



(12) **EUROPEAN PATENT APPLICATION**
 published in accordance with Art. 153(4) EPC

(43) Date of publication:
02.07.2008 Bulletin 2008/27

(51) Int Cl.:
B66B 1/32 (2006.01) B66B 5/02 (2006.01)
B66B 11/08 (2006.01)

(21) Application number: **05793494.5**

(86) International application number:
PCT/JP2005/019044

(22) Date of filing: **17.10.2005**

(87) International publication number:
WO 2007/046129 (26.04.2007 Gazette 2007/17)

(84) Designated Contracting States:
DE

(72) Inventor: **SHIBATA, Masunori**
Tokyo 100-8310 (JP)

(71) Applicant: **MITSUBISHI DENKI KABUSHIKI KAISHA**
Chiyoda-ku
Tokyo 100-8310 (JP)

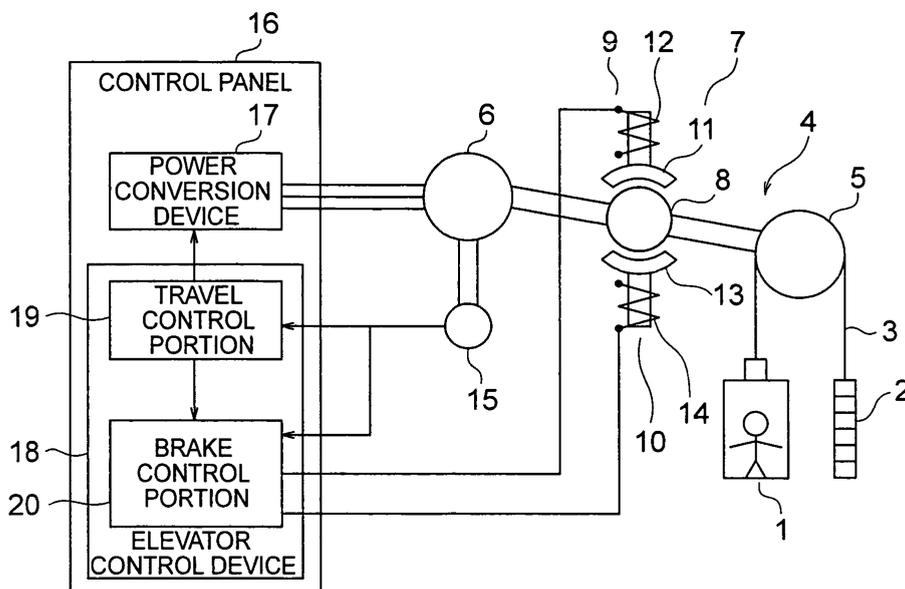
(74) Representative: **Siegert, Georg**
Hoffmann - Eitle
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **ELEVATOR DEVICE**

(57) In an elevator apparatus, running of a car is braked by a first brake device and a second brake device. Operations of the first brake device and the second brake device are controlled by a brake control portion. When a sudden stop command to make a sudden stop of the car

is issued, the brake control portion first causes the first brake device to perform braking operation. When the deceleration of the car is equal to or smaller than a predetermined value after a lapse of a predetermined time, the brake control portion causes the second brake device to perform braking operation.

FIG. 1



Description

Brief Description of the Drawings

Technical Field

[0007]

[0001] The present invention relates to an elevator apparatus having a first brake device and a second brake device for braking running of a car.

5 Fig. 1 is a schematic diagram showing an elevator apparatus according to Embodiment 1 of the present invention.

Background Art

Fig. 2 is a circuit diagram showing a control circuit of each of a first brake device and a second brake device of Fig. 1.

[0002] In a conventional elevator apparatus, a hoisting machine is provided with a plurality of brake devices for stopping a car as an emergency measure. When an emergency stop signal is generated during power running operation, an emergency stop torque TS required for stopping the car within a remaining distance from a current position of the car to a terminal floor located in front of the car in a traveling direction thereof, and a rest retaining torque TL required for retaining the car at rest are calculated. The larger one of TS and TL is then selected as a required braking torque T. This required braking torque T is generated by a minimum number of the braking devices, so the car is stopped as an emergency measure (e.g., see Patent Document 1).

10 Fig. 3 is a flowchart showing an operation of a brake control portion of Fig. 1.

Fig. 4 is a timing chart showing a relationship among a speed of a car, an acceleration of the car, a state of a first contact, and a state of a second contact in an event of an issuance of a sudden stop command during regenerative operation of the elevator apparatus of Fig. 1.

15 Fig. 5 is a timing chart showing a relationship among a speed of the car, an acceleration of the car, a state of the first contact, and a state of the second contact in the event of the issuance of the sudden stop command during power running operation of the elevator apparatus of Fig. 1.

[0003] Patent Document 1: JP 2001-278572 A

20 Fig. 6 is a timing chart showing a relationship among a speed of the car, an acceleration of the car, a state of the first contact, and a state of the second contact in the event of the issuance of an emergency stop command in the elevator apparatus of Fig. 1.

