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(54) **BRAKE DEVICE FOR ELEVATOR**

BREMSVORRICHTUNG FÜR AUFZUG

DISPOSITIF DE FREINAGE POUR ASCENSEUR

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(56) References cited:
EP-A1- 1 431 226 EP-A1- 1 544 148
JP-A- 2001 146 366 JP-A- 2003 083 372
JP-A- 2005 126 183 JP-A- 2005 126 183
JP-B2- 07 080 650

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Description

Technical Field

[0001] The present invention relates to a brake device for an elevator for braking the raising/lowering of a car and a counterweight.

Background Art

[0002] Conventionally, there is proposed a brake device for an elevator having a structure in which a disc rotating integrally with a motor shaft is clamped between a plate and an armature so that rotation of the disc is braked. In the conventional brake device, the plate and the armature are provided respectively with shock absorbing materials for abating impact noise during braking (see Patent Document 1).

[0003]

Patent Document 1: JP 2003-184919 A

As a further prior art document, JP 2005-126183 refers to a brake control device for an elevator capable of eliminating the elevator stopping in the inter-floor area, even if a failure is generated in the brake and reducing the rate of occurrence of accidents.

Another brake controller for an elevator is disclosed by EP 1 431 226 A1.

Disclosure of the Invention

Problem to be solved by the Invention

[0004] However, the conventional brake device for the elevator requires the shock absorbing materials for abating impact noise, and hence entails an increase in the cost of manufacturing.

[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 a brake device for an elevator which makes it possible to abate noise generated during braking operation and reduce the cost of manufacturing.

Means for solving the Problem

[0006] A brake device for an elevator according to the present invention includes the features according to independent claim 1.

Brief Description of the Drawings

[0007]

Fig. 1 is a schematic diagram showing an elevator according to Embodiment 1 of the present invention. Fig. 2 is a lateral sectional view showing the brake

device body of Fig. 1.

Fig. 3 is a schematic diagram showing the electromagnet of Fig. 2.

Fig. 4 is a schematic diagram showing the braking device body at a time when each of the first braking body and the second braking body of Fig. 2 is at the braking position.

Fig. 5 is a schematic diagram showing the brake device body at a time when each of the first braking body and the second braking body of Fig. 4 is at the open position.

Fig. 6 is a graphical representation for explaining the operation of the brake device of Fig. 3.

Fig. 7 is a schematic diagram showing the braking device body at a time when the first braking body of Fig. 5 yields.

Fig. 8 is a graphic representation for explaining the operation of a brake device according to Embodiment 2 of the present invention.

Fig. 9 is a graphic representation for explaining the operation of a brake device according to Embodiment 3 of the present invention.

Fig. 10 is a graphic representation for explaining the operation of a brake device according to Embodiment 4 of the present invention.

Fig. 11 is a graphic representation for explaining the operation of a brake device according to Embodiment 5 of the present invention.

Best Modes for carrying out the Invention

[0008] Preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

Embodiment 1

[0009] Fig. 1 is a schematic diagram showing an elevator according to Embodiment 1 of the present invention. Referring to Fig. 1, a car 2 and a counterweight 3 are provided within a hoistway 1 in such a manner that the car 2 and the counterweight 3 can be raised/lowered. A hoisting machine (drive device) 4 for raising/lowering the car 2 and the counterweight 3 is provided in an upper portion of the hoistway 1. The hoisting machine 4 has a hoisting machine body 5, and a drive sheave 6 rotated by the hoisting machine body 5. A plurality of main ropes 7 are looped around the drive sheave 6. The car 2 and the counterweight 3 are suspended within the hoistway 1 by means of the respective main ropes 7. The car 2 and the counterweight 3 are raised/lowered within the hoistway 1 through rotation of the drive sheave 6.

[0010] Rotation of the drive sheave 6 is braked by a brake device 8. The brake device 8 has a brake device body 9 mounted on the hoisting machine body 5, and a brake control device 10 for controlling the operation of the brake device body 9.

[0011] Fig. 2 is a lateral sectional view showing the

brake device body 9 of Fig. 1. Referring to Fig. 2, the hoisting machine body 5 has a motor 11. The motor 11 has a motor shaft 12 rotated integrally with the drive sheave 6.

[0012] A cover plate 13 is fixed to the motor 11 via a plurality of rods 14 disposed parallel to the motor shaft 12. Thus, the cover plate 13 is disposed apart from the motor 11 in an axial direction of the motor shaft 12. The brake device body 9 is disposed between the motor 11 and the cover plate 13.

[0013] The brake device body 9 has a first brake disc (rotating body) 15 and a second brake disc (rotating body) 16, a first braking body 17 and a second braking body 18, a plurality of springs (urging bodies) 19, and an electromagnet 20. The first brake disc 15 and the second brake disc 16 can rotate integrally with the motor shaft 12. Each of the first braking body 17 and the second braking body 18 is displaceable between a braking position at which each of the first braking body 17 and the second braking body 18 is in contact with at least one of the first brake disc 15 and the second brake disc 16, and an open position at which each of the first braking body 17 and the second braking body 18 is spaced apart from the first brake disc 15 and the second brake disc 16. The springs 19 urge each of the first braking body 17 and the second braking body 18 toward the braking position. The electromagnet 20 is designed to displace each of the first braking body 17 and the second braking body 18 to the open position against urging forces of the respective springs 19.

[0014] The first brake disc 15 and the second brake disc 16 are provided on the motor shaft 12 via a spline hub 21. Thus, the first brake disc 15 and the second brake disc 16 are displaceable with respect to the motor shaft 12 in the axial direction of the motor shaft 12, and fixed to the motor shaft 12 in a rotational direction of the motor shaft 12. The first brake disc 15 and the second brake disc 16 are disposed apart from each other in the axial direction of the motor shaft 12. In this example, the first brake disc 15 is disposed further apart from the cover plate 13 than the second brake disc 16.

[0015] The first braking body 17 and the second braking body 18 are disposed apart from each other in the axial direction of the motor shaft 12. In this example, the first braking body 17 is disposed further apart from the cover plate 13 than the second braking body 18. The first brake disc 15 is disposed between the first braking body 17 and the second braking body 18, and the second brake disc 16 is disposed between the second braking body 18 and the cover plate 13.

[0016] During displacement from the open position to the braking position, each of the first braking body 17 and the second braking body 18 is displaced toward the cover plate 13 while pressing a corresponding one of the first brake disc 15 and the second brake disc 16. By being displaced from the braking position to the open position, each of the first braking body 17 and the second braking body 18 is displaced away from the cover plate 13 and

hence spaced apart from a corresponding one of the first brake disc 15 and the second brake disc 16.

[0017] The first braking body 17 has a discoid armature 22 slidably supported by the respective rods 14, and a sliding material 23 provided on the armature 22 and brought into contact with the first brake disc 15 when the first braking body 17 is at the braking position. The second braking body 18 has a discoid movable plate 24 slidably supported by the respective rods 14, and sliding-materials 25 and 26 provided on the movable plate 24 and brought into contact with the first brake disc 15 and the second brake disc 16, respectively, when the second braking body 18 is at the braking position. The cover plate 13 is provided with a sliding material 27 brought into contact with the second brake disc 16 when each of the first braking body 17 and the second braking body 18 is at the braking position.

[0018] The electromagnet 20 is fixed to the motor 11. Each of the springs 19 is disposed in a compressed state between the electromagnet 20 and the armature 22. Thus, the first braking body 17 is urged away from the electromagnet 20 by the respective springs 19.

[0019] Fig. 3 is a schematic diagram showing the electromagnet 20 of Fig. 2. Referring to Fig. 3, the electromagnet 20 has a columnar fixed core 28 (Fig. 2) fixed to the motor 11, and a pair of first electromagnetic coils 29 and a pair of second electromagnetic coils 30 for generating electromagnetic suction forces for sucking the armature 22 through energization.

[0020] The first electromagnetic coils 29 and the second electromagnetic coils 30 are disposed on a plane perpendicular to a direction in which the first braking body 17 is displaced. The first electromagnetic coils 29 and the second electromagnetic coils 30 are alternately disposed at equal intervals in a circumferential direction of the fixed core 28. In addition, the respective first electromagnetic coils 29 are disposed symmetrically with respect to an axis of the motor shaft 12, and the respective second electromagnetic coils 30 are disposed symmetrically with respect to the axis of the motor shaft 12.

[0021] The respective first electromagnetic coils 29 are supplied with power from a first power supply 31, and the respective electromagnetic coils 30 are supplied with power from a second power supply 32. An amount of energization of each of the first electromagnetic coils 29 through the supply of power from the first power supply 31 is measured by a first current detector (CT) 33, and an amount of energization of each of the second electromagnetic coils 30 through the supply of power from the second power supply 32 is measured by a second current detector (CT) 34. In addition, an operation control device (not shown) for controlling the operation of the elevator is electrically connected to the brake control device 10.

[0022] Pieces of information are input to the brake control device 10 from the first current detector 33, the second current detector 34, and the operation control device, respectively. The brake control device 10 controls ener-

gization of the first electromagnetic coils 29 and energization of the second electromagnetic coils 30 based on the pieces of information obtained from the first current detector 33, the second current detector 34, and the operation control device, respectively.

[0023] The brake control device 10 outputs a voltage command for the first electromagnetic coils 29 to the first power supply 31, and a voltage command for the second electromagnetic coils 30 to the second power supply 32. The first power supply 31 applies to each of the first electromagnetic coils 29 a voltage corresponding to a value of the voltage command for the first electromagnetic coils 29, and the second power supply 32 applies to each of the second electromagnetic coils 30 a voltage corresponding to a value of the voltage command for the second electromagnetic coils 30. That is, the brake control device 10 outputs the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30, respectively, thereby controlling energization of the first electromagnetic coils 29 and energization of the second electromagnetic coils 30.

