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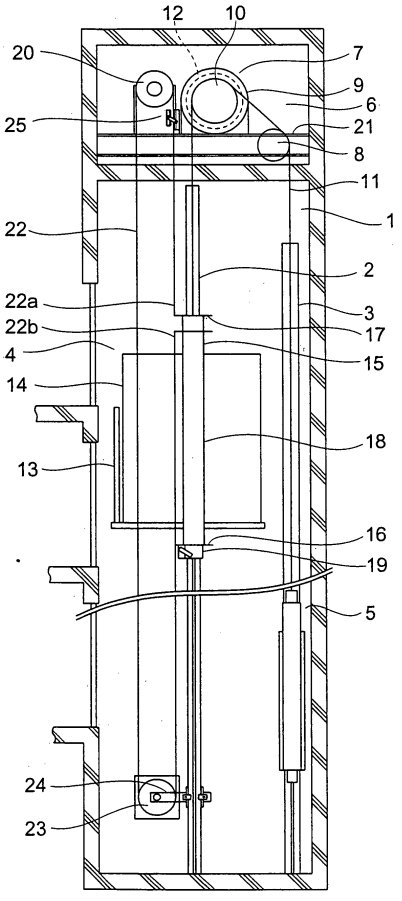
(54) SAFETY DEVICE FOR ELEVATOR

(57) An elevator has: a car that can be raised and lowered inside a hoistway; a main rope that suspends the car; and a hoisting machine that includes a drive sheave onto which the main rope is wound and that raises and lowers the car by rotation of the drive sheave. An elevator safety apparatus includes: a hoisting machine braking apparatus for applying a braking force to the main rope by braking rotation of the drive sheave; an auxiliary brake rope that is connected to the car, and that is separate from the main rope; an auxiliary brake pulley that is disposed in an upper portion of the hoistway, and around which the auxiliary brake rope is wound; and an auxiliary braking apparatus for applying a braking force to the auxiliary brake rope. The car receives the respective braking -forces from the main rope and the auxiliary brake rope by respective operation of the hoisting machine braking apparatus and the auxiliary braking apparatus, and is braked by the received braking forces.

FIG. 1



EP 2 017 213 A1

Description

TECHNICALFIELD

[0001] The present invention relates to an -elevator safety apparatus -for performing braking of a car in an emergency, or stopping and holding of the car, for example.

BACKGROUND ART

[0002] Conventionally, elevators have been proposed in which an auxiliary brake is disposed on a deflection sheave in order to increase rope traction on main ropes that suspend a car. The auxiliary brake operates interdependently with a brake that is mounted to a drive sheave of a hoisting machine (See Patent Literature 1).

[0003]

Patent Literature 1
Japanese Patent Laid-Open No. HEI 4-129988 (Gazette)

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] However, because a contact angle of the main ropes relative to the deflection sheave is smaller than a contact angle of the main ropes relative to the drive sheave, increase in rope traction on the main ropes due to the auxiliary brake is small. Consequently, when the hoisting machine brake and the auxiliary brake are operated to stop the car, the main ropes may slip relative to the drive sheave and the deflection sheave depending on the load weight in the car, and braking force may not be reliably transferred to the car.

[0005] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator safety apparatus that enables braking force to be applied to a car more reliably.

MEANS FOR SOLVING THE PROBLEM

[0006] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator safety apparatus that is disposed in an elevator that has: a car that can be raised and lowered inside a hoistway; a main rope that suspends the car; and a hoisting machine that includes a drive sheave onto which the main rope is wound and that raises and lowers the car by rotation of the drive sheave, the elevator safety apparatus including: a hoisting machine braking apparatus for applying a braking force to the main rope by braking rotation of the drive sheave; an auxiliary brake rope that is connected to the car, and that is separate from the main rope; an auxiliary brake pulley that is disposed in an upper portion of the hoistway, and around which the auxiliary brake rope is wound; and an auxiliary braking apparatus for applying a braking force to the auxiliary brake rope, the elevator safety apparatus being **characterized in that** the car receives the respective braking forces from the main rope and the auxiliary brake rope by respective operation of the hoisting machine braking apparatus and the auxiliary braking apparatus, and is braked directly by the received braking forces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a side elevation that shows an elevator according to Embodiment 1 of the present invention;
Figure 2 is an enlargement that shows an auxiliary braking apparatus from Figure 1; and
Figure 3 is a side elevation that shows an elevator according to Embodiment 2 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

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

Embodiment 1

[0009] Figure 1 is a side elevation that shows an elevator according to Embodiment of the present invention. In the figure, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are respectively installed inside a hoistway 1. A car 4 is guided by the car guide rails 2 while being raised and lowered inside the hoistway 1. A counterweight 5 is guided by the counterweight guide rails 3 while being raised and lowered inside the hoistway 1.

