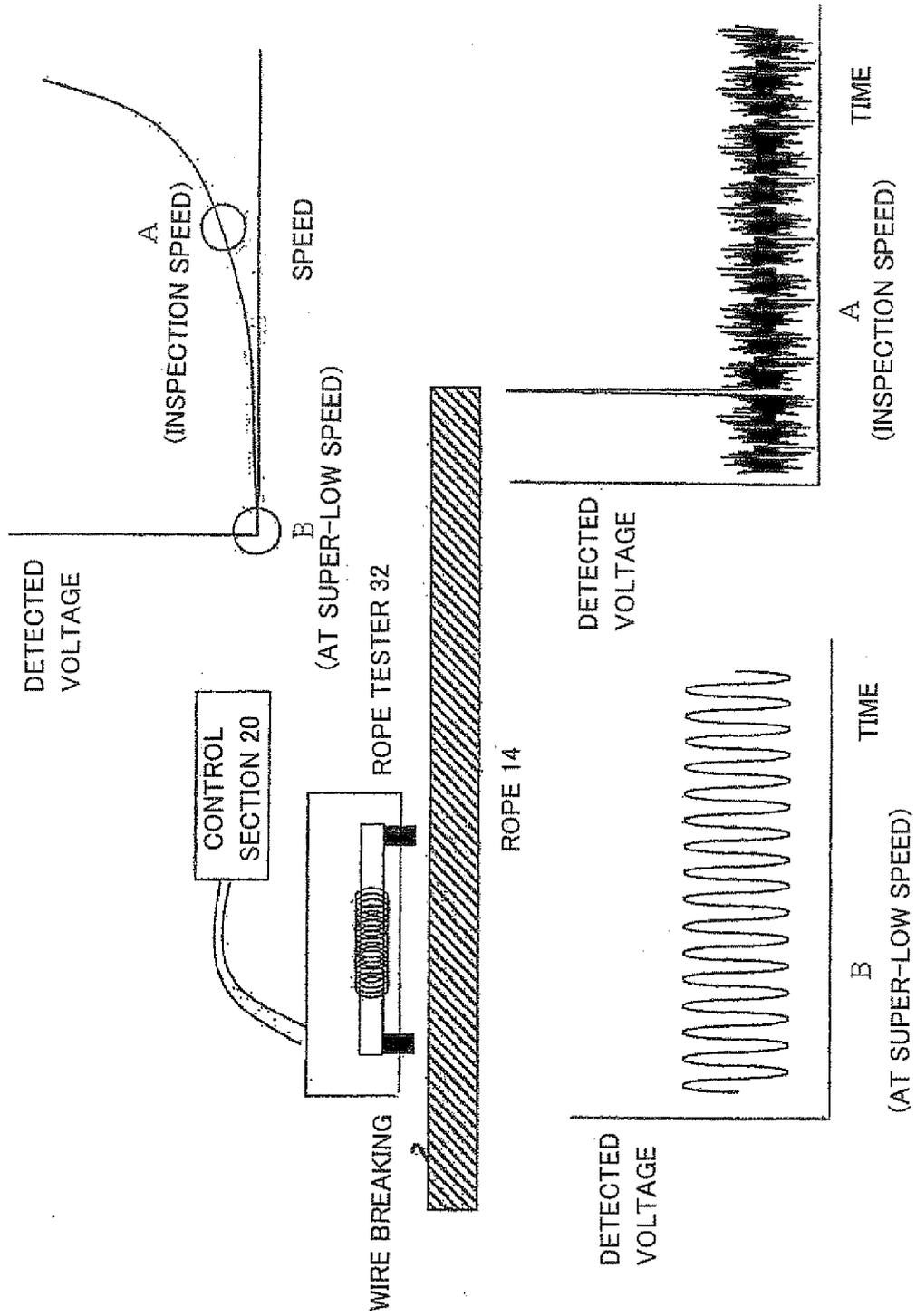