[0024] When operating the brake device body 9, the brake control device 10 performs different types of energization control for the first electromagnetic coils 29 and the second electromagnetic coils 30, respectively. That is, when operating the brake device body 9, the brake control device 10 controls the amount of energization of the first electromagnetic coils 29 and the amount of energization of the second electromagnetic coils 30 such that electromagnetic suction forces thereof become out of balance with each other.

[0025] In this example, when operating the brake device body 9, the brake control device 10 performs different types of energization control for the first electromagnetic coils 29 and the second electromagnetic coils 30 such that the first braking body 17 yields due to the urging forces exerted by the respective springs 19 and electromagnetic suction forces generated by the first electromagnetic coils 29 and the second electromagnetic coils 30.

[0026] Fig. 4 is a schematic diagram showing the braking device body 9 at a time when each of the first braking body 17 and the second braking body 18 of Fig. 2 is at the braking position. As shown in Fig. 4, when the first electromagnetic coils 29 and the second electromagnetic coils 30 have been stopped from being energized, the first braking body 17, the first brake disc 15, the second braking body 18, and the second brake disc 16 are pressed against the cover plate 13 while overlapping with one another in the axial direction of the motor shaft 12 due to urging forces of the respective springs 19. At this moment, the sliding materials 23 and 25 are in contact with the first brake disc 15, and the sliding materials 26 and 27 are in contact with the second brake disc 16, so rotation of each of the first brake disc 15 and the second brake disc 16 is braked.

[0027] Fig. 5 is a schematic diagram showing the brake device body 9 at a time when each of the first braking

body 17 and the second braking body 18 of Fig. 4 is at the open position. As shown in Fig. 5, when the first electromagnetic coils 29 and the second electromagnetic coils 30 are energized, the first braking body 17 is sucked by the electromagnet 20 and has been displaced away from the cover plate 13. Thus, the braking of each of the first brake disc 15 and the second brake disc 16 is cancelled.

[0028] Next, an operation will be described. Fig. 6 is a graphical representation for explaining the operation of the brake device 8 of Fig. 3. Fig. 6(a) is a graph showing a relationship between a brake opening command and a time in the operation control device. Fig. 6(b) is a graph showing a relationship between a voltage command for the first electromagnetic coils 29 and a time. Fig. 6(c) is a graph showing a relationship between a voltage command for the second electromagnetic coils 30 and a time. Fig. 6(d) is a graph showing a relationship between an amount of energization of the first electromagnetic coils 29 and a time. Fig. 6(e) is a graph showing a relationship between an amount of energization of the second electromagnetic coils 30 and a time.

[0029] As shown in Fig. 6, when the car 2 is stopped at a floor (at a time T_0), the brake opening command is stopped from being output from the operation control device to the brake control device 10 (Fig. 6(a)). At this moment, the first electromagnetic coils 29 and the second electromagnetic coils 30 are stopped from being supplied with power (Figs. 6(b) and 6(c)), and each of the first braking body 17 and the second braking body 18 is displaced to the braking position due to the urging forces of the respective springs 19 (Fig. 4). Thus, rotation of each of the first brake disc 15 and the second brake disc 16 is braked, so the stop position of the car 2 is maintained.

[0030] When a movement of the car 2 is started (at a time T_1), the brake opening command is output from the operation control device to the brake control device 10 (Fig. 6(a)). Thus, the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 are simultaneously output from the brake control device 10 to the first power supply 31 and the second power supply 32, respectively (Figs. 6(b) and 6(c)), so the first electromagnetic coils 29 and the second electromagnetic coils 30 are supplied with power. After that, the amounts of energization of the first electromagnetic coils 29 and the second electromagnetic coils 30 increase. Then, at a time T_2 (Figs. 6(d) and 6(e)), each of the first braking body 17 and the second braking body 18 is displaced to the open position (Fig. 5), so the braking of each of the first brake disc 15 and the second brake disc 16 is cancelled.

[0031] After that, the car 2 is moved. Then, when the car 2 is stopped again at another floor, the brake opening command is stopped from being output from the operation control device (Fig. 6(a)). Thus, only the voltage command for the first electromagnetic coils 29 is first stopped from being output from the brake control device

10 (Fig. 6(b)). Then, at a time T4, the voltage command for the second electromagnetic coils 30 is stopped from being output with a delay of a time T (Fig. 6 (c)). That is, energization of the first electromagnetic coils 29 and energization of the second electromagnetic coils 30 are controlled respectively by the brake control device 10 such that a timing for stopping energization of the first electromagnetic coils 29 and a timing for stopping energization of the second electromagnetic coils 30 become different from each other. Thus, the amount of energization of the second electromagnetic coils 30 starts decreasing after the lapse of the time T from a timing when the amount of energization of the first electromagnetic coils 29 starts decreasing (Figs. 6(d) and 6(e)).

[0032] After that, the amounts of energization of the first electromagnetic coils 29 and the second electromagnetic coils 30 continue to decrease. Then, at a time T5 (Figs. 6(d) and 6(e)), while the first braking body 17 remains sucked by the second electromagnetic coils 30, only that portion of the first braking body 17 which is sucked by the first electromagnetic coils 29 moves away from the electromagnet 20 due to the urging forces of the respective springs 19. That is, the electromagnetic suction force of each of the first electromagnetic coils 29 whose amount of energization starts decreasing first is weaker than the electromagnetic suction force of each of the second electromagnetic coils 30, so that a portion of the first braking body 17 which is sucked by the first electromagnetic coils 29 first moves away from the electromagnet 20. Thus, the first braking body 17 yields.

[0033] Fig. 7 is a schematic diagram showing the braking device body 9 at a time when the first braking body 17 of Fig. 5 yields. As shown in Fig. 7, when the first braking body 17 yields, the clearance between a certain portion of the first braking body 17 and the first brake disc 15 becomes narrower as the degree of yield of that portion of the first braking body 17 increases. That is, the clearance between the first braking body 17 and the brake disc 15 is partially narrow.

[0034] After that, when the amounts of energization of the first electromagnetic coils 29 and the second electromagnetic coils 30 further decrease to become close to 0, the urging forces of the respective springs 19 surpass the electromagnetic suction forces of the second electromagnetic coils 30 as well, so each of the first braking body 17 and the second braking body 18 is displaced to the braking position. That is, displacement of the first braking body 17 to the braking position is started in a state where the clearance between the first braking body 17 and the first brake disc 15 has become partially narrow, so each of the first braking body 17 and the second braking body 18 is displaced to the braking position. Thus, rotation of each of the first brake disc 15 and the second brake disc 16 is braked.

[0035] In the brake device 8 for the elevator constructed as described above, the brake control device 10 performs the different types of energization control for the first electromagnetic coils 29 and the second electromag-

netic coils 30 when displacing the first braking body 17, so the magnitude of the electromagnetic suction forces of the first electromagnetic coils 29 and the magnitude of the electromagnetic suction forces of the second electromagnetic coils 30 can be made different from each other when displacing the first braking body 17. Thus, displacement of the entire first braking body 17 to the braking position can be started after the first braking body 17 has been partially spaced apart from the electromagnet 20 due to the urging forces of the respective springs 19. Accordingly, the speed of the first braking body 17 when reaching the braking position can be reduced, so impact noise generated during braking operation of the brake device body 9 can be abated. Further, no shock absorbing material for absorbing a shock is required, so a reduction in the cost of manufacturing can also be achieved.

[0036] The brake control device 10 performs energization control such that the timing for stopping energization of the first electromagnetic coils 29 and the timing for stopping energization of the second electromagnetic coils 30 become different from each other, so the magnitude of the electromagnetic suction forces of the first electromagnetic coils 29 and the magnitude of the electromagnetic suction forces of the second electromagnetic coils 30 can be made different from each other with ease. As a result, impact noise generated during braking operation of the brake device body 9 can be abated.

[0037] During displacement of the first braking body 17 from the open position to the braking position, the first braking body 17 yields due to the electromagnetic suction forces of the first electromagnetic coils 29 and the second electromagnetic coils 30 and the urging forces of the respective springs 19. Thus, impact noise generated during the braking operation of the brake device body 9 can be abated, and further, the first braking body 17 can be deformed laterally symmetrically. Consequently, higher stability is guaranteed in performing the braking operation.

Embodiment 2

[0038] In Embodiment 1 of the present invention, the timing for stopping energization of the first electromagnetic coils 29 and the timing for stopping energization of the second electromagnetic coils 30 are made different from each other to cause the first electromagnetic coils 29 and the second electromagnetic coils 30 to generate electromagnetic suction forces different in magnitude from each other during the braking operation of the brake device body 9. However, a length of time from the start of stoppage of a voltage command for the first electromagnetic coils 29 to equalization thereof with 0 and a length of time from the start of stoppage of a voltage command for the second electromagnetic coils 30 to equalization thereof with 0 may be made different from each other to cause the first electromagnetic coils 29 and the second electromagnetic coils 30 to generate electromagnetic suction forces different in magnitude from each

other during braking operation of the brake device body 9.

[0039] That is, Fig. 8 is a graphic representation for explaining the operation of a brake device according to Embodiment 2 of the present invention. Fig. 8 (a) is a graph showing a relationship between a brake opening command and a time in the operation control device. Fig. 8 (b) is a graph showing a relationship between a voltage command for the first electromagnetic coils 29 and a time. Fig. 8(c) is a graph showing a relationship between a voltage command for the second electromagnetic coils 30 and a time. Fig. 8 (d) is a graph showing a relationship between an amount of energization of the first electromagnetic coils 29 and a time. Fig. 8(e) is a graph showing a relationship between an amount of energization of the second electromagnetic coils 30 and a time.