[0010] A machine room 6 is disposed in an upper portion of the hoistway 1. A hoisting machine (a driving machine) 7 and a deflection sheave 8 for raising and lowering the car 4 and the counterweight 5 are disposed inside the machine room 6. The hoisting machine 7 has: a hoisting machine main body 9 that includes a motor; and a drive sheave 10 that is rotated by the hoisting machine main body 9.

[0011] A plurality of main ropes 11 are wound around the drive sheave 10 and the deflection sheave 8. First end portions of the main ropes 11 are connected to the car 4, and second end portions of the main ropes 11 are connected to the counterweight 5. The car 4 and the counterweight 5 are suspended by the main ropes 11. The car 4 and the counterweight 5 are raised and lowered by rotation of the drive sheave 10.

[0012] A hoisting machine braking apparatus 12 for braking rotation of the drive sheave 10 is disposed on the hoisting machine 7. The hoisting machine braking apparatus 12 has: a rotating body that is rotated together with the drive sheave 10; a braking body that can separably contact the rotating body; and a brake driving portion that displaces the braking body in a direction toward

or away from the rotating body (none of which are shown). The rotation of the drive sheave 10 is braked by the braking body contacting the rotating body. A braking force is applied to the main ropes 11 by braking the rotation of the drive sheave 10. The braking force that is applied to the drive sheave 10 by the hoisting machine braking apparatus 12 is removed by separating the braking body from the rotating body.

[0013] The car 4 has: a cage 14 in which a car entrance 13 is disposed; and a car frame 15 that surrounds the cage 14. The car frame 15 has: a lower frame 16 onto which the cage 14 is mounted; an upper frame 17 that is disposed above the cage 14; and a pair of vertical frames 18 that connect two end portions of the lower frame 16 and the upper frame 17. The first end portions of the main ropes 11 are connected to the upper frame 17.

[0014] An emergency stopping apparatus 19 for preventing falling of the car 4 is disposed on the lower frame 16 (i.e., on a lower portion of the car 4). The emergency stopping apparatus 19 has: a gripper that is fixed to the lower frame 16; and a wedge that is displaceable relative to the gripper (neither of which is shown). The emergency stopping apparatus 19 is activated by the wedge jamming between the gripper and the car guide rails 2. The car 4 is prevented from falling by activation of the emergency stopping apparatus 19.

[0015] A speed governor (not shown) for activating the emergency stopping apparatus 19 if the speed of the car 4 becomes abnormal is disposed inside the machine room 6. The speed governor has: a speed governor pulley (not shown) around which is wound a speed governor rope (not shown) that is moved together with the car 4. The speed governor pulley is rotated at a speed that corresponds to movement of the car 4.

[0016] The speed governor rope is connected to an operating lever (not shown) that is disposed on the emergency stopping apparatus 19. In other words, the speed governor rope is coupled to the emergency stopping apparatus 19 by means of the operating lever (not shown). The speed governor rope is gripped by the speed governor if the speed of the car 4 becomes abnormal. The operating lever is operated by the gripping of the speed governor rope by the speed governor, activating the emergency stopping apparatus 19.

[0017] An auxiliary brake pulley (upper portion pulley) 20 that is rotatable around a horizontal axis is also disposed inside the machine room 6. The deflection sheave 8, the drive sheave 10, and the auxiliary brake pulley 20 are disposed so as to be spaced apart from each other. The hoisting machine 7, the deflection sheave 8, and the auxiliary brake pulley 20 are supported by a shared machine base 21 that is fixed inside the machine room 6.

[0018] An auxiliary brake rope 22 that is moved together with the car 4 is wound around the auxiliary brake pulley 20. The auxiliary brake pulley 20 is thereby rotated at a speed that corresponds to the movement of the car 4. The auxiliary brake rope 22 is separate from the main ropes 11.

[0019] An auxiliary brake tension sheave (lower portion pulley) 23 for applying tension to the auxiliary brake rope 22 is disposed in a lower portion inside the hoistway 1. The auxiliary brake tension sheave 23 is rotatable around a horizontal axis. The auxiliary brake tension sheave 23 is disposed on a tip end portion of a pivoting arm 24 that can pivot relative to one of the car guide rails 2. The auxiliary brake tension sheave 23 is displaced vertically by the pivoting of the pivoting arm 24 relative to the car guide rail 2.