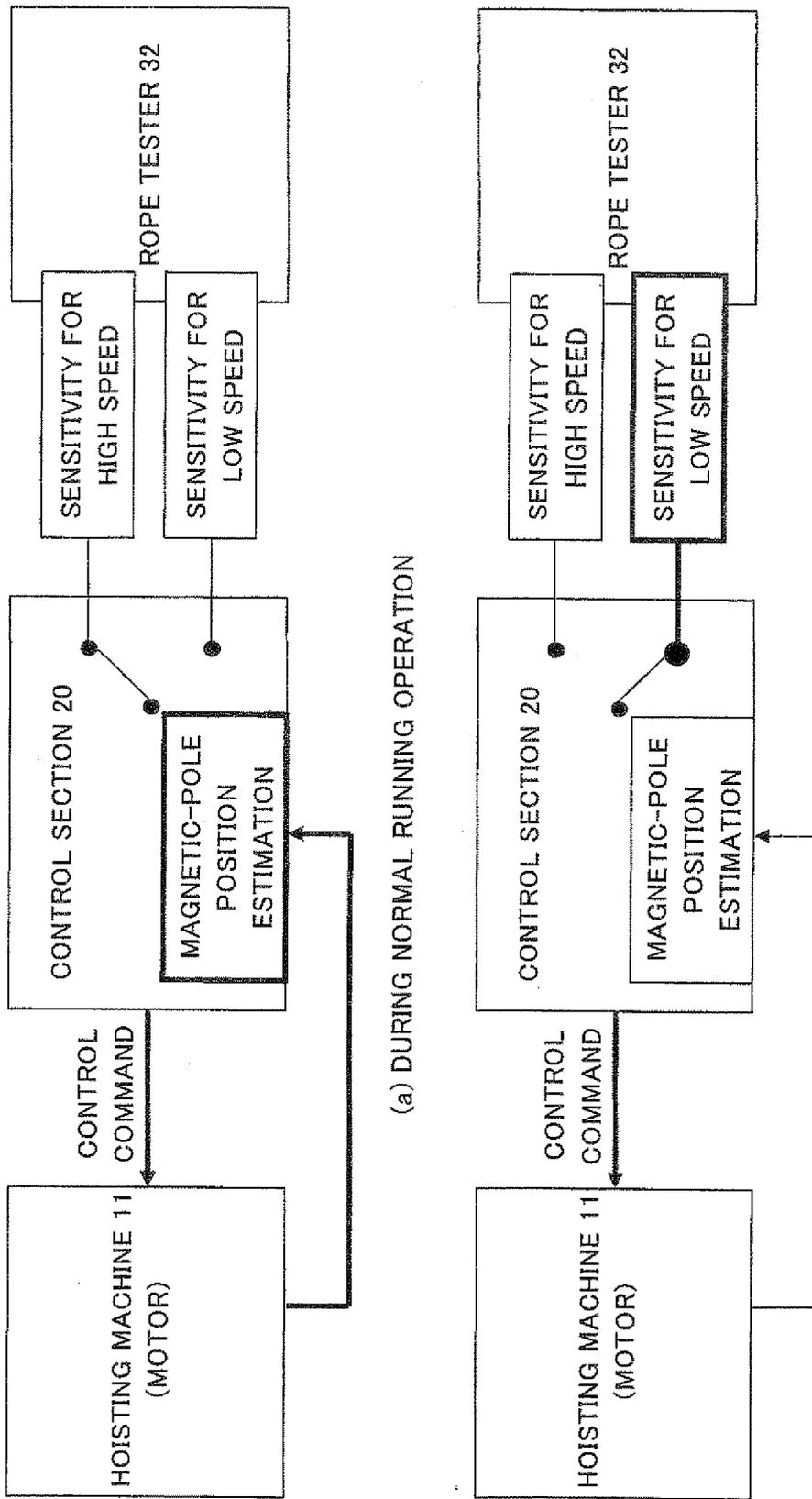