Disclosure of the Invention

Problem to be solved by the Invention

30

Best Mode for carrying out the Invention

[0004] In the conventional elevator apparatus as described above, however, calculation processings performed therein and a system configuration thereof are complicated.

[0005] The present invention has been made to solve the above-mentioned problem, and it is therefore an object of the present invention to obtain an elevator apparatus in which it is possible to prevent occurrence of an excessive deceleration upon an issuance of a sudden stop command with a simple construction.

35 **[0008]** A preferred embodiment of the present invention will be described hereinafter with reference to the drawings.

Embodiment 1

Means for solving the Problem

[0006] According to the present invention, an elevator apparatus includes: a car; a first brake device and a second brake device for braking running of the car; and a brake control portion for controlling operations of the first brake device and the second brake device. In the elevator apparatus, the brake control portion first causes the first brake device to perform braking operation when a sudden stop command for making a sudden stop of the car is issued, and the brake control portion causes the second brake device to perform braking operation when a deceleration of the car is equal to or smaller than a predetermined value after a lapse of a predetermined time.

40 **[0009]** Fig. 1 is a schematic diagram showing an elevator apparatus according to Embodiment 1 of the present invention. A car 1 and a counterweight 2, which are suspended within a hoistway by means of a main rope 3, are raised/lowered within the hoistway due to a driving force of a hoisting machine 4. The hoisting machine 4 has a drive sheave 5 around which the main rope 3 is looped, a motor 6 for rotating the drive sheave 5, and braking means 7 for braking rotation of the drive sheave 5.

45 **[0010]** The braking means 7 has a brake pulley 8 rotated integrally with the drive sheave 5, a first brake device 9 and a second brake device 10 for braking rotation of the brake pulley 8. The first brake device 9 has a first brake shoe 11 to be brought into contact with and away from the brake pulley 8, a first brake spring (not shown) for pressing the first brake shoe 11 against the brake pulley 8, and a first brake release coil 12 for causing the first brake shoe 11 to be spaced away from the brake pulley 8 against the first brake spring.

[0011] The second brake device 10 has a second brake shoe 13 to be brought into contact with and away from the brake pulley 8, a second brake spring (not shown) for pressing the second brake shoe 13 against the brake pulley 8, and a second brake release coil 14 for causing the second brake shoe 13 to be spaced away from the brake pulley 8 against the second brake spring.

[0012] The motor 6 is provided with a speed detector 15 for generating a signal corresponding to a rotational speed of a rotary shaft of the motor 6, namely, a rotational speed of the drive sheave 5. For example, an encoder is employed as the speed detector 15.

[0013] A control panel 16 is provided with a power conversion device 17 such as an inverter for supplying power to the motor 6, and an elevator control device 18. The elevator control device 18 has a travel control portion 19 and a brake control portion 20. The travel control portion 19 controls the power conversion device 17 and the brake control portion 20 in response to a signal from the speed detector 15. The brake control portion 20 controls the first brake device 9 and the second brake device 10 in response to a command from the travel control portion 19 and a signal from the speed detector 15.

[0014] More specifically, when the car 1 is stopped at a stop floor during normal operation, the brake control portion 20 causes the first brake device 9 and the second brake device 10 to perform braking operation to retain the car 1 at rest. When a command to make a sudden stop of the car 1 is issued, the brake devices 9 and 10 first cause the first brake device 9 to perform the braking operation. When a deceleration (absolute value of a negative acceleration) of the car 1 after a lapse of a predetermined time is equal to or smaller than a predetermined value, the brake devices 9 and 10 cause the second brake device 10 to perform the braking operation.

[0015] In addition, when an emergency stop command, which has a higher degree of urgency than the sudden stop command, is issued, the brake control portion 20 immediately causes both the first brake device 9 and the second brake device 10 to perform braking operation. The sudden stop command and the emergency stop command are issued by a safety monitoring device for monitoring the safety of the elevator apparatus or the like, and input to the brake control portion 20.

[0016] The sudden stop command is issued when the speed detector 15 has broken down, when the power conversion device 17 has broken down, or when an excessive speed or the like of the car 1 has been detected. That is, the sudden stop command is issued when the motor 6 cannot be controlled but the brake devices 9 and 10 can be controlled. Accordingly, when the sudden stop command is issued, the power supplied to the motor 6 is swiftly shut off. The emergency stop command is issued when, for example, the car 1 has reached a terminal end of the hoistway.

[0017] The elevator control device 18 is constituted by a computer having a calculation processing portion (CPU), a storage portion (a ROM, a RAM, a hard disk,

and the like), and signal input/output portions. The functions of the travel control portion 19 and the brake control portion 20 are realized by the computer. That is, programs for realizing the functions of the travel control portion 19 and the brake control portion 20 are stored in the storage portion of the computer.