[0020] A first end portion 22a and a second end portion 22b of the auxiliary brake rope 22 are connected directly to the upper frame 17. In other words, the auxiliary brake rope 22 is connected to the car 4 so as to avoid the emergency stopping apparatus 19. The auxiliary brake rope 22 is wound from the first end portion 22a sequentially around the auxiliary brake pulley 20 and the auxiliary brake tension sheave 23 to the second end portion 22b.

[0021] An auxiliary braking apparatus 25 for applying a braking force to the auxiliary brake rope 22 is also supported by the machine base 21. In this example, the auxiliary braking apparatus 25 is disposed on a portion of the auxiliary brake rope 22 that is between the auxiliary brake pulley 20 and the first end portion 22a.

[0022] Moreover, driving of the elevator is controlled by a control apparatus (not shown). The hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are activated interdependently with each other by control from the control apparatus. The control apparatus activates the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 to apply braking force to the car 4 when holding the car 4 at a normal stopping position (performing stopping and holding of the car), or when making the car 4 perform an emergency stop (performing emergency braking of the car 4), etc. In other words, the car 4 receives respective braking forces from the main ropes 11 and the auxiliary brake rope 22 due to respective activation of the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25, and is braked directly by the received braking forces.

[0023] Figure 2 is an enlargement that shows the auxiliary braking apparatus 25 from Figure 1. In the figure, the auxiliary braking apparatus 25 has: a rope gripping portion 26 for gripping the auxiliary brake rope 22; and a gripping portion driving portion 27 that activates the rope gripping portion 26.

[0024] The rope gripping portion 26 has: a receiving portion 28 that is fixed relative to the machine base 21; and a displacing portion 29 that is displaceable relative to the receiving portion 28. The displacing portion 29 is displaceable between a gripping position in which the auxiliary brake rope 22 is gripped against the receiving portion 28; and a released position that is further away from the receiving portion 28 than the gripping position. Braking force is applied to the auxiliary brake rope 22 by displacing the displacing portion 29 toward the gripping position. Braking force that is applied to the auxiliary brake rope 22 is released by disengaging the displacing

portion 29 from the gripping position.

[0025] The displacing portion 29 is disposed on the gripping portion driving portion 27 by means of a pivoting body 30. The pivoting body 30 is pivoted by the gripping portion driving portion 27. The displacing portion 29 is displaced between the gripping position and the released position by the pivoting of the pivoting body 30 by the gripping portion driving portion 27. Moreover, a restricting portion 31 for holding the displacing portion 29 in the gripping position is disposed on the receiving portion 28.

[0026] The gripping portion driving portion 27 has: a forcing spring (forcing body) that forces the pivoting body 30 in a direction in which the displacing portion 29 is displaced from the released position toward the gripping position; and a releasing apparatus that pivots the pivoting body 30 in a direction in which the displacing portion 29 is displaced from the gripping position toward the released position in opposition to the force from the forcing spring (neither of which is shown). An electromagnet, or a hydraulic apparatus, etc., can be used for the releasing apparatus, for example.

[0027] Next, operation will be explained. When the car 4 is being raised and lowered inside the hoistway 1 by normal driving of the elevator, respective braking forces that are applied to the drive sheave 10 and the auxiliary brake rope 22 are released by control from the control apparatus.

[0028] When the car 4 is stopped normally at a floor, the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are respectively activated by control from the control apparatus, applying respective braking forces to the main ropes 11 and the auxiliary brake rope 22. The car 4 is thereby stopped and held.

[0029] When movement of the car 4 is started, the respective braking forces that are applied to the main ropes 11 and the auxiliary brake rope 22 are released by control of the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 by the control apparatus.

[0030] If the speed of the car 4 becomes abnormal for any reason and reaches a first preset overspeed that has been set in advance, for example, power supply to the hoisting machine 7 is stopped and the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are also respectively activated by control from the control apparatus. Respective braking forces are thereby applied to the car 4 from the main ropes 11 and the auxiliary brake rope 22, performing an emergency stop on the car 4.

[0031] If the car 4 still does not stop even though the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 have been activated, such as for example when the main ropes 11 have broken, etc., and the speed of the car 4 reaches a second preset overspeed that is larger than the first preset overspeed, the speed governor rope is gripped by the speed governor, activating the emergency stopping apparatus 19. Braking force is thereby applied to the car 4, performing an emergency stop on the car 4.