[0040] As shown in Fig. 8, the brake control device 10 starts stopping voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 simultaneously at the time T3 (Figs. 8(b) and 8(c)). The brake control device 10 performs control such that the voltage command for the first electromagnetic coils 29 becomes 0 instantaneously upon the start of stoppage of the voltage command, and that the voltage command for the second electromagnetic coils 30 decreases continuously at a certain rate after the start of stoppage of the voltage command and then becomes 0 after a lapse of a predetermined time. That is, the brake control device 10 controls the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 such that the length of time from the start of stoppage of the voltage command for the first electromagnetic coils 29 to equalization thereof with 0 and the length of time from the start of stoppage of the voltage command for the second electromagnetic coils 30 to equalization thereof with 0 become different from each other. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0041] Next, an operation will be described. The operation of opening the brake device body 9, namely, the operation performed during displacement of each of the first braking body 17 and the second braking body 18 from the braking position to the open position is the same as in Embodiment 1 of the present invention.

[0042] When the operation control device stops outputting the brake opening command (Fig. 8 (a)) and the brake device body 9 performs the braking operation, the brake control device 10 performs control to start stopping output of the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 simultaneously at the time T3. After that, owing to the control performed by the brake control device 10, the voltage command for the first electromagnetic coils 29 becomes 0 instantaneously (Fig. 8 (b)), and the voltage command for the second electromagnetic coils 30 decreases continuously, and becomes 0 after the lapse of a predetermined time (Fig. 8(c)).

[0043] Thus, after the time T3, the amount of energiza-

tion of the first electromagnetic coils 29 and the amount of energization of the second electromagnetic coils 30 become different from each other (Figs. 8(d) and 8(e)), so the first braking body 17 yields in the same manner as in Embodiment 1 of the present invention. The subsequent operation is the same as that of Embodiment 1 of the present invention.

[0044] In the brake device for the elevator constructed as described above, during the braking operation of the brake device body 9, the brake control device 10 performs control such that the length of time from the start of stoppage of the voltage command for the first electromagnetic coils 29 to equalization thereof with 0 and the length of time from the start of stoppage of the voltage command for the second electromagnetic coils 30 to equalization thereof with 0 become different from each other. Therefore, as is the case with Embodiment 1 of the present invention, displacement of the entire first braking body 17 to the braking position can be started after the first braking body 17 has been partially spaced apart from the electromagnet 20. Accordingly, impact noise generated during the braking operation of the brake device body 9 can be abated.

Embodiment 3

[0045] In Embodiment 2 of the present invention, the voltage applied to the second electromagnetic coils 30 is continuously reduced at a certain rate during braking operation of the brake device body 9. However, the voltage applied to the second electromagnetic coils 30 may be reduced continuously at a certain rate after having been reduced instantaneously to a value set in advance.

[0046] That is, Fig. 9 is a graphic representation for explaining the operation of a brake device according to Embodiment 3 of the present invention. Fig. 9 (a) is a graph showing a relationship between a brake opening command and a time in the operation control device. Fig. 9 (b) is a graph showing a relationship between a voltage command for the first electromagnetic coils 29 and a time. Fig. 9(c) is a graph showing a relationship between a voltage command for the second electromagnetic coils 30 and a time. Fig. 9 (d) is a graph showing a relationship between an amount of energization of the first electromagnetic coils 29 and a time. Fig. 9(e) is a graph showing a relationship between an amount of energization of the second electromagnetic coils 30 and a time.

[0047] As shown in Fig. 9, the brake control device 10 starts stopping voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 simultaneously at the time T3 (Figs. 9(b) and 9(c)). The brake control device 10 performs control such that the voltage command for the first electromagnetic coils 29 becomes 0 instantaneously upon the start of stoppage of the voltage command, and that the voltage command for the second electromagnetic coils 30 decreases instantaneously to the value set in advance after the start of stoppage of the voltage command, then decreases

continuously at a certain rate, and becomes 0 after the lapse of a predetermined time. The set value is between a maximum value (predetermined value) of the voltage command for the second electromagnetic coils 30 and 0. Embodiment 3 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0048] Next, an operation will be described. The operation of opening the brake device body 9, namely, the operation performed during displacement of each of the first braking body 17 and the second braking body 18 from the braking position to the open position is the same as in Embodiment 1 of the present invention.

[0049] When the operation control device stops outputting the brake opening command (Fig. 9 (a)) and the brake device body 9 performs the braking operation, the brake control device 10 performs control to start stopping the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 simultaneously at the time T3. After that, owing to the control performed by the brake control device 10, the voltage command for the first electromagnetic coils 29 becomes 0 instantaneously (Fig. 9(b)). On the other hand, the voltage command for the second electromagnetic coils 30 decreases instantaneously to the set value and then decreases continuously at a certain rate, and becomes 0 after the lapse of a predetermined time (Fig. 8(c)).

[0050] Thus, after the time T3, the amount of energization of the first electromagnetic coils 29 and the amount of energization of the second electromagnetic coils 30 become different from each other (Figs. 9(d) and 9(e)), so the first braking body 17 yields in the same manner as in Embodiment 1 of the present invention. The subsequent operation is the same as that of Embodiment 1 of the present invention.

[0051] In the brake device for the elevator constructed as described above as well, during the braking operation of the brake device body 9, the brake control device 10 performs control such that the length of time from the start of stoppage of the voltage command for the first electromagnetic coils 29 to equalization thereof with 0 and the length of time from the start of stoppage of the voltage command for the second electromagnetic coils 30 to equalization thereof with 0 become different from each other. Therefore, as is the case with Embodiment 2 of the present invention, impact noise generated during the braking operation of the brake device body 9 can be abated. During the braking operation of the brake device body 9, the voltage command for the second electromagnetic coils 30 decreases instantaneously to the set value and then decreases continuously at a certain rate. Therefore, the voltage command for the second electromagnetic coils 30 can be reduced instantaneously to a minimum value of the voltage command allowing the first braking body 17 to be held at the braking position. As a result, a reduction in the operation time of the brake device body 9 can also be achieved.

Embodiment 4

[0052] In Embodiment 1 of the present invention, only the timing for stopping energization of the first electromagnetic coils 29 and the timing for stopping energization of the second electromagnetic coils 30 are made different from each other to abate impact noise during braking operation of the brake device body 9. However, the timing for starting energization of the first electromagnetic coils 29 and the timing for starting energization of the second electromagnetic coils 30 may be made different from each other to abate impact noise during opening operation of the brake device body 9 as well.

[0053] That is, Fig. 10 is a graphic representation for explaining the operation of a brake device according to Embodiment 4 of the present invention. Fig. 10(a) is a graph showing a relationship between a brake opening command and a time in the operation control device. Fig. 10(b) is a graph showing a relationship between a voltage command for the first electromagnetic coils 29 and a time. Fig. 10(c) is a graph showing a relationship between a voltage command for the second electromagnetic coils 30 and a time. Fig. 10(d) is a graph showing a relationship between an amount of energization of the first electromagnetic coils 29 and a time. Fig. 10(e) is a graph showing a relationship between an amount of energization of the second electromagnetic coils 30 and a time.

[0054] As shown in Fig. 10, upon receiving a brake opening command from the operation control device, the brake control device 10 starts outputting a voltage command for the first electromagnetic coils 29, and then starts outputting a voltage command for the second electromagnetic coils 30 with a delay of the time T. Embodiment 4 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0055] Next, an operation will be described. When the brake control device 10 receives the brake opening command from the operation control device, only the voltage command for the first electromagnetic coils 29 is first output from the brake control device 10 (Fig. 10(b)). After that, the voltage command for the second electromagnetic coils 30 is output with a delay of the time T, namely, at a time T6 (Fig. 10(c)). Thus, energization of the second electromagnetic coils 30 is started after the lapse of the time T from a timing when energization of the first electromagnetic coils 29 is started (Figs. 10 (d) and 10 (e)). That is, in this example, the brake control device 10 controls energization of the first electromagnetic coils 29 and energization of the second electromagnetic coils 30 such that the timing for starting energization of the first electromagnetic coils 29 and the timing for starting energization of the second electromagnetic coils 30 become different from each other.

[0056] After that, the amount of energization of the first electromagnetic coils 29 and the amount of energization of the second electromagnetic coils 30 increase respectively, so only the portion of the first braking body 17 which is sucked by the first electromagnetic coils 29 first

overcomes the urging forces of the respective springs 19 to be displaced toward the electromagnet 20 while the portion of the first braking body 17 which is sucked by the second electromagnetic coils 30 remains at the braking position. Thus, the first braking body 17 yields.

[0057] After that, the portion of the first braking body 17 which is sucked by the second electromagnetic coils 30 also overcomes the urging forces of the respective springs 19, so the entire first braking body 17 is displaced to the open position. The subsequent operation is the same as that of Embodiment 1 of the present invention.

[0058] In the brake device for the elevator constructed as described above, the brake control device 10 performs control such that the timing for starting energization of the first electromagnetic coils 29 and the timing for starting energization of the second electromagnetic coils 30 become different from each other. Therefore, during the opening operation of the brake device body 9 as well, the magnitude of the electromagnetic suction forces of the first electromagnetic coils 29 and the magnitude of the electromagnetic suction forces of the second electromagnetic coils 30 can be made different from each other with ease. Thus, impact noise resulting from the operation of the brake device body 9 can be abated.

Embodiment 5

[0059] In Embodiment 2 of the present invention, each of the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 reaches its maximum value (predetermined value) instantaneously after the start of the outputting thereof from the brake control device 10. However, the length of time from the start of the outputting of the voltage command for the first electromagnetic coils 29 to equalization thereof with its maximum value and the length of time from the start of the outputting of the voltage command for the second electromagnetic coils 30 to equalization thereof with its maximum value may be made different from each other to abate impact noise during the opening operation of the brake device body 9 as well.

[0060] That is, Fig. 11 is a graphic representation for explaining the operation of a brake device according to Embodiment 5 of the present invention. Fig. 11(a) is a graph showing a relationship between a brake opening command and a time in the operation control device. Fig. 11(b) is a graph showing a relationship between a voltage command for the first electromagnetic coils 29 and a time. Fig. 11(c) is a graph showing a relationship between a voltage command for the second electromagnetic coils 30 and a time. Fig. 11(d) is a graph showing a relationship between an amount of energization of the first electromagnetic coils 29 and a time. Fig. 11(e) is a graph showing a relationship between an amount of energization of the second electromagnetic coils 30 and a time.