FIG. 3



(a) DURING NORMAL RUNNING OPERATION

(b) DURING (SUPER)LOW-SPEED RUNNING OPERATION

FIG. 4

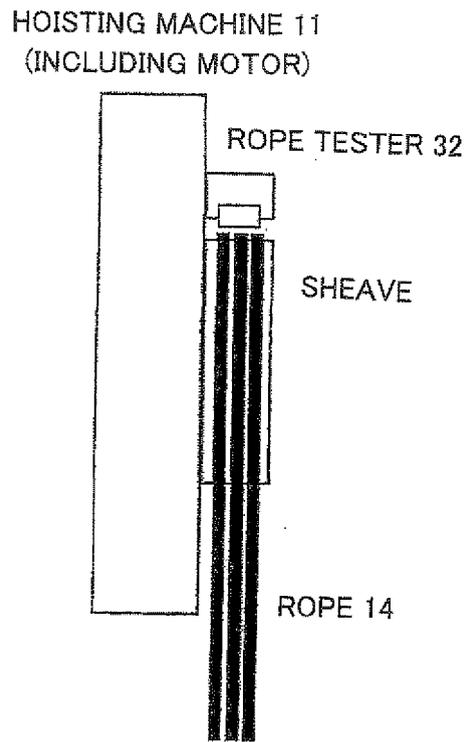


FIG. 5

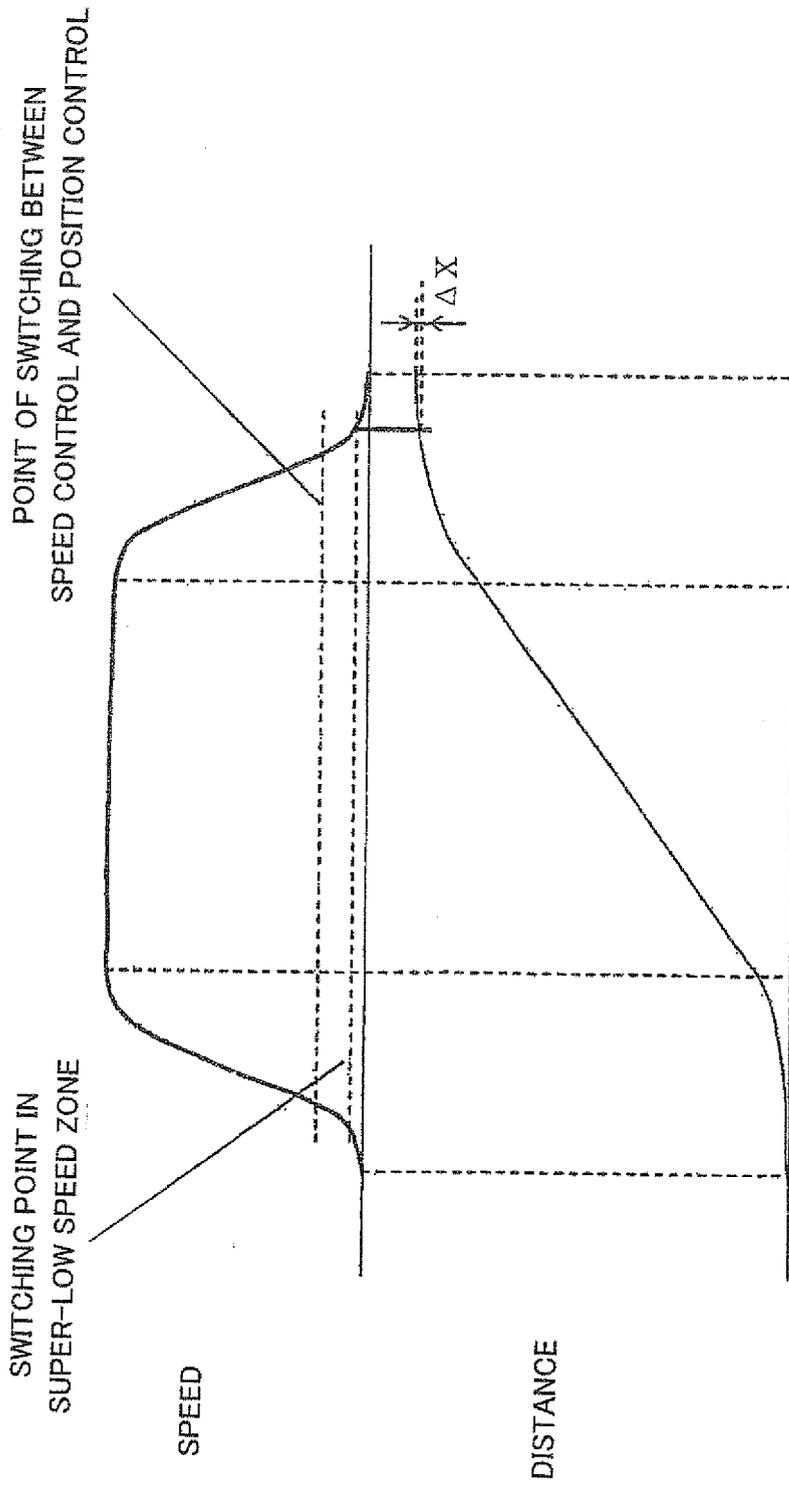


FIG. 6

EP 2 452 908 A1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/062297

<p>A. CLASSIFICATION OF SUBJECT MATTER B66B5/02 (2006.01) i, B66B1/30 (2006.01) i</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																				
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) B66B5/02, B66B1/30</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009 Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>																				
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y A</td> <td>JP 2009-51656 A (Mitsubishi Electric Corp.), 12 March, 2009 (12.03.09), Par. Nos. [0015] to [0058]; Figs. 1 to 4 (Family: none)</td> <td>1-5, 7 6</td> </tr> <tr> <td>Y</td> <td>JP 59-31274 A (Tokyo Shibaura Electric Co., Ltd.), 20 February, 1984 (20.02.84), Page 3, upper left column, line 8 to lower right column, line 9; Fig. 3 (Family: none)</td> <td>1-5, 7</td> </tr> <tr> <td>Y</td> <td>WO 2005/115902 A1 (Mitsubishi Electric Corp.), 08 December, 2005 (08.12.05), Page 45, lines 8 to 27 & US 2008/0190710 A1 & EP 1749780 A1 & CA 2547002 A & CN 1845868 A</td> <td>2-5, 7</td> </tr> </tbody> </table> <p><input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p> <p>* 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 application or patent 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 "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "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</p> <table border="1"> <tr> <td>Date of the actual completion of the international search 