[0032] In an elevator safety apparatus of this kind, because the car 4 is subjected to respective braking forces from the main ropes 11 and the auxiliary brake rope 22 due to activation of the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25, braking force applied -to the car 4 can be respectively shared by the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 Because the auxiliary braking apparatus 25 brakes the auxiliary brake rope 22, which is separate from the main ropes 11, the auxiliary braking apparatus 25 can be installed easily and the main ropes 11 and the auxiliary brake rope 22 can also each be braked independently. Consequently, burden on the hoisting machine braking apparatus 12 can be reduced compared to when the deflection sheave 8 is braked, and the main ropes 11 can be prevented from slipping relative to the drive sheave 10. Braking force can thereby be applied to the car 4 more reliably.

[0033] Because the auxiliary brake rope 22 is braked by gripping of the auxiliary brake rope 22 by the rope gripping portion 26, the auxiliary brake rope 22 can be braked directly, enabling braking force to be applied to the car 4 even more reliably.

[0034] Moreover, in the above example, the auxiliary brake rope 22 is braked by the auxiliary braking apparatus 25 gripping the auxiliary brake rope 22, but the auxiliary brake rope 22 may also be braked by an- auxiliary braking apparatus braking rotation of the auxiliary brake pulley 20.

[0035] In that case, the auxiliary braking apparatus has: a rotating body that is rotated together with the auxiliary brake pulley 20; and a braking body that can separably contact the rotating body. The rotation of the auxiliary brake pulley 20 is braked by the braking body contacting the rotating body. Braking force that is applied to the auxiliary brake pulley 20 is released by the braking body separating from the rotating body. Because the contact angle of the auxiliary brake rope 22 relative to the auxiliary brake pulley 20 can thereby also be made greater than the contact angle of the main ropes 11 relative to the deflection sheave 8, burden on the hoisting machine braking apparatus 12 can be reduced compared to when rotation of the deflection sheave 8 is braked. Consequently, the main ropes 11 can be prevented from slipping relative to the drive sheave 10, enabling braking force to be applied to the car 4 more reliably. Moreover, a groove on the auxiliary brake pulley 20 into which the auxiliary brake rope 22 is inserted may also be given a V-shaped cross-section (V-shaped groove) in order to improve frictional force from the auxiliary brake rope 22 on the auxiliary brake pulley 20.

[0036] In the above example, the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are activated interdependently, but respective activation of the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 may also be performed selectively. For example, the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 may

also both be activated if the speed of the car 4 is abnormal, and only the hoisting machine braking apparatus 12 activated when performing stopping and holding of the car 4.

Embodiment 2

[0037] Figure 3 is a side elevation that shows an elevator according to Embodiment 2 of the present invention. In the figure, an operating lever (lifting bar) 41 is disposed on an emergency stopping apparatus 19. The emergency stopping apparatus 19 is activated by operating the operating lever 41. A speed governor 42 for activating the emergency stopping apparatus 19 if the speed of a car 4 becomes abnormal (in this example, if the speed of the car 4 reaches a second preset overspeed) is disposed inside a machine room 6.

[0038] The speed governor 42 has: a speed governor main body 43; and a speed governor pulley 44 that is rotatable relative to the speed governor main body 43. The speed governor pulley 44 is disposed so as to be coaxial with an auxiliary brake pulley 20. The speed governor pulley 44 and the auxiliary brake pulley.20 are rotated together.

[0039] A speed governor rope 45 that is connected to the operating lever 41 is wound around the speed governor pulley 44. In other words, the speed governor rope 45, which is coupled to the emergency stopping apparatus 19 by means of the operating lever 41, is wound around the speed governor pulley 44. The speed governor pulley 44 is thereby rotated at a speed that corresponds to the movement of the car 4.

[0040] A speed governor tension sheave 46 for applying tension to the speed governor rope 45 is disposed in a lower portion inside a hoistway 1. The speed governor tension sheave 46 is disposed so as to be coaxial with an auxiliary brake tension sheave 23. Consequently, the speed governor tension sheave 46 is displaced vertically together with the auxiliary brake tension sheave 23 by pivoting of a pivoting arm 24 relative to a car guide rail 2. The speed governor tension sheave 46 and the auxiliary brake tension sheave 23 are rotated together.

[0041] A first end portion 45a and a second end portion 45b of the speed governor rope 45 are respectively connected to the operating lever 41. The speed governor rope 45 is wound from the first end portion 45a sequentially around the speed governor pulley 44 and the speed governor tension sheave 46 to the second end portion 45b.