[0061] As shown in Fig. 11, the brake control device 10 starts outputting voltage commands for the first electromagnetic coils 29 and the second electromagnetic

coils 30 simultaneously upon receiving a brake opening command from the operation control device. The brake control device 10 performs control such that the voltage command for the first electromagnetic coils 29 reaches its maximum value instantaneously after the start of the outputting of the voltage command, and that the voltage command for the second electromagnetic coils 30 rises continuously at a certain rate after the start of the outputting of the voltage command and then reaches its maximum value after the lapse of a predetermined time. That is, the brake control device 10 controls the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 such that the length of time from the start of the outputting of the voltage command for the first electromagnetic coils 29 to equalization thereof with its maximum value and the length of time from the start of the outputting of the voltage command for the second electromagnetic coils 30 to equalization thereof with its maximum value become different from each other. Embodiment 5 of the present invention is identical to Embodiment 2 of the present invention in other constructional details.

[0062] Next, an operation will be described. Upon receiving the brake opening command from the operation control device, the brake control device 10 starts outputting the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 simultaneously. After that, the voltage command for the first electromagnetic coils 29 reaches its maximum value instantaneously (Fig. 11 (b)), and the voltage command for the second electromagnetic coils 30 rises continuously at a certain rate and then reaches its maximum value after the lapse of the predetermined time (Fig. 11 (c)). That is, in this example, the brake control device 10 controls the voltage commands for the first electromagnetic coils 29 and the second electromagnetic coils 30 such that the length of time until the voltage command for the first electromagnetic coils 29 reaches its maximum value and the length of time until the voltage command for the second electromagnetic coils 30 reaches its maximum value become different from each other.

[0063] At this moment, the portion of the first braking body 17 which is sucked by the first electromagnetic coils 29 first overcomes the urging forces of the respective springs 19 to be displaced toward the electromagnet 20 while the portion of the first braking body 17 which is sucked by the second electromagnetic coils 30 remains at the braking position. Thus, the first braking body 17 yields.

[0064] After that, the portion of the first braking body 17 which is sucked by the second electromagnetic coils 30 also overcomes the urging forces of the respective springs 19, so the entire first braking body 17 is displaced to the open position. The subsequent operation is the same as that of Embodiment 2 of the present invention.

[0065] In the brake device for the elevator constructed as described above, the brake control device 10 performs control such that the length of time from the start of the

outputting of the voltage command for the first electromagnetic coils 29 from the brake control device 10 to equalization thereof with the predetermined value and the length of time from the start of the outputting of the voltage command for the second electromagnetic coils 30 from the brake control device 10 to equalization thereof with the predetermined value become different from each other. Therefore, during opening operation of the brake device body 9 as well, the electromagnetic suction forces of the first electromagnetic coils 29 and the second electromagnetic coils 30 can be made different in magnitude from each other with ease. Consequently, impact noise resulting from the operation of the brake device body 9 can be abated.

[0066] In each of the foregoing embodiments of the present invention, the number of the first electromagnetic coils 29 is two, and the number of the second electromagnetic coils 30 is two as well. However, it is also appropriate to provide only one first electromagnetic coil 29 and only one second electromagnetic coil 30, or three or more first electromagnetic coils 29 and three or more second electromagnetic coils 30.

[0067] In each of the foregoing embodiments of the present invention, the brake control device 10 controls the voltages applied to the first electromagnetic coils 29 and the second electromagnetic coils 30 according to predetermined patterns respectively, thereby changing the amounts of energization of the first electromagnetic coils 29 and the second electromagnetic coils 30, respectively. However, the brake control device 10 may control the voltages applied to the first electromagnetic coils 29 and the second electromagnetic coils 30 based on pieces of information from the first current detector 33 and the second current detector 34 respectively such that the amounts of energization of the first electromagnetic coils 29 and the second electromagnetic coils 30 change according to predetermined patterns, respectively.

Claims

1. A brake device for an elevator, comprising:

a rotating body (15);
 a braking body (17) displaceable between a braking position at which the braking body (17) is in contact with the rotating body (15) and an open position at which the braking body (17) is spaced apart from the rotating body (15);
 an urging body (19) for urging the braking body (17) in a direction in which the braking body (17) is displaced to the braking position;
 an electromagnet (20) having a first electromagnetic coil (29) for generating an electromagnetic suction force through energization and a second electromagnetic coil (30) for generating an electromagnetic suction force through energization, for displacing the braking body (17) to the open

position through generation of the electromagnetic suction forces against an urging force exerted by the urging body (19); and
 a brake control device (10) for controlling energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30) respectively, **characterized in that** the brake control device (10) performs different types of energization control for the first electromagnetic coil (29) and the second electromagnetic coil (30) when displacing the braking body (17).

2. The brake device for an elevator according to Claim 1, wherein the brake control device (10) controls energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30) respectively such that at least either timings for starting energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30) or timings for stopping energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30) become different from each other.

3. The brake device for an elevator according to Claim 1, wherein the brake control device (10) controls voltages applied to the first electromagnetic coil (29) and the second electromagnetic coil (30) respectively such that a length of time for changing the voltage applied to the first electromagnetic coil (29) from 0 to a predetermined value becomes shorter than a length of time for changing the voltage applied to the second electromagnetic coil (30) from 0 to the predetermined value when starting energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30).

4. The brake device for an elevator according to Claim 1, wherein the brake control device (10) controls voltages applied to the first electromagnetic coil (29) and the second electromagnetic coil (30) respectively such that a length of time for changing the voltage applied to the first electromagnetic coil (29) from a predetermined value to 0 becomes shorter than a length of time for changing the voltage applied to the second electromagnetic coil (30) from the predetermined value to 0 when stopping energization of the first electromagnetic coil (29) and energization of the second electromagnetic coil (30).

5. The brake device for an elevator according to Claim 4, wherein the brake control device (10) reduces the voltage applied to the second electromagnetic coil (30) from the predetermined value to a set value smaller than the predetermined value instantaneously, and then from the set value to 0 in a predetermined length of time when stopping energization

of the second electromagnetic coil (30).

6. The brake device for an elevator according to Claim 1, wherein the braking body (17) yields due to the electromagnetic suction forces and the urging force as a result of the different types of energization control performed by the brake control device (10) for the first electromagnetic coil (29) and the second electromagnetic coil (30).

Patentansprüche

1. Bremseinrichtung für einen Aufzug, mit:

einem Drehkörper (15);
 einem Bremskörper (17), der zwischen einer Bremsstellung, in welcher der Bremskörper (17) in Kontakt mit dem Drehkörper (15) steht und einer offenen Stellung, in welcher der Bremskörper (17) von dem Drehkörper (15) beabstandet ist, verlagerbar ist;
 einem Beaufschlagungselement (19) zum Beaufschlagen des Bremskörpers (17) in eine Richtung, in welcher der Bremskörper (17) in die Bremsstellung verlagert wird;
 einem Elektromagnet (20), der eine erste elektromagnetische Spule (29) zur Erzeugung einer elektromagnetischen Anziehungskraft durch Erregung, und eine zweite elektromagnetische Spule (30) zur Erzeugung einer elektromagnetischen Anziehungskraft durch Erregung, zum Verlagern des Bremskörpers (17) in die offene Stellung durch Erzeugung der elektromagnetischen Anziehungskraft gegen eine, durch das Beaufschlagungselement (19) ausgeübte Beaufschlagungskraft, aufweist; und
 einer Bremssteuerungseinrichtung (10) zum Steuern der Erregung der ersten elektromagnetischen Spule (29) bzw. der Erregung der zweiten elektromagnetischen Spule (30), **dadurch gekennzeichnet, dass**
 die Bremssteuerungseinrichtung (10) verschiedene Typen von Erregungssteuerungen für die erste elektromagnetische Spule (29) und die zweite elektromagnetische Spule (30) durchführt, wenn der Bremskörpers (17) verlagert wird.

2. Bremseinrichtung für einen Aufzug nach Anspruch 1, wobei
 die Bremssteuerungseinrichtung (10) die Erregung der ersten elektromagnetischen Spule (29) bzw. die Erregung der zweiten elektromagnetischen Spule (30) steuert, sodass sich entweder Zeitpunkte zum Starten der Erregung der ersten elektromagnetischen Spule (29) und der Erregung der zweiten elektromagnetischen Spule (30) oder Zeitpunkte zum

Stoppen der Erregung der ersten elektromagnetischen Spule (29) und der Erregung der zweiten elektromagnetischen Spule (30), voneinander unterscheiden.

3. Bremseinrichtung für einen Aufzug nach Anspruch 1, wobei
 die Bremssteuerungseinrichtung (10) die Spannungen, die an die erste elektromagnetische Spule (29) bzw. an die zweite elektromagnetischen Spule (30) angelegt werden, steuert, sodass eine Zeitdauer zum Ändern, der an der ersten elektromagnetischen Spule (29) angelegten Spannung von 0 bis zu einem vorbestimmten Wert, kürzer ist als eine Zeitdauer, die zum Ändern, der an der zweiten elektromagnetischen Spule (30) angelegten Spannung von 0 bis zu einem vorbestimmten Wert, wenn die Erregung der ersten elektromagnetischen Spule (29) und die Erregung der zweiten elektromagnetischen Spule (30) gestartet wird.

4. Bremseinrichtung für einen Aufzug nach Anspruch 1, wobei
 die Bremssteuerungseinrichtung (10) Spannungen, die an die erste elektromagnetische Spule (29) bzw. an die zweite elektromagnetischen Spule (30) angelegt werden, steuert, sodass eine Zeitdauer zum Ändern, der an der ersten elektromagnetischen Spule (29) angelegten Spannung von einem vorbestimmten Wert bis zu 0, kürzer ist als eine Zeitdauer, die zum Ändern, der an der zweiten elektromagnetischen Spule (30) angelegten Spannung von einem vorbestimmten Wert bis zu 0, wenn die Erregung der ersten elektromagnetischen Spule (29) und die Erregung der zweiten elektromagnetischen Spule (30) gestoppt wird.