04 September, 2009 (04.09.09)</td> <td>Date of mailing of the international search report 15 September, 2009 (15.09.09)</td> </tr> <tr> <td>Name and mailing address of the ISA/ Japanese Patent Office</td> <td>Authorized officer</td> </tr> <tr> <td>Facsimile No.</td> <td>Telephone No.</td> </tr> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y A	JP 2009-51656 A (Mitsubishi Electric Corp.), 12 March, 2009 (12.03.09), Par. Nos. [0015] to [0058]; Figs. 1 to 4 (Family: none)	1-5, 7 6	Y	JP 59-31274 A (Tokyo Shibaura Electric Co., Ltd.), 20 February, 1984 (20.02.84), Page 3, upper left column, line 8 to lower right column, line 9; Fig. 3 (Family: none)	1-5, 7	Y	WO 2005/115902 A1 (Mitsubishi Electric Corp.), 08 December, 2005 (08.12.05), Page 45, lines 8 to 27 & US 2008/0190710 A1 & EP 1749780 A1 & CA 2547002 A & CN 1845868 A	2-5, 7	Date of the actual completion of the international search 04 September, 2009 (04.09.09)	Date of mailing of the international search report 15 September, 2009 (15.09.09)	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	Facsimile No.	Telephone No.
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Y A	JP 2009-51656 A (Mitsubishi Electric Corp.), 12 March, 2009 (12.03.09), Par. Nos. [0015] to [0058]; Figs. 1 to 4 (Family: none)	1-5, 7 6																		
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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2009/062297
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 59-650 A (Hitachi, Ltd.), 05 January, 1984 (05.01.84), All pages; all drawings (Family: none)	6

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REFERENCES CITED IN THE DESCRIPTION

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