[0042] The speed governor main body 43 grips the speed governor rope 45 if the rotational speed of the speed governor pulley 44 reaches a predetermined overspeed. The car 4 is displaced relative to the speed governor rope 45 by gripping of the speed governor rope 45 by the speed governor main body 43. The operating lever 41 is thereby operated, activating the emergency stopping apparatus 19. The rest of the configuration and operation thereof are similar to Embodiment 1.

[0043] Next, operation will be explained. When the car 4 is being raised and lowered inside the hoistway 1 by normal driving of the elevator, respective braking forces that are applied to the drive sheave 10 and the auxiliary brake rope 22 are released by control from the control apparatus. Here, the auxiliary brake pulley 20 and the speed governor pulley 44 are rotated together.

[0044] When the car 4 is stopped normally at a floor by control from the control apparatus, the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are respectively activated by control from the control apparatus, applying respective braking forces to the main ropes 11 and the auxiliary brake rope 22. The car 4 is thereby stopped and held.

[0045] When movement of the car 4 is started, the respective braking forces that are applied to the main ropes 11 and the auxiliary brake rope 22 are released by control of the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 by the control apparatus.

[0046] If the speed of the car 4 becomes abnormal for any reason and reaches a first preset overspeed that has been set in advance, for example, power supply to the hoisting machine 7 is stopped and the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 are also respectively activated by control from the control apparatus. Respective braking forces are thereby applied to the car 4 from the main ropes 11 and the auxiliary brake rope 22, performing an emergency stop on the car 4.

[0047] If the car 4 still does not stop even though the hoisting machine braking apparatus 12 and the auxiliary braking apparatus 25 have been activated, such as for example when the main ropes 11 have broken, etc., and the speed of the car 4 reaches a second preset overspeed that is larger than the first preset overspeed, the speed governor rope 45 is gripped by the speed governor main body 43, activating the emergency stopping apparatus 19. Braking force is thereby applied to the car 4, performing an emergency stop on the car 4.

[0048] In an elevator safety apparatus of this kind, because the auxiliary brake pulley 20 and the speed governor pulley 44 are disposed coaxially, the auxiliary brake pulley 20 and the speed governor pulley 44 can be rotated around a shared shaft, enabling reductions in installation space for the auxiliary brake pulley 20 and the speed governor pulley 44.

[0049] Moreover, in the above example, the auxiliary brake pulley 20 and the speed governor pulley 44 are integrated, and the auxiliary brake tension sheave 23 and the speed governor tension sheave 46 are integrated, but the auxiliary brake pulley 20 and the speed governor pulley 44 may also respectively be made independently rotatable from each other, and the auxiliary brake tension sheave 23 and the speed governor tension sheave 46 may also respectively be made independently rotatable from each other. Braking force can thereby be prevented from being transferred between the auxiliary brake rope

22 and the speed governor rope 45. Thus, braking force that is applied to the auxiliary brake rope 22 can be prevented from hindering rotation of the speed governor pulley 44, for example, enabling respective functions of the auxiliary braking apparatus 25 and the speed governor 42 to be performed more reliably.

[0050] In the above example, the auxiliary brake tension sheave 23 and the speed governor tension sheave 46 are disposed coaxially, but the auxiliary brake tension sheave 23 may also be displaceable vertically relative to the speed governor tension sheave 46. Methods for making the auxiliary brake tension sheave 23 displaceable vertically relative to the speed governor tension sheave 46 include respectively disposing the auxiliary brake tension sheave 23 and the speed governor tension sheave 46 on two pivoting arms that pivot independently from each other, or guiding the shaft of the auxiliary brake tension sheave 23 relative to the shaft of the speed governor tension sheave 46 using a rail, for example. Reductions in respective tensions that are applied to the auxiliary brake rope 22 and the speed governor rope 45 can thereby be prevented even if respective amounts of long-term elongation of the auxiliary brake rope 22 and the speed governor rope 45 are different from each other.

[0051] In the above example, the auxiliary braking apparatus 25 is disposed inside the machine room 6, but the auxiliary braking apparatus 25 may also be disposed in a gap between the inner wall surface of the hoistway 1 and the car 4. Space inside the hoistway 1 can thereby be utilized effectively.