5. Bremseinrichtung für einen Aufzug nach Anspruch 4, wobei
 die Bremssteuerungseinrichtung (10) die an der zweiten elektromagnetischen Spule (30) angelegte Spannung sofort von dem vorbestimmten Wert auf einen eingestellten Wert kleiner als der vorbestimmte Wert reduziert, und anschließend von dem eingestellten Wert auf 0 in einer vorbestimmten Zeitdauer, wenn die Erregung der zweiten elektromagnetischen Spule (30) gestoppt wird.

6. Bremseinrichtung für einen Aufzug nach Anspruch 1, wobei
 der Bremskörper (17) aufgrund der elektromagnetischen Anziehungskräfte und der Beaufschlagungskraft als Ergebnis der unterschiedlichen Typen von Erregungssteuerung, die durch die Bremssteuerungseinrichtung (10) für die erste elektromagnetische Spule (29) und die zweite elektromagnetische Spule (30) durchgeführt werden, nachgibt.

Revendications

1. Dispositif de freinage pour un ascenseur, comprenant :

un corps rotatif (15) ;
 un corps de freinage (17) déplaçable entre une position de freinage dans laquelle le corps de freinage (17) est en contact avec le corps rotatif (15) et une position ouverte dans laquelle le corps de freinage (17) est espacé du corps rotatif (15) ;
 un corps de poussée (19) pour pousser le corps de freinage (17) dans une direction dans laquelle le corps de freinage (17) est déplacé vers la position de freinage ;
 un électroaimant (20) ayant une première bobine électromagnétique (29) pour générer une force de succion électromagnétique par excitation et une deuxième bobine électromagnétique (30) pour générer une force de succion électromagnétique par excitation, pour déplacer le corps de freinage (17) vers la position ouverte par génération des forces de succion électromagnétiques à l'encontre d'une force de poussée exercée par le corps de poussée (19) ; et
 un dispositif de commande de freinage (10) pour commander l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30) respectivement,

caractérisé en ce que :

- le dispositif de commande de freinage (10) exécute différents types de commandes d'excitation pour la première bobine électromagnétique (29) et la deuxième bobine électromagnétique (30) lorsqu'il déplace le corps de freinage (17).
 2. Dispositif de freinage pour un ascenseur selon la revendication 1, dans lequel le dispositif de commande de freinage (10) commande l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30) respectivement de telle manière qu'au moins soit des cadencements pour débiter l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30), soit des cadencements pour arrêter l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30) deviennent différents les uns des autres.
 3. Dispositif de freinage pour un ascenseur selon la revendication 1, dans lequel le dispositif de commande de freinage (10) commande des tensions appliquées à la première bobine électromagnétique (29)

et à la deuxième bobine électromagnétique (30) respectivement de telle manière qu'une durée de temps pour changer la tension appliquée à la première bobine électromagnétique (29) de 0 jusqu'à une valeur prédéterminée devient plus courte qu'une durée de temps pour changer la tension appliquée à la deuxième bobine électromagnétique (30) de 0 jusqu'à la valeur prédéterminée lorsqu'on fait débiter l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30).

4. Dispositif de freinage pour un ascenseur selon la revendication 1, dans lequel le dispositif de commande de freinage (10) commande des tensions appliquées à la première bobine électromagnétique (29) et à la deuxième bobine électromagnétique (30) respectivement de telle manière qu'une durée de temps pour changer la tension appliquée à la première bobine électromagnétique (29) d'une valeur prédéterminée jusqu'à 0 devient plus courte qu'une durée de temps pour changer la tension appliquée à la deuxième bobine électromagnétique (30) de la valeur prédéterminée jusqu'à 0 lorsqu'on arrête l'excitation de la première bobine électromagnétique (29) et l'excitation de la deuxième bobine électromagnétique (30).
 5. Dispositif de freinage pour un ascenseur selon la revendication 4, dans lequel le dispositif de commande de freinage (10) réduit la tension appliquée à la deuxième bobine électromagnétique (30) de la valeur prédéterminée jusqu'à une valeur réglée plus faible que la valeur prédéterminée instantanément, et puis de la valeur réglée jusqu'à 0 en une durée de temps prédéterminée lorsqu'on arrête l'excitation de la deuxième bobine électromagnétique (30).
 6. Dispositif de freinage pour un ascenseur selon la revendication 1, dans lequel le corps de freinage (17) est actif en raison des forces de succion électromagnétiques et de la force de poussée en tant qu'un résultat des différents types de commandes d'excitation exécutées par le dispositif de commande de freinage (10) pour la première bobine électromagnétique (29) et la deuxième bobine électromagnétique (30).

