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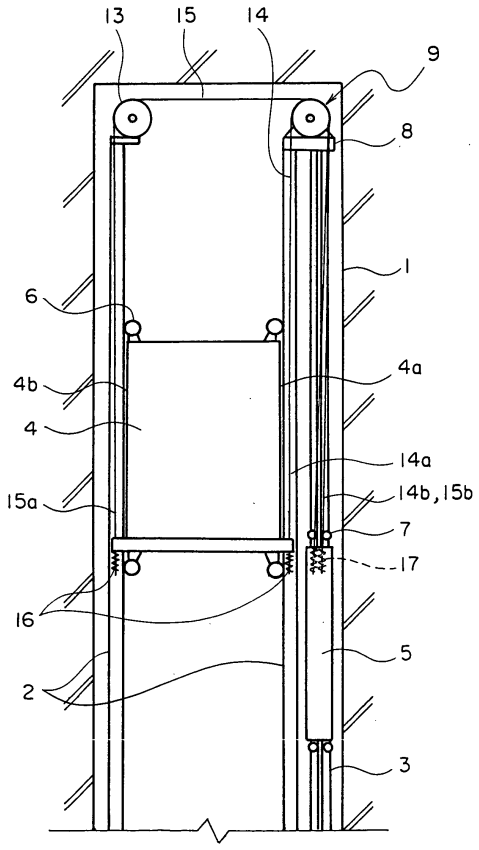
(54) **ELEVATOR APPARATUS**

(57) In an elevator apparatus, a driving machine having a drive sheave is installed in an upper portion of a hoistway. A return pulley is also installed in an upper portion of the hoistway. A car and a counterweight are suspended by first and second main ropes. The first main ropes have: first car end portions connected to the car near a first side surface portion; and first counterweight end portions connected to the counterweight, and are wound around the drive sheave. The second main ropes have: second car end portions connected to the car near a second side surface portion; and second counterweight end portions connected to the counterweight, and are wound around the drive sheave and the return pulley.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator apparatus in which a car and a counterweight are raised and lowered inside a hoistway by a driving force from a driving machine installed in an upper portion of the hoistway.

BACKGROUND ART

[0002] In conventional elevator apparatuses such as that shown in Japanese Patent No. 3353032 (Gazette), for example, a hoisting machine is installed above a counterweight inside a hoistway. A car and a counterweight are suspended inside the hoistway by a main rope wound around a drive sheave of the hoisting machine. In order to ensure sufficient traction, a contact angle of the main rope relative to the drive sheave is approximately 180 degrees.

[0003] However, in conventional elevator apparatuses, since the contact angle of the main rope is 180 degrees, a point of suspension of the car by the main rope is to one side of the car, in other words, at a position away from a center of gravity. For that reason, a large load acts on guide rails for guiding raising and lowering of the car, giving rise to a necessity to use expensive, high-strength guide rails. Since large reaction forces act on guide rollers engaging the guide rails, vibrations are generated in the car when the car is operated at high speed, hindering increases in speed.

[0004] In addition, if a two-to-one (2:1) roping method is adopted in order to suspend the car at the center of gravity, overall construction becomes complicated, and the number of parts also increases, and there is a risk that equipment costs and installation costs may be increased.

DISCLOSURE OF THE INVENTION

[0005] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling a point of suspension of a car to be positioned closer to a center of gravity by a simple construction.