[0018] Fig. 2 is a circuit diagram showing a control circuit of the first brake device 9 and the second brake device 10 of Fig. 1. The first brake release coil 12 and the second brake release coil 14 are connected in parallel with each other with respect to a power supply 21. A first contact 22 is connected in series to the first brake release coil 12. When the first contact 22 is closed, power is supplied to the first brake release coil 12, so the first brake device 9 is released. When the first contact 22 is opened, the power supplied to the first brake release coil 12 is shut off, so the first brake device 9 performs braking operation.

[0019] A second contact 23 is connected in series to the second brake release coil 14. When the second contact 23 is closed, power is supplied to the second brake release coil 14, so the second brake device 10 is released. When the second contact 23 is opened, the power supplied to the second brake release coil 14 is shut off, so the second brake device 10 performs braking operation.

[0020] A first diode 24 and a first electrical resistor 25 are connected in parallel to the first brake release coil 12. A circuit composed of the first diode 24 and the first electrical resistor 25 protects the brake control portion 20 from a back electromotive force generated in the first brake release coil 12 upon the opening of the first contact 22.

[0021] A second diode 26 and a second electrical resistor 27 are connected in parallel to the second brake release coil 14. A circuit composed of the second diode 26 and the second electrical resistor 27 protects the brake control portion 20 from a back electromotive force generated in the second brake release coil 14 upon the opening of the second contact 23.

[0022] Next, an operation will be described. Fig. 3 is a flowchart showing an operation of the brake control portion 20 of Fig. 1. The brake control portion 20 repeatedly performs an operation shown in Fig. 3 on a predetermined cycle.

[0023] The brake control portion 20 monitors whether or not the car 1 is stopped (step S1), whether or not an emergency stop command has been issued (step S2), and whether or not a sudden stop command has been issued (step S3). When the car 1 is stopped, the brake control portion 20 sets a counter value to 0 (step S4). When the emergency stop command has been issued, the brake control portion 20 outputs a command to turn the first contact 22 and the second contact 23 off (step S5). When the car 1 is running and neither the emergency stop command nor the sudden stop command has been issued, the brake control portion 20 terminates the current round of processings. That is, the brake control por-

tion 20 allows the car 1 to keep running.

[0024] When the car 1 is running, the emergency stop command has not been issued, and the sudden stop command has been issued, the brake control portion 20 outputs a command to turn the first contact 22 off (step S6), and applies 1 to the counter value (step S7). After that, the brake control portion 20 determines whether or not the counter value has reached a set value $t1$ that has been set in advance, namely, whether or not a predetermined time has elapsed after the outputting of the command to turn the first contact 22 off in response to the sudden stop command (step S8). When the counter value has not reached the set value $t1$ ($cnt < t1$), the brake control portion 20 terminates the current round of the processings.

[0025] When the counter value has reached the set value $t1$ ($cnt \geq t1$), the brake control portion 20 determines whether or not the acceleration of the car 1 is equal to or larger than a threshold αL (step S9). In other words, the brake control portion 20 determines whether or not the deceleration of the car 1 is equal to or smaller than a predetermined value. The acceleration of the car 1 can be calculated by subjecting a speed calculated based on a signal from the speed detector 15 to a differential processing or a bypass filter processing.

[0026] When the acceleration of the car 1 is smaller than the threshold αL (acceleration $< \alpha L$), the brake control portion 20 terminates the current round of the processing. That is, the brake control portion 20 continues the monitoring operation while holding the first contact 22 open and the second contact 23 closed. When the acceleration of the car 1 is equal to or larger than the threshold αL , namely, when the deceleration of the car 1 is equal to or smaller than the predetermined value, the brake control portion 20 outputs a command to turn the second contact 23 off (step S10).

[0027] Fig. 4 is a timing chart showing a relationship among the speed of the car, the acceleration of the car, the state of the first contact 22, and the state of the second contact 23 in the event of the issuance of a sudden stop command during regenerative operation of the elevator apparatus of Fig. 1. The speed is indicated on the assumption that the traveling direction of the car 1 is positive. During regenerative operation of the elevator apparatus, a gravitational acceleration acts in such a direction that the car 1 cannot be stopped with ease, as in a case where the car 1 is being raised with no load applied thereto or a case where the car 1 is being lowered in a packed state.

[0028] When a sudden stop command is issued at a time point $t0$, the first contact 22 is opened immediately. The power supplied to the motor 6 is shut off at this moment, so the speed of the car 1 is instantaneously increased due to the gravitational acceleration before actual generation of a braking force by the first brake device 9. However, when the first brake shoe 11 is pressed against the brake pulley 8 to generate the braking force, the car 1 starts decelerating.

[0029] After that, since the acceleration of the car 1 is equal to or larger than the threshold αL at a time point $t1$, the second contact 23 is opened, and a braking force generated by the second brake device 10 is also applied. As described above, the car 1 cannot be stopped with ease during regenerative operation, so the deceleration of the car 1 does not become excessive even when both the first brake device 9 and the second brake device 10 are caused to perform braking operation.