FIG. 1

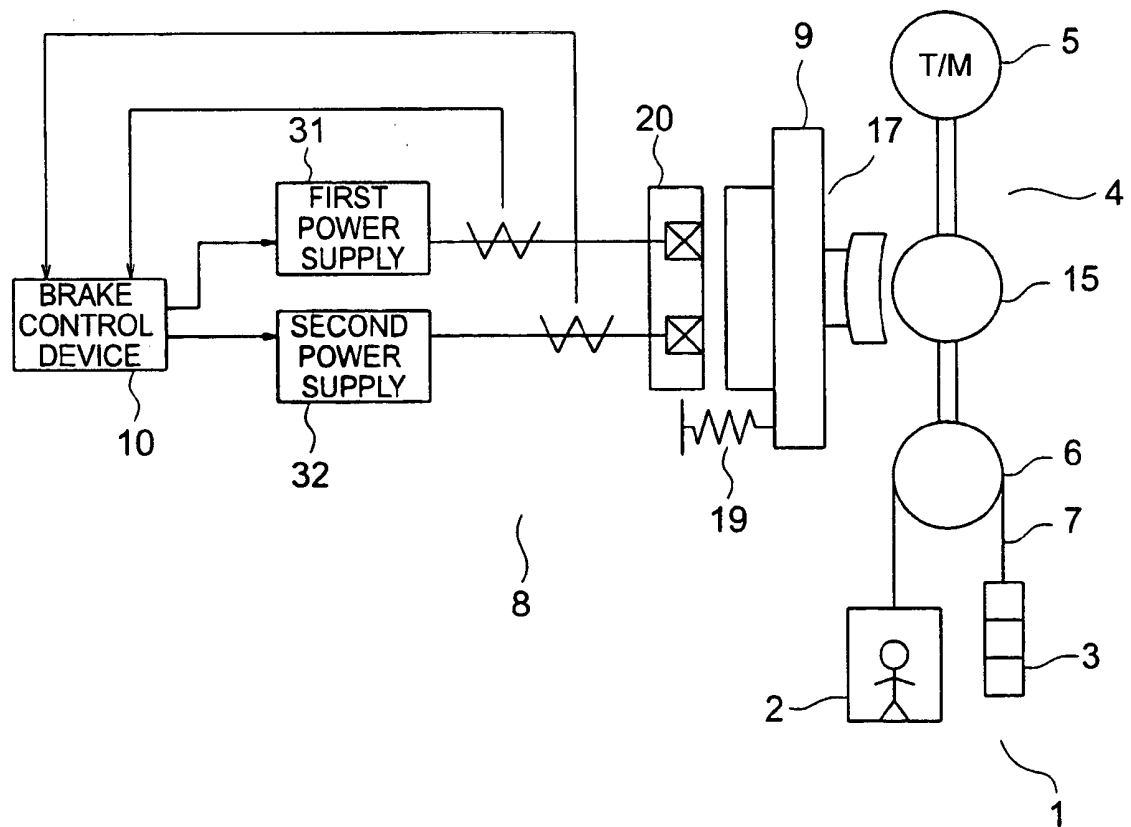


FIG. 2

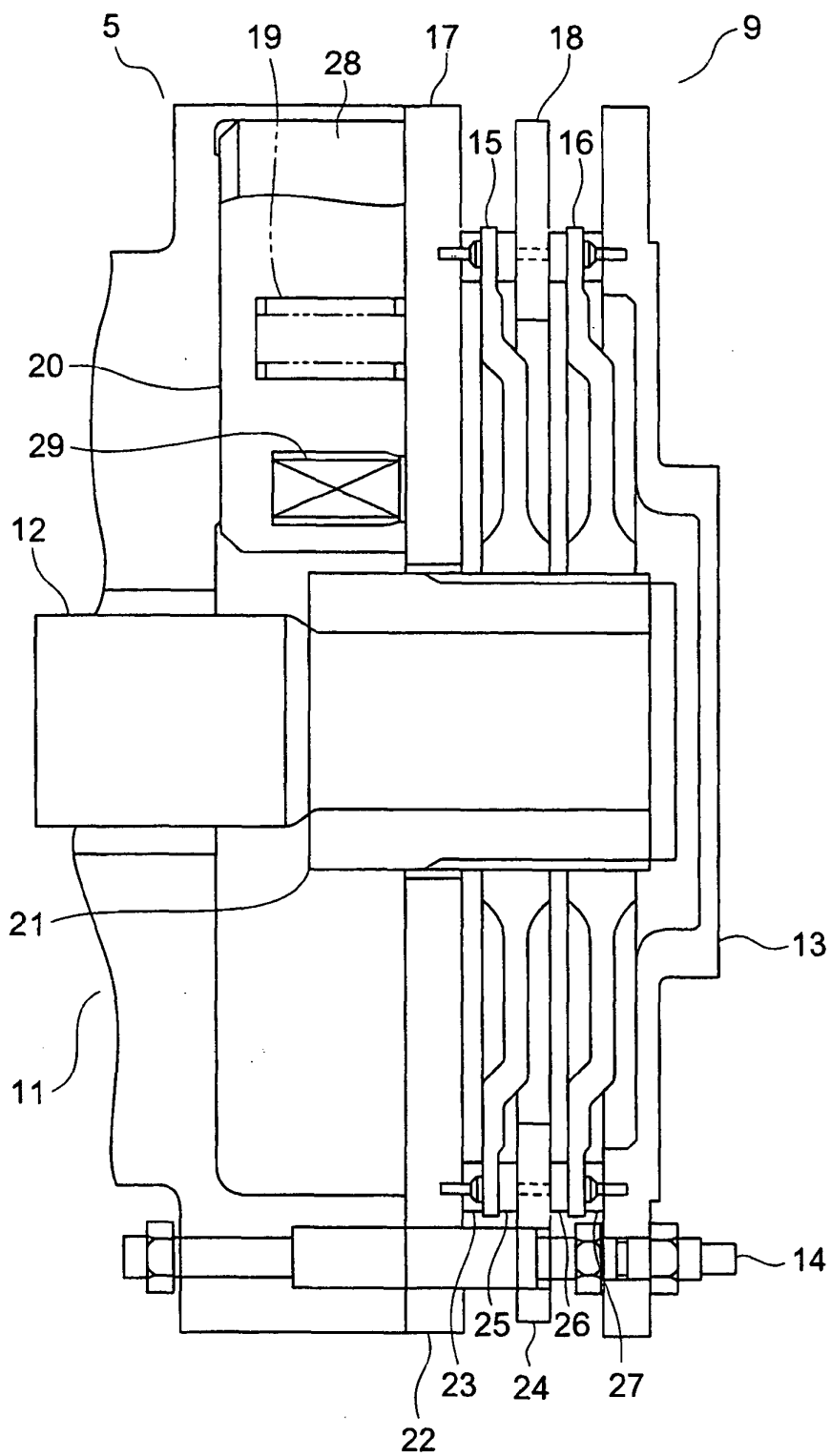


FIG. 3

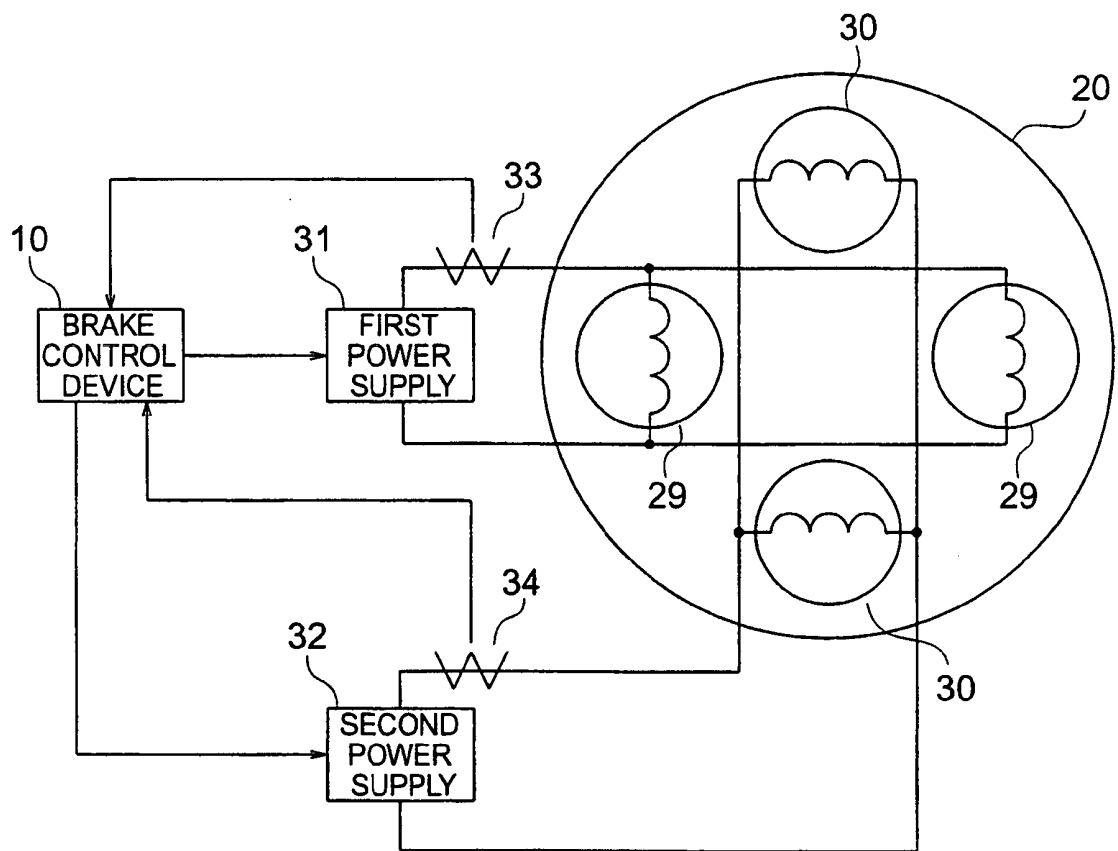


FIG. 4

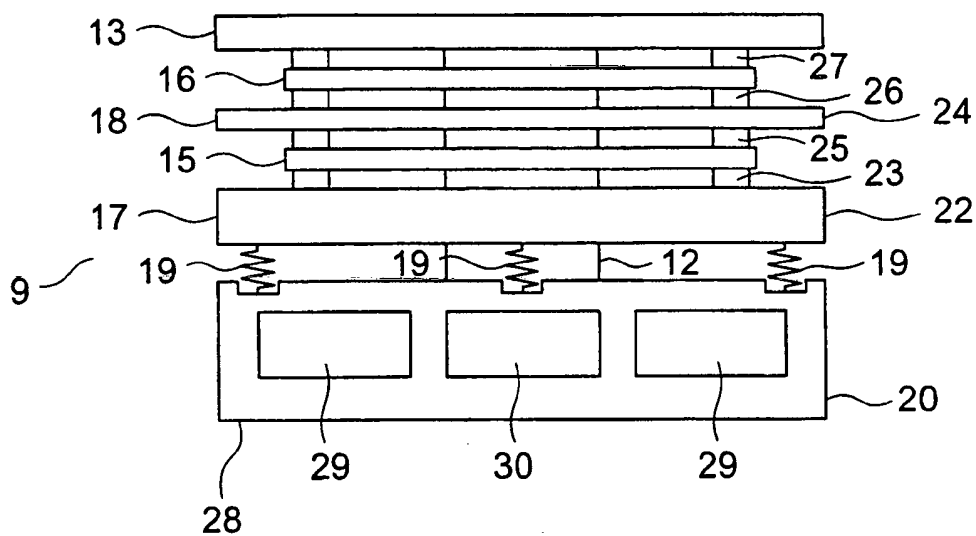


FIG. 5