[0006] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus including: a driving machine having a drive sheave, the driving machine being disposed in an upper portion of a hoistway; a car having mutually opposite first and second side surface portions, the car being raised and lowered inside the hoistway by a driving force from the driving machine; a counterweight raised and lowered inside the hoistway by a driving force from the driving machine; a return pulley disposed above the second side surface portion; a first main rope including a first car end portion connected to the car near the first side surface portion and a first counterweight end portion connected to the counterweight, the first main rope being wound around the drive sheave, and suspending the car and the counterweight; and a second main rope including a second car end portion connected to the car near the second side surface portion and a second counterweight end portion connected to the counterweight, the second main rope being wound around the drive sheave and the return pulley, and suspending the car and the counterweight.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a front elevation showing part of an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a plan showing the elevator apparatus in Figure 1;
Figure 3 is a front elevation showing part of an elevator apparatus according to Embodiment 2 of the present invention;
Figure 4 is a plan showing the elevator apparatus in Figure 3;
Figure 5 is a front elevation showing part of an elevator apparatus according to Embodiment 3 of the present invention; and
Figure 6 is a front elevation showing part of an elevator apparatus according to Embodiment 4 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 front elevation showing part of an elevator apparatus according to Embodiment 1 of the present invention, and Figure 2 is a plan showing the elevator apparatus in Figure 1.

[0010] In the figures, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are installed inside a hoistway 1. A car 4 is guided by the car guide rails 2 so as to be raised and lowered inside the hoistway 1. A counterweight 5 is guided by the counterweight guide rails 3 so as to be raised and lowered inside the hoistway 1.

[0011] The car 4 includes mutually opposite first and second side surface portions 4a and 4b. The counterweight 5 is disposed so as to face the first side surface portion 4a in a plane projected vertically. The car guide rails 2 and the counterweight guide rails 3 are disposed such that an imaginary straight line connecting the counterweight guide rails 3 extends at a right angle relative to an imaginary straight line connecting the car guide

rails 2 in a plane projected vertically.

[0012] A plurality of car guiding apparatuses 6 for engaging the car guide rails 2 are mounted to the car 4. The car guiding apparatuses 6 are disposed on first and second edge portions in a width direction on an upper portion of the car 4 and on first and second edge portions in the width direction on a lower portion of the car 4.

[0013] A plurality of counterweight guiding apparatuses 7 for engaging the counterweight guide rails 3 are mounted to the counterweight 5. The counterweight guiding apparatuses 7 are disposed on first and second edge portions in a width direction on an upper portion of the counterweight 5 and on first and second edge portions in the width direction on a lower portion of counterweight 5.

[0014] Roller guiding apparatuses, for example, can be used for the car guiding apparatuses 6 and the counterweight guiding apparatuses 7.

[0015] A supporting platform 8 (omitted from Figure 2) is installed in an upper portion inside the hoistway 1. The supporting platform 8 is fixed relative to at least one of the guide rails 2 and 3, and load on the supporting platform 8 is supported by that guide rail 2 or 3.

[0016] A driving machine 9 for raising and lowering the car 4 and the counterweight 5 is disposed on the supporting platform 8, specifically, above the counterweight 5. The driving machine 9 has: a driving machine main body 10; a drive sheave 11 rotated by the driving machine main body 10; and a shaft supporting portion 12 for supporting a rotating shaft of the drive sheave 11 at an opposite end from the driving machine main body 10. A motor for generating a driving force, and a braking apparatus for braking rotation of the drive sheave 11 are disposed on at least one of the driving machine main body 10 and the shaft supporting portion 12.

[0017] A cylindrical hoisting machine having an axial length dimension that is greater than a diameter of the drive sheave 10 is used for the driving machine 9. The driving machine 9 is disposed so as to overlap partially with the counterweight 5 and not to overlap with the car 4 in a plane projected vertically. In addition, the driving machine 9 is installed such that a rotating shaft of the drive sheave 10 extends parallel (including generally parallel) to a depth direction of the car 4 and a width direction of the counterweight 5 and horizontally (including generally horizontally).

[0018] A rotatable return pulley 13 is disposed above the second side surface portion 4b inside the hoistway 1. The return pulley 13 is mounted onto the supporting platform 8 so as to be at a height equal to that of the drive sheave 11. The return pulley 13 is installed such that a rotating shaft thereof extends parallel to a rotating shaft of the drive sheave 11. In addition, a diameter of the return pulley 13 is equal to a diameter of the drive sheave 11.