Claims

1. An elevator safety apparatus that is disposed in an elevator that has:

   a car that can be raised and lowered inside a hoistway;
   a main rope that suspends the car; and
   a hoisting machine that includes a drive sheave onto which the main rope is wound and that raises and lowers the car by rotation of the drive sheave,
   the elevator safety apparatus comprising:
   a hoisting machine braking apparatus for applying a braking force to the main rope by braking rotation of the drive sheave;
   an auxiliary brake rope that is connected to the car, and that is separate from the main rope;
   an auxiliary brake pulley that is disposed in an upper portion of the hoistway, and around which the auxiliary brake rope is wound; and
   an auxiliary braking apparatus for applying a braking force to the auxiliary brake rope,
   the elevator safety apparatus being **characterized in that** the car receives the respective braking forces from the main rope and the auxiliary brake rope by respective operation of the hoisting machine braking apparatus and the auxiliary braking apparatus, and is braked directly by the received braking forces.

2. An elevator safety apparatus according to Claim 1, **characterized in that** the auxiliary braking apparatus applies the braking force to the auxiliary brake rope by gripping the auxiliary brake rope.

3. An elevator safety apparatus according to Claim 1, **characterized in that** the auxiliary braking apparatus applies the braking force to the auxiliary brake rope by braking rotation of the auxiliary brake pulley.

4. An elevator safety apparatus according to Claim 1, **characterized in that:**

   an emergency stopping apparatus for preventing falling of the car is disposed on the car;
   a speed governor that activates the emergency stopping apparatus if a speed of the car becomes abnormal is disposed in an upper portion of the hoistway;
   the speed governor has a speed governor sheave onto which is wound a speed governor rope that is coupled to the emergency stopping apparatus; and
   the auxiliary brake pulley and the speed governor sheave are disposed coaxially.

5. An elevator safety apparatus according to Claim 4, **characterized in that** the auxiliary brake pulley and the speed governor sheave are rotatable independently from each other.

6. An elevator safety apparatus according to Claim 4, **characterized in that:**

   a first end portion and a second end portion of the auxiliary brake rope are respectively connected to the car;
   a first end portion and a second end portion of the speed governor rope are respectively coupled to the emergency stopping apparatus;
   a speed governor tension sheave for applying tension to the speed governor rope and an auxiliary brake tension sheave for applying tension to the auxiliary brake rope are disposed in a lower portion of the hoistway; and
   the auxiliary brake tension sheave is displaceable vertically relative to the speed governor tension sheave.

7. An elevator safety apparatus according to Claim 1, **characterized in that** the auxiliary braking apparatus is disposed in a gap between an inner wall surface of the hoistway and the car.