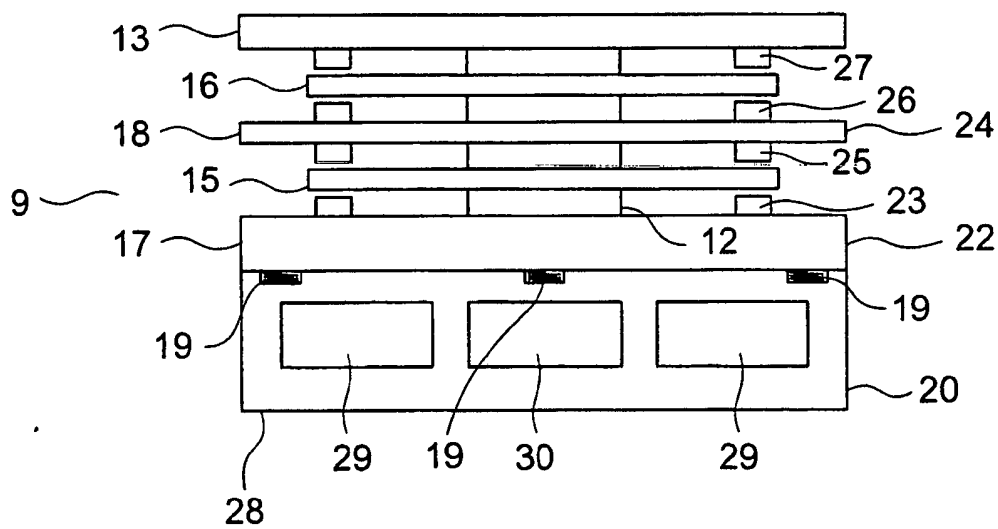


FIG. 6

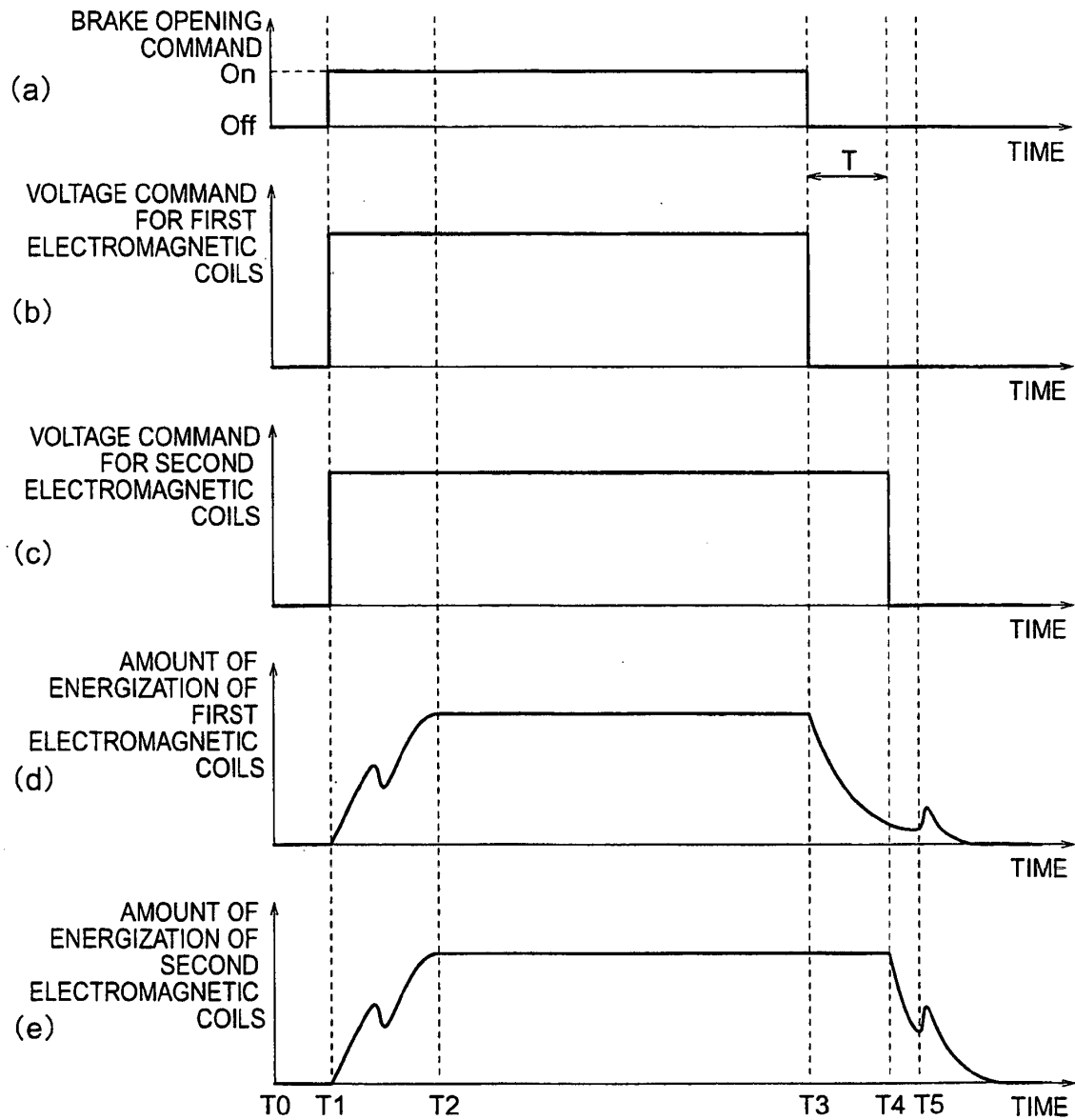


FIG. 7

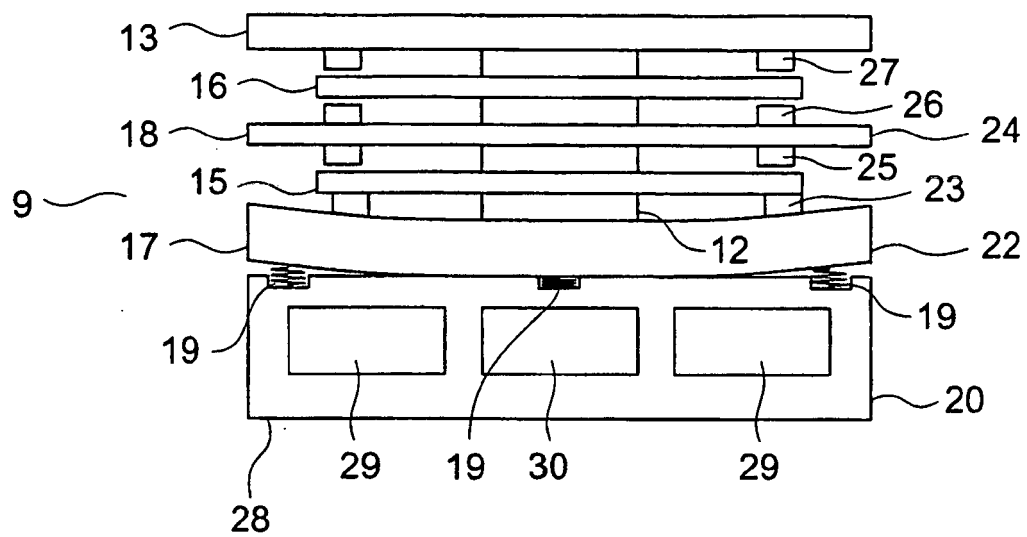


FIG. 8

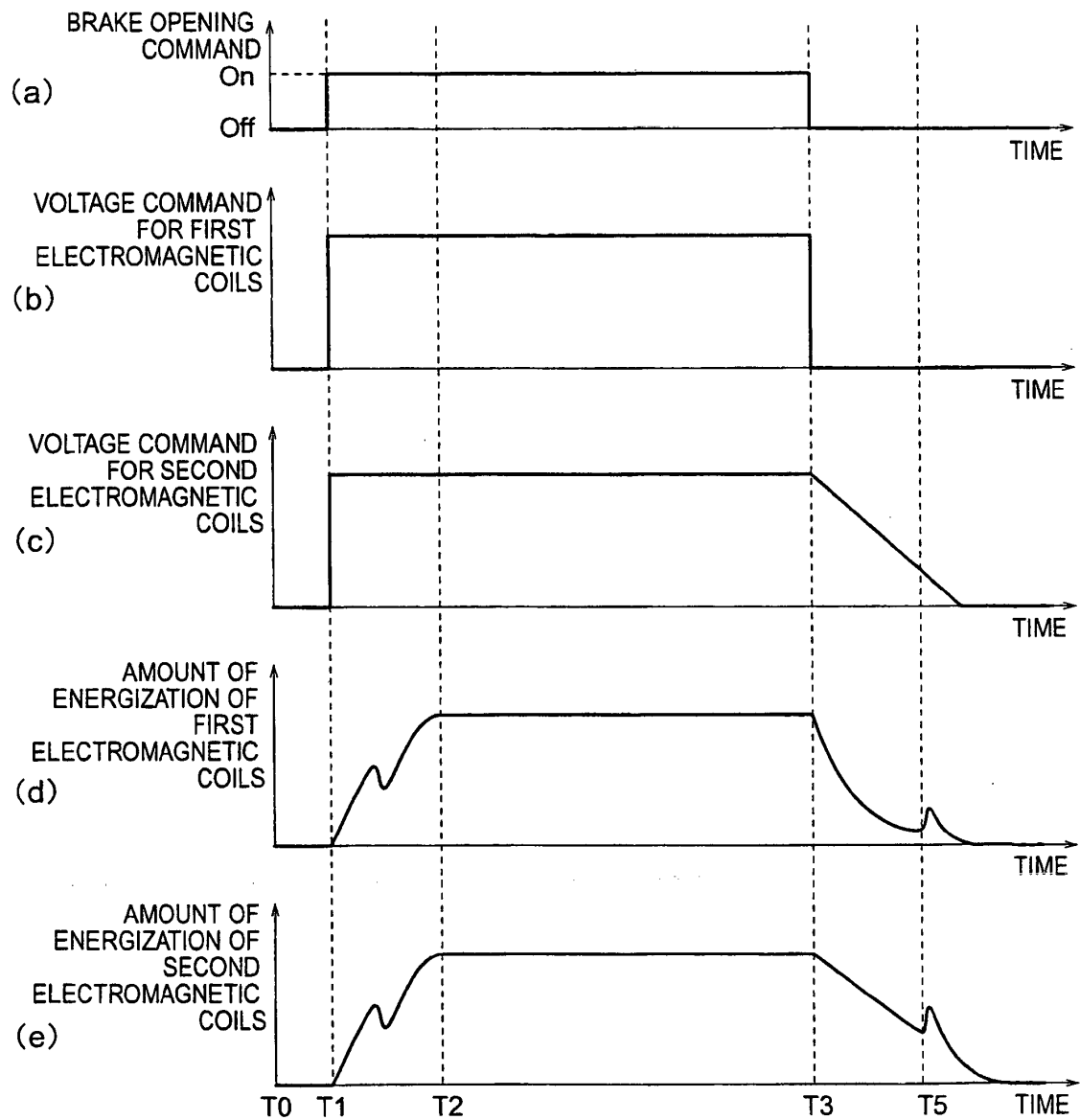


FIG. 9

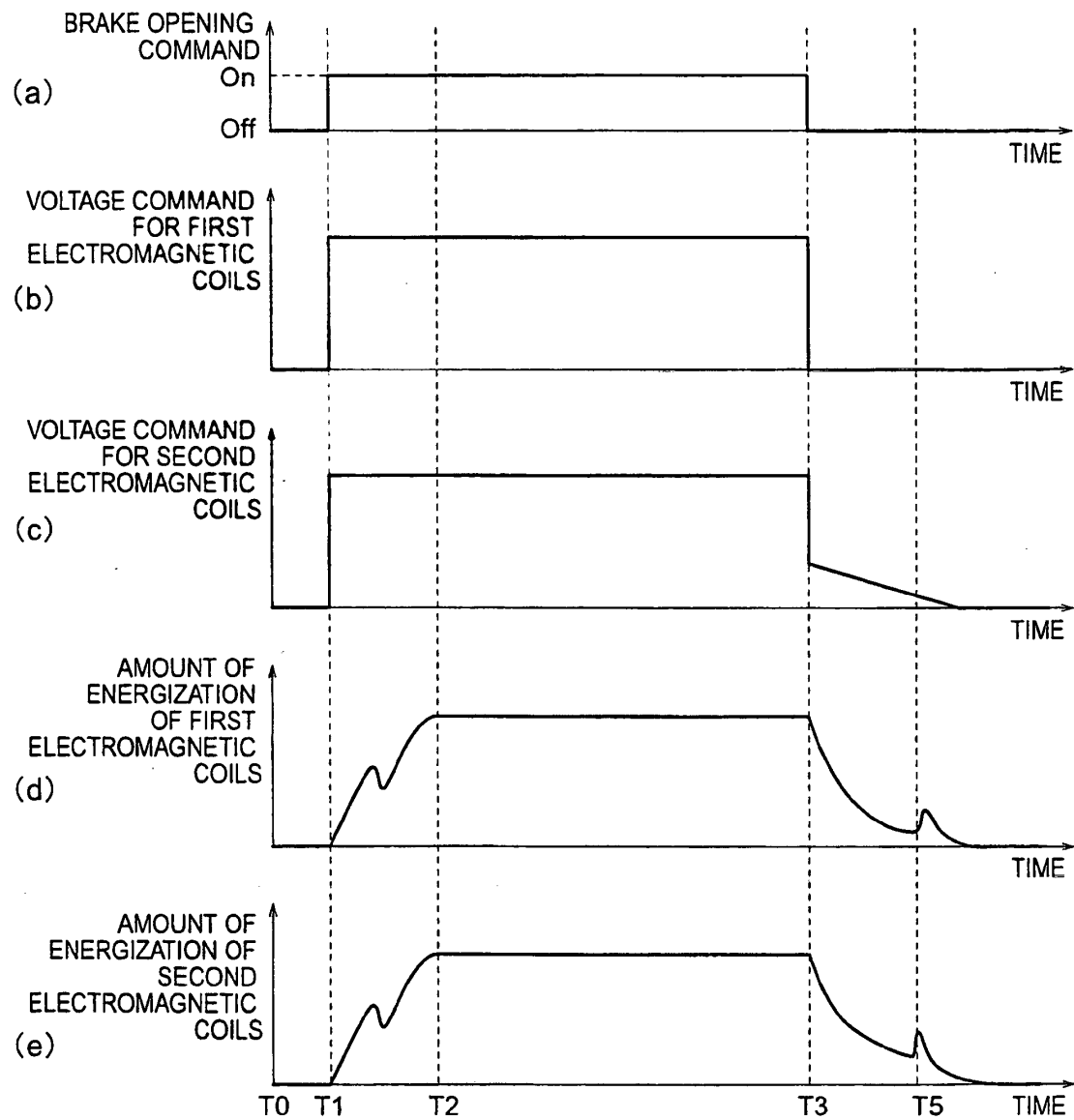