[0030] Fig. 5 is a timing chart showing a relationship among the speed of the car, the acceleration of the car, the state of the first contact 22, and the state of the second contact 23 in the event of the issuance of a sudden stop command during power running operation of the elevator apparatus of Fig. 1. During power running operation of the elevator apparatus, the gravitational acceleration acts in such a direction that the car 1 can be stopped with ease, as in a case where the car 1 is being lowered with no load applied thereto or a case where the car 1 is being raised in a packed state.

[0031] When a sudden stop command is issued at the time point $t0$, the first contact 22 is opened immediately. The power supplied to the motor 6 is shut off at this moment, so the car 1 starts decelerating due to the gravitational acceleration. After that, when the first brake shoe 11 is pressed against the brake pulley 8 to generate a braking force, the deceleration of the car 1 further increases.

[0032] The acceleration of the car 1 is smaller than the threshold αL at the time point $t1$, so the monitoring of the acceleration is continuously performed. When the acceleration of the car 1 has become equal to or larger than the threshold αL at a time point $t2$, the second contact 23 is opened, and a braking force generated by the second brake device 10 is also applied.

[0033] During power running operation, the elevator apparatus is operated in such a direction that the car 1 can be stopped with ease. It is therefore possible to prevent the deceleration of the car 1 from becoming excessive and alleviate a feeling of discomfort of passengers within the car 1 by monitoring the acceleration of the car 1 and decelerating the car 1 mainly with the aid of only the braking force generated by the first brake device 9. Further, the braking force generated by the second brake device 10 is applied when the car 1 has decelerated sufficiently. In stopping the car 1 completely, therefore, the first brake 9 and the second brake 10 can bring the car 1 to a halt more reliably. That is, the elevator apparatus according to Embodiment 1 can prevent the deceleration of the car 1 from becoming excessive in the event of issuance of a sudden stop command with a simple configuration.

[0034] In a case where a resin-coated rope having an outer periphery portion coated with resin is employed as the main rope 3, a large frictional force acts between the main rope 3 and the drive sheave 5. Therefore, when the deceleration of the car 1 becomes excessive, the main rope 3 slips and the resin thereof may be damaged. How-

ever, according to the configuration of Embodiment 1, no excessive deceleration is generated, so the resin is prevented from being damaged.

[0035] Fig. 6 is a timing chart showing a relationship among the speed of the car 1, the acceleration of the car 1, the state of the first contact 22, and the state of the second contact 23 in the event of the issuance of an emergency stop command in the elevator apparatus of Fig. 1. When the emergency stop command is issued at the time point t1, the first contact 22 and the second contact 23 are opened simultaneously and immediately. Braking forces are thereby simultaneously generated by the first brake device 9 and the second brake device 10, so the car 1 is stopped swiftly.

[0036] For example, when the car 1 has reached the terminal end of the hoistway, the first brake device 9 and the second brake device 10 are caused to perform braking operation simultaneously. As a result, the car 1 can be stopped under a smaller impact than in a case where the car 1 has collided with a shock absorber (not shown) installed at the terminal end.

[0037] In the foregoing example, the acceleration of the car 1 is calculated from an output of the speed detector 15 provided on the hoisting machine 4. However, the acceleration of the car may be calculated from an output of a speed detector provided at another location, for example, on a speed governor or the car.

Further, in the foregoing example, the brake control portion 20 is provided to perform some of the functions of the elevator control device 18. However, the brake control portion 20 may be provided on another device, for example, the safety monitoring device for monitoring the safety of the elevator device.

Further, the brake control portion may be configured as a device independent of the elevator control device and the safety monitoring device.

Still further, the function of the brake control portion can also be realized by an electrical circuit for processing analog signals.

Further, in the foregoing example, the hoisting machine 4 is provided with the first brake device 9 and the second brake device 10. However, the first brake device 9 and the second brake device 10 may be provided at another location. That is, the first brake device 9 and the second brake device 10 may each be designed as, for example, a car brake mounted on the car, a rope brake for gripping the main rope to brake the car, or the like.

Further, the first brake device and the second brake device may be disposed at different locations.

Still further, in the foregoing example, the two brake devices 9 and 10 are employed. However, three or more brake devices may be employed. In this case, the brake devices may be divided into a first group and a second group to perform a control operation similar to that of Embodiment 1 of the present invention.

Claims

1. An elevator apparatus, comprising:
 - a car;
 - a first brake device and a second brake device for braking running of the car; and
 - a brake control portion for controlling operations of the first brake device and the second brake device, wherein:
 - the brake control portion first causes the first brake device to perform braking operation when a sudden stop command for making a sudden stop of the car is issued; and
 - the brake control portion causes the second brake device to perform braking operation when a deceleration of the car is equal to or smaller than a predetermined value after a lapse of a predetermined time.
2. An elevator apparatus according to Claim 1, wherein the brake control portion immediately causes the first brake device and the second brake device to perform braking operation when an emergency stop command, which has a higher degree of urgency than the sudden stop command, is issued.