FIG. 1

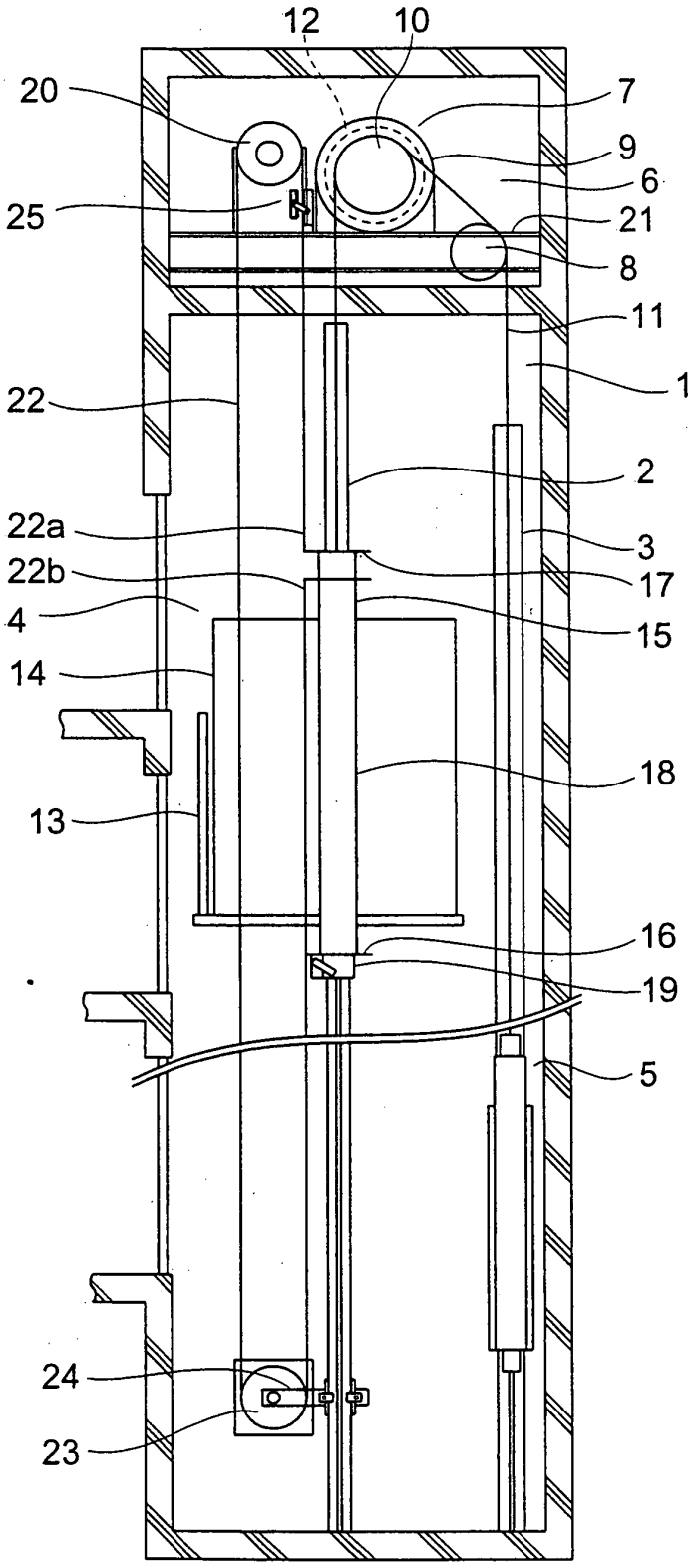


FIG. 2

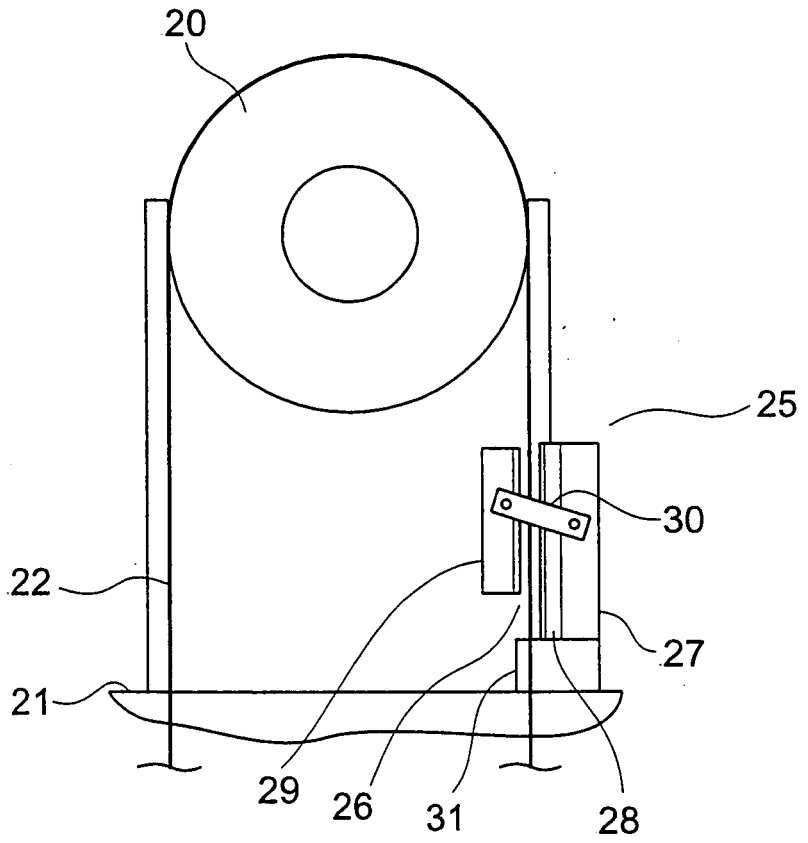
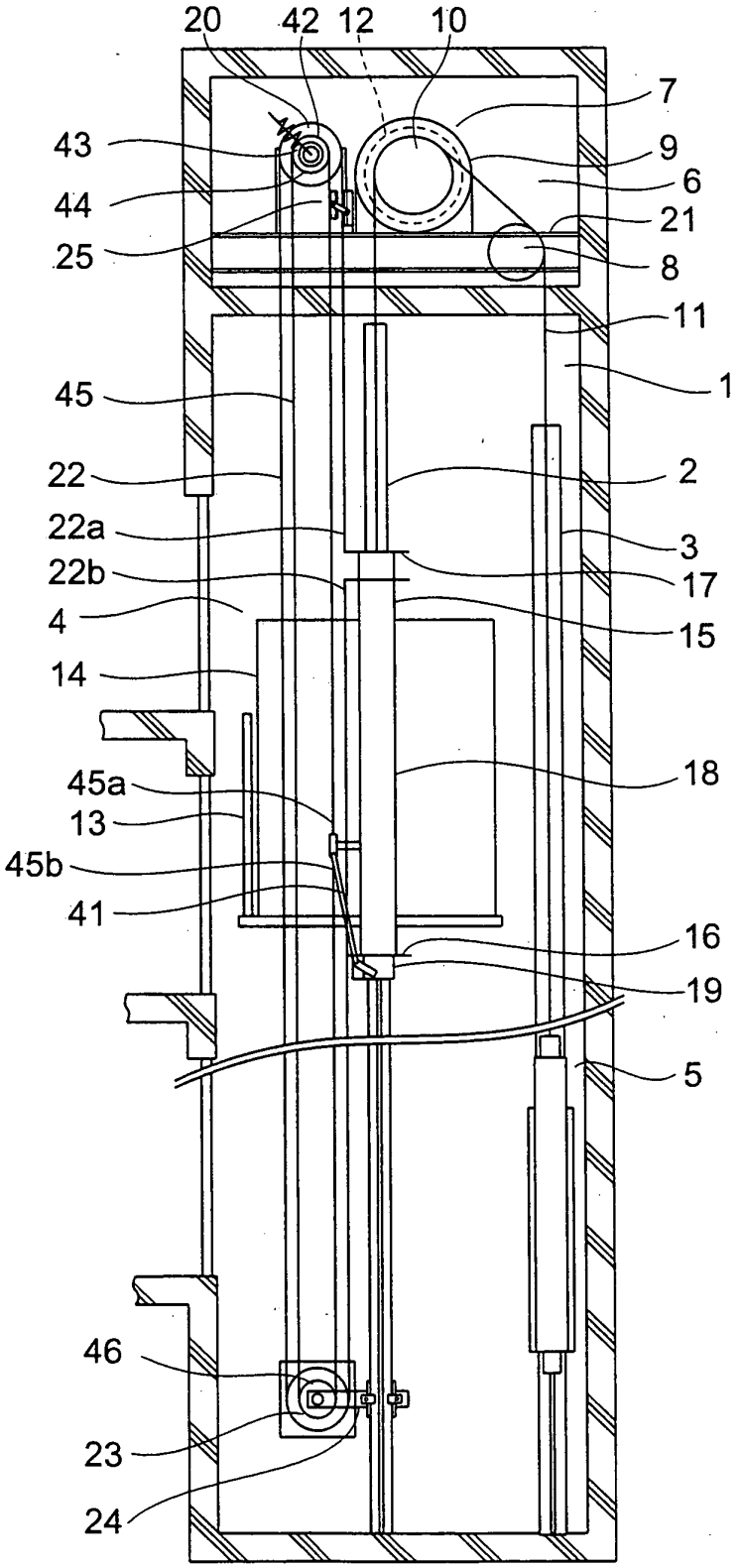


FIG. 3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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/309393

A. CLASSIFICATION OF SUBJECT MATTER
B66B5/16(2006.01)i, *B66B7/06*(2006.01)i

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-B66B20/00

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2006-027784 A (Hitachi, Ltd.), 02 February, 2006 (02.02.06), Claim 1; Par. No. [0007]; Figs. 1 to 3 (Family: none)	1,3,7 2 4-6
Y A	JP 59-074875 A (Mitsubishi Electric Corp.), 27 April, 1984 (27.04.84), Page 3, lower left column, lines 2 to 6; Fig. 6 Page 2, lower right column, line 20 to page 3, lower left column, line 1; Figs. 4 to 5 (Family: none)	2 4-6
A	WO 2002/072461 A1 (Mitsubishi Electric Corp.), 19 September, 2002 (19.09.02), Abstract; Fig. 1 & US 2003/0155185 A1 & EP 1367017 A1 & CN 1429173 A	1

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

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
26 January, 2007 (26.01.07)	06 February, 2007 (06.02.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/309393

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 2001-010774 A (Mitsubishi Electric Corp.), 16 January, 2001 (16.01.01), Par. Nos. [0040] to [0047]; Figs. 7 to 11 (Family: none)	1
A	JP 55-145984 A (Hitachi, Ltd.), 13 November, 1980 (13.11.80), Claims 1 to 2; Figs. 2 to 3 (Family: none)	1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP HEI4129988 B **[0003]**