FIG. 10

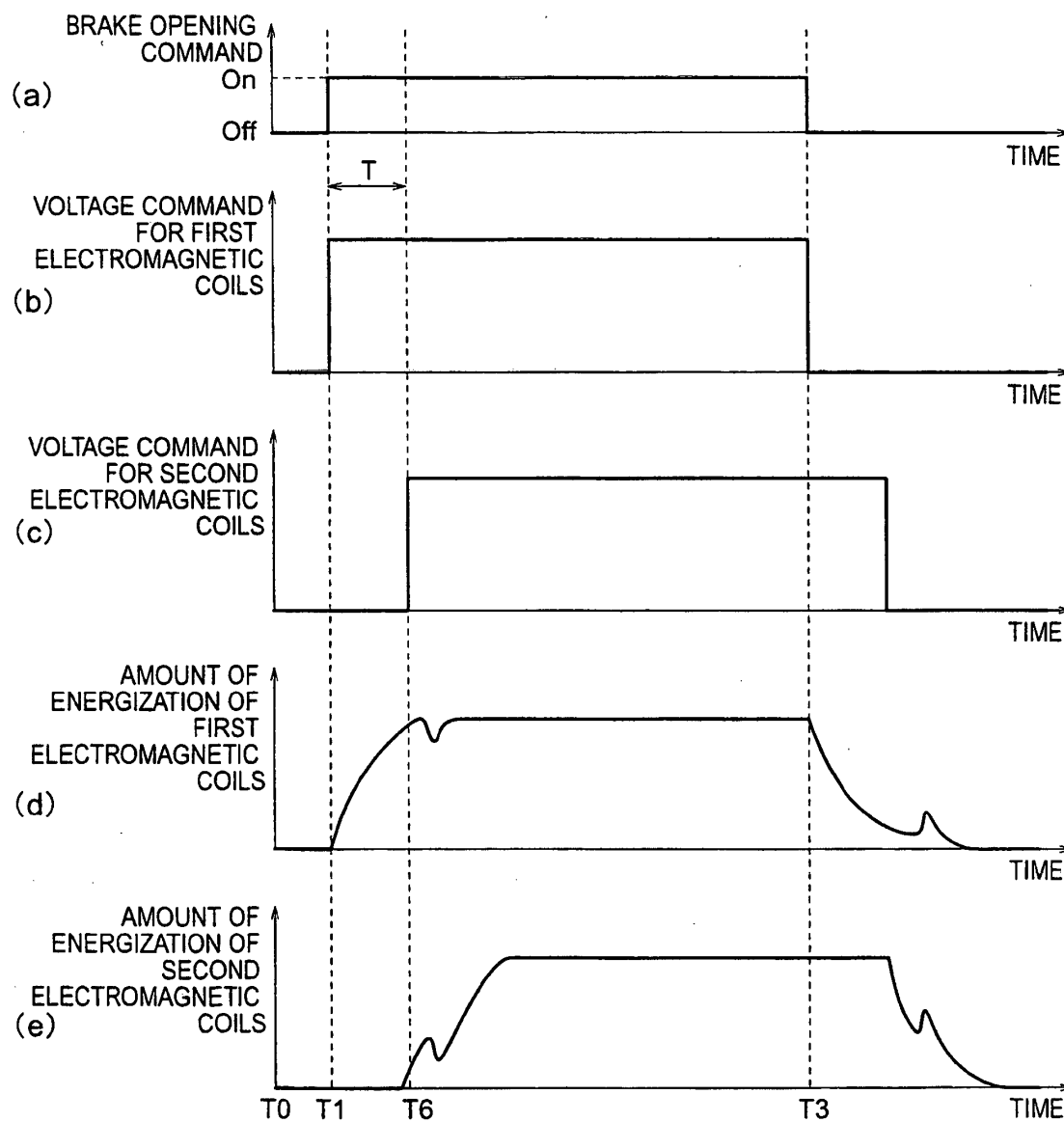
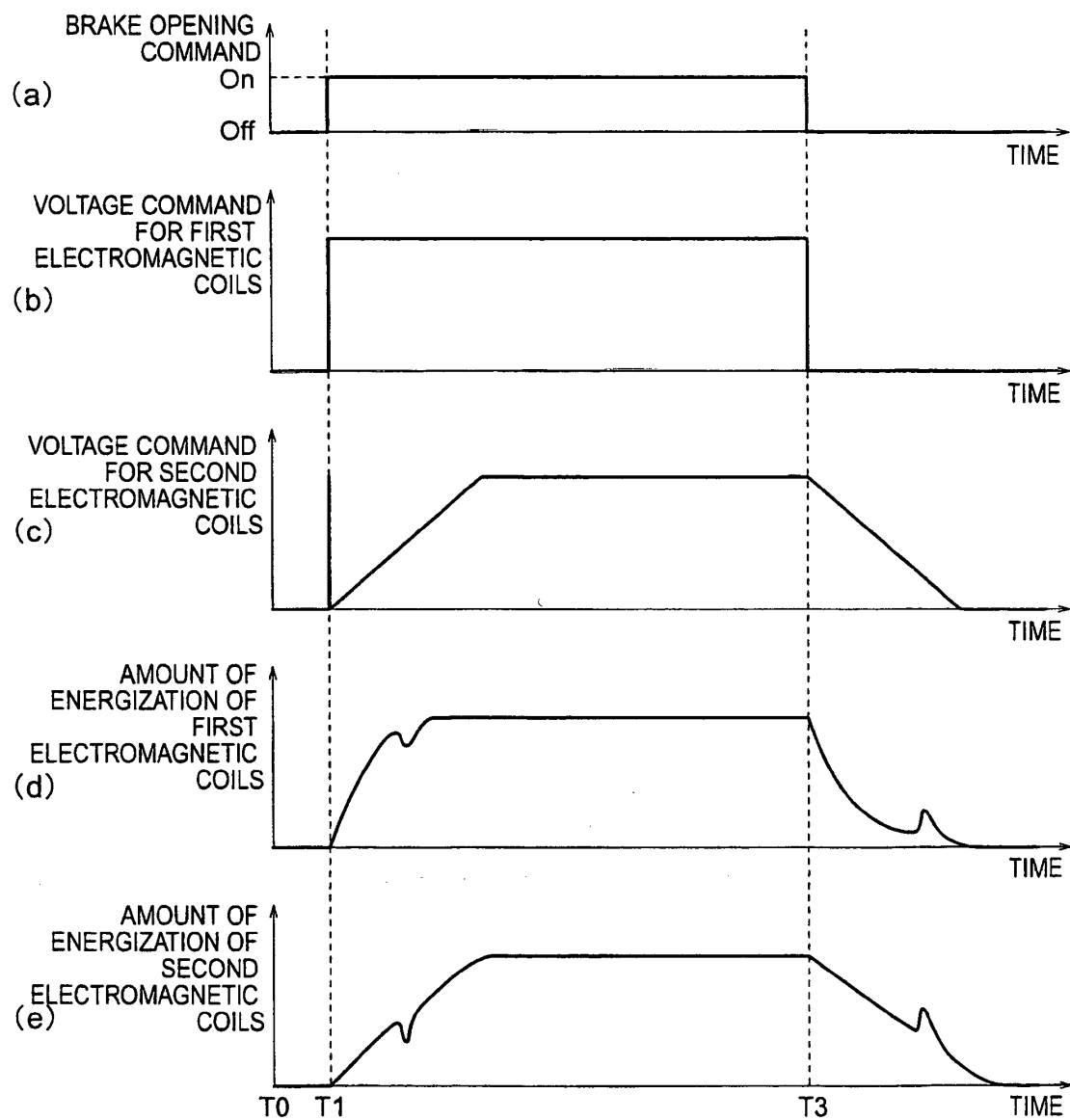


FIG. 11



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003184919 A [0003]
- JP 2005126183 A [0003]
- EP 1431226 A1 [0003]