FIG. 1

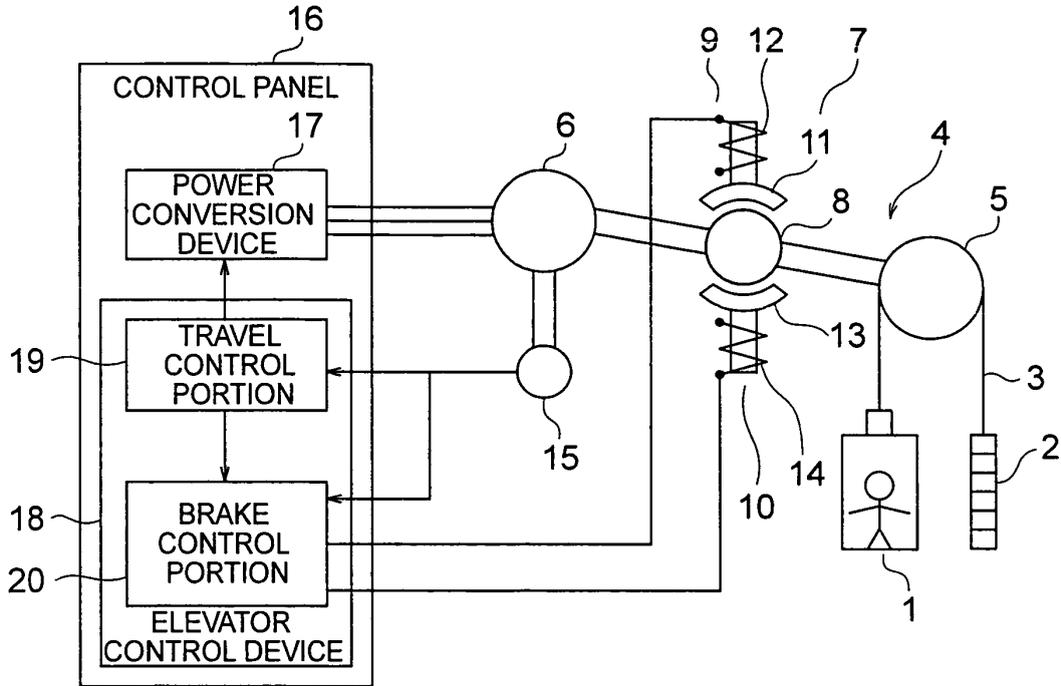


FIG. 2

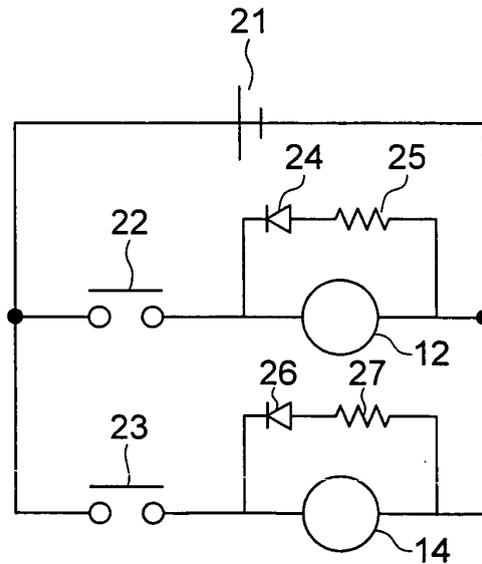


FIG. 3

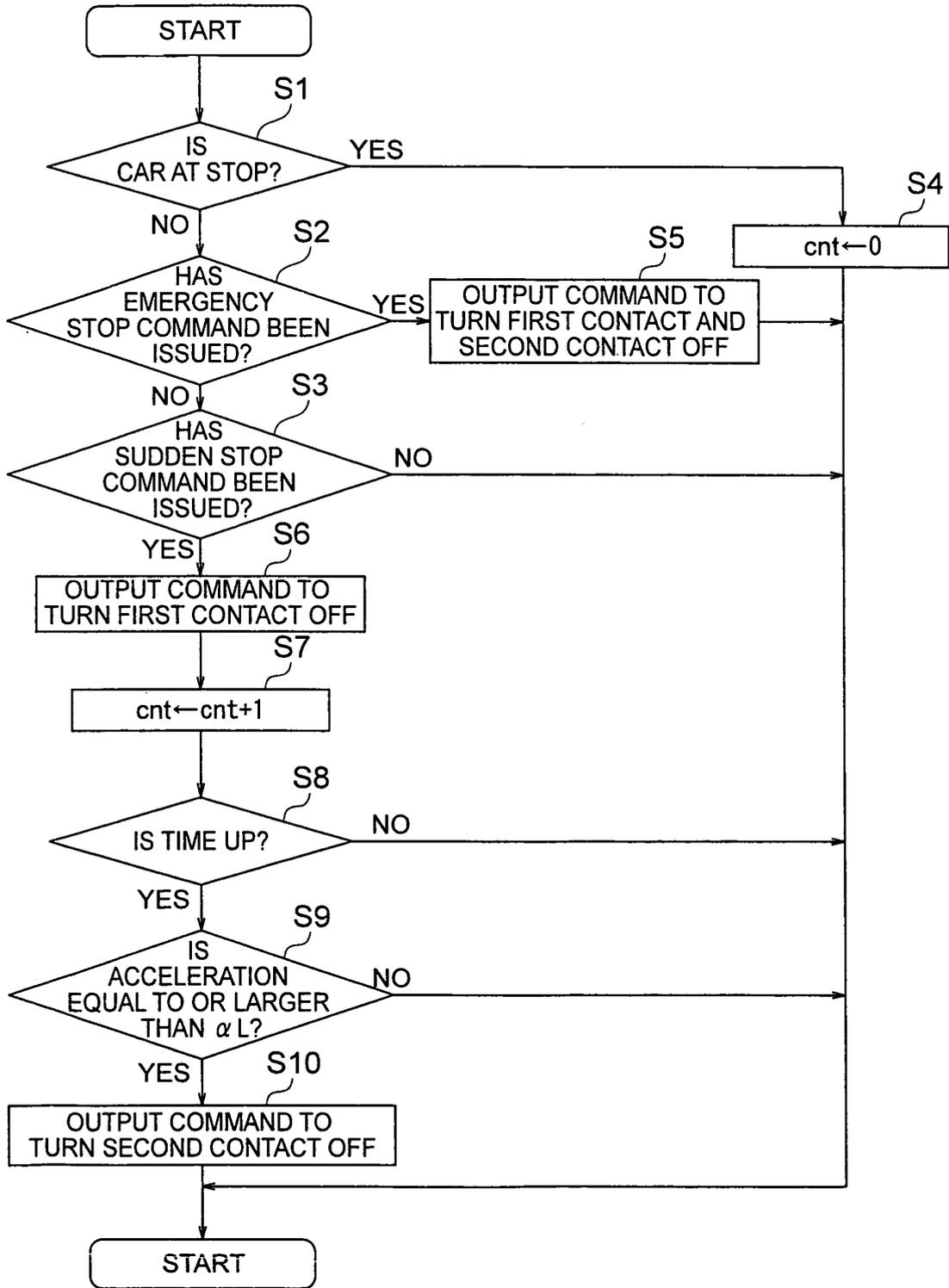


FIG. 4

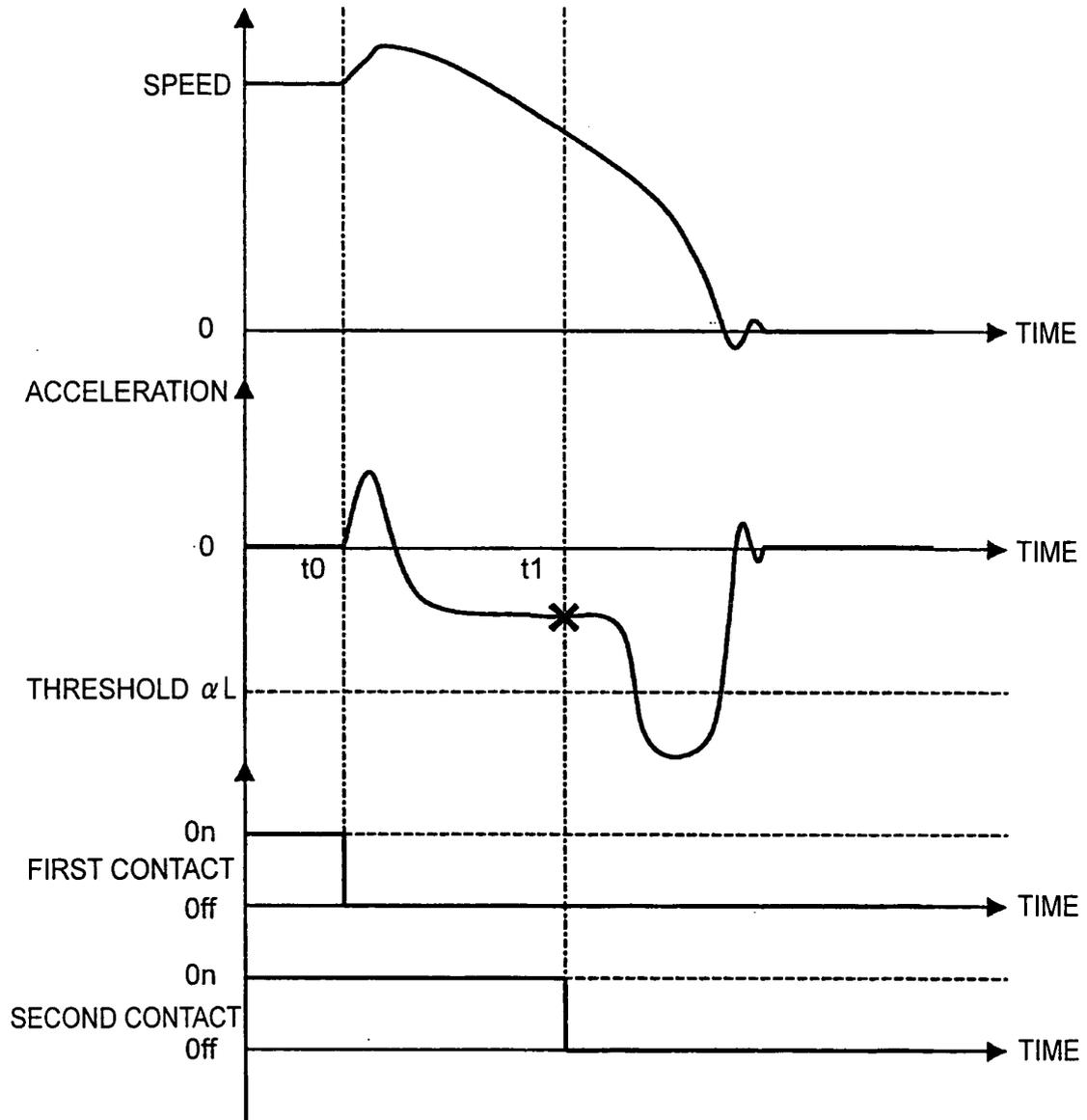


FIG. 5

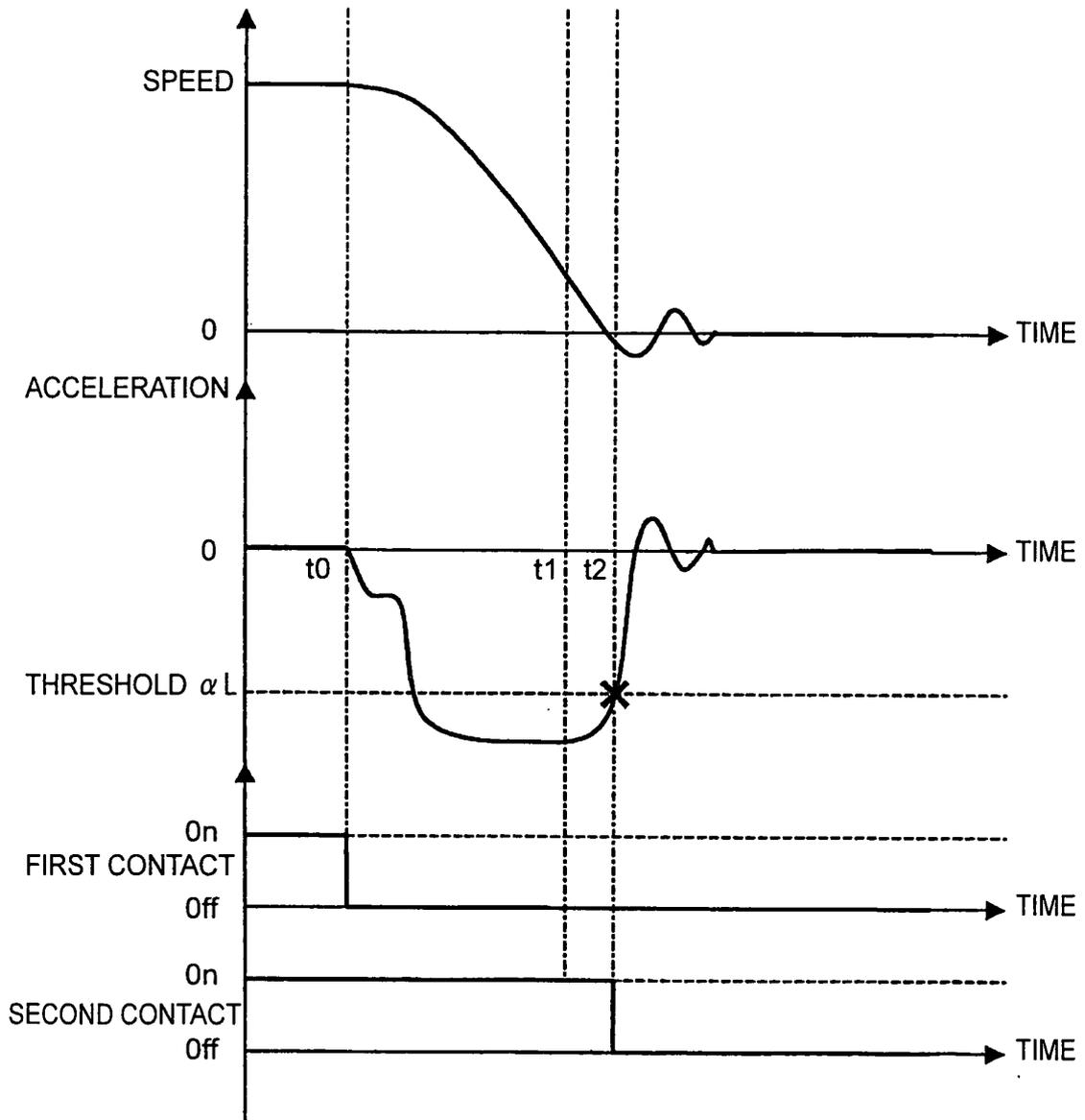
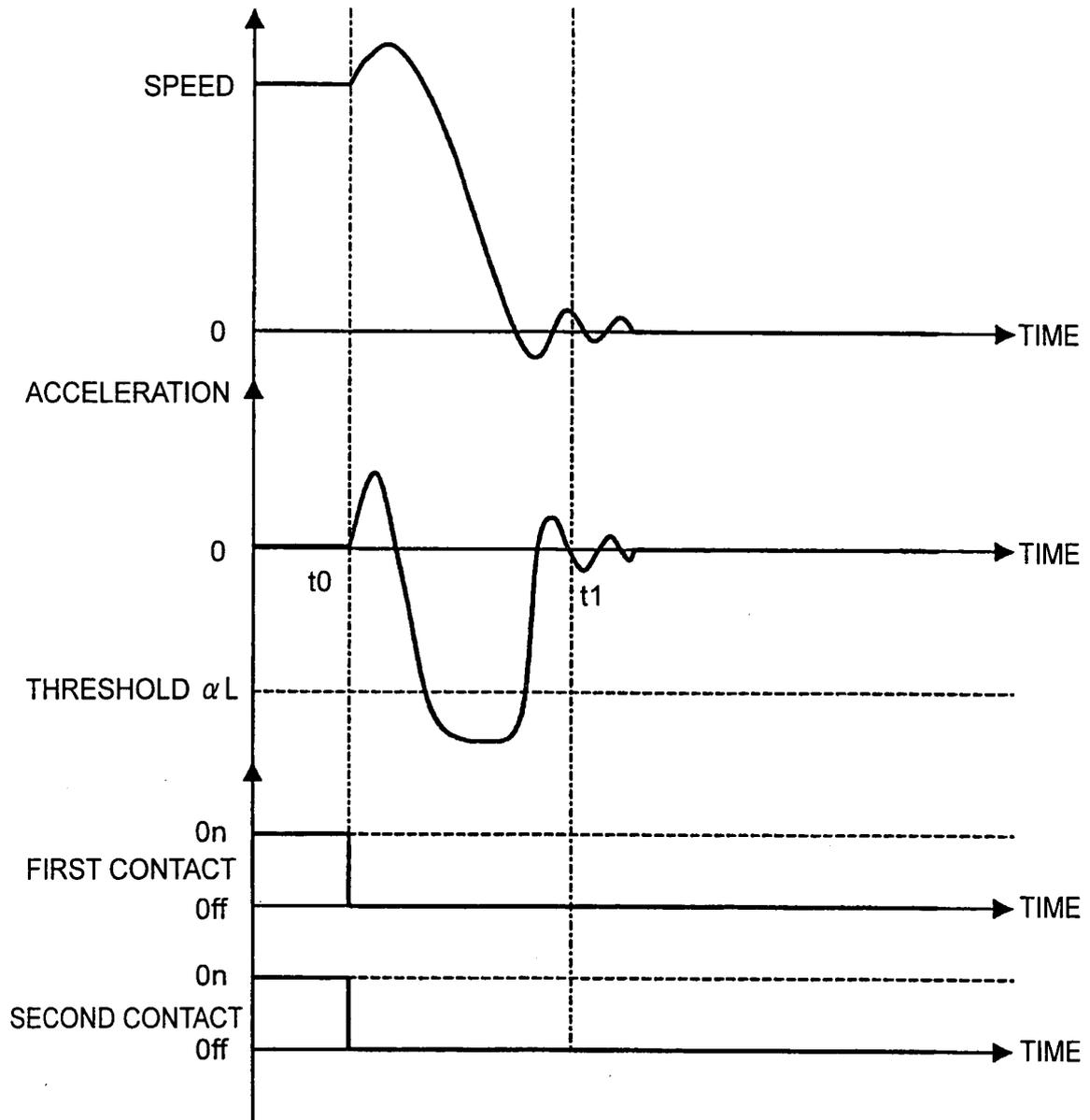


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/019044

A. CLASSIFICATION OF SUBJECT MATTER B66B1/32 (2006.01), B66B5/02 (2006.01), B66B11/08 (2006.01)		
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) B66B1/00 (2006.01) - B66B11/08 (2006.01)		
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 1996-2006 Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006		
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.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 086015/1983 (Laid-open No. 190769/1984) (Mitsubishi Electric Corp.), 18 December, 1984 (18.12.84), (Family: none)	1
A	JP 03-243576 A (Mitsubishi Electric Corp.), 30 October, 1991 (30.10.91), (Family: none)	1-2
A	JP 2001-278572 A (Mitsubishi Electric Corp.), 10 October, 2001 (10.10.01), (Family: none)	2
<input type="checkbox"/> Further documents are listed in the continuation of Box C.		<input type="checkbox"/> 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 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
Date of the actual completion of the international search 13 July, 2006 (13.07.06)		Date of mailing of the international search report 25 July, 2006 (25.07.06)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2001278572 A [0003]