[0019] The car 4 and the counterweight 5 are suspended inside the hoistway 1 by a plurality of first main ropes 14 and a plurality of second main ropes 15. Here, the number of first and second main ropes 14 and 15 is equal (two of each in Figure 2, for example).

[0020] The first main ropes 14 are wound around the drive sheave 11. The first main ropes 14 have: first car end portions 14a connected to a lower portion of the car 4 near the first side surface portion 4a; and first counterweight end portions 14b connected to the counterweight 5.

[0021] The second main ropes 15 are wound around the drive sheave 11 and the return pulley 13. The second main ropes 15 have: second car end portions 15a connected to a lower portion of the car 4 near the second side surface portion 4b; and second counterweight end portions 15b connected to the counterweight 5.

[0022] A plurality of car springs 16 that permit inclination of the main ropes 14 and 15 are disposed on connecting portions between the first and second main ropes 14 and 15 and the car 4. A plurality of counterweight springs 17 that permit inclination of the main ropes 14 and 15 are disposed on connecting portions between the first and second main ropes 14 and 15 and the counterweight 5.

[0023] Main rope connecting portions 4c and 4d (see Figure 2) to which the first and second car end portions 14a and 15a are connected are disposed on first and second sides in a width direction of a lower portion of the car 4. An imaginary straight line connecting the main rope connecting portions 4c and 4d extends parallel to a direction of frontage of the car 4 and passes through a center of gravity of the car 4 in a plane projected vertically. In other words, a point of suspension of the car 4 by the first and second main ropes 14 and 15 is aligned with the center of gravity of the car 4.

[0024] In an elevator apparatus of this kind (a machine-roomless elevator), since the car 4 is suspended substantially at its center of gravity by distributing the first and second main ropes 14 and 15 to two sides of the car 4, the car 4 can be raised and lower stably, enabling the strength of the guide rails 2 and 3 to be reduced, and costs also to be reduced. Vibrations generated in the car 4 during running are also suppressed, making it possible to operate the car 4 at high speed.

[0025] In addition, since the configuration uses a one-to-one (1:1) roping method, fewer parts are required than for a two-to-one (2:1) roping method, enabling the construction to be simplified.

[0026] Since a contact angle of the second main ropes 15 on the drive sheave 11 can be made approximately 180 degrees, sufficient traction capacity can be ensured.

Embodiment 2

[0027] Figure 3 is a front elevation showing part of an elevator apparatus according to Embodiment 2 of the present invention, and Figure 4 is a plan showing the elevator apparatus in Figure 3.

[0028] In the figures, a first pulley 21 that rotates together with the drive sheave 11 is disposed on the rotat-

ing shaft of the drive sheave 11. A second pulley 22 that rotates together with the return pulley 13 is disposed on the rotating shaft of the return pulley 13. An annular timing belt 23 functioning as an annular member is wound around the first and second pulleys 21 and 22. A synchronizing means includes: the first pulley 21, the second pulley 22, and the timing belt 23. The rest of the configuration is similar to that of Embodiment 1.

[0029] In an elevator apparatus of this kind, rotation of the drive sheave 11 is transmitted to the return pulley 13 by means of the first pulley 21, the timing belt 23, and the second pulley 22. Thus, rotation of the drive sheave 11 and rotation of the return pulley 13 are constantly synchronized. In other words, the return pulley 13 functions in a similar manner to the drive sheave 11. Consequently, traction can also be substantially improved for the second main ropes 15.

Embodiment 3

[0030] Figure 5 is a front elevation showing part of an elevator apparatus according to Embodiment 3 of the present invention. In the figure, a tension adjusting mechanism 24 for adjusting tension in a timing belt 23 is disposed in a vicinity of a first pulley 21. The tension adjusting mechanism 24 has: an idle pulley rotating in contact with the timing belt 23; and a pressing means for pressing the idle pulley against the timing belt 23. The pressing force of the idle pulley on the timing belt 23 is adjustable. The rest of the configuration is similar to that of Embodiment 2.

[0031] In an elevator apparatus of this kind, the tension in the timing belt 23 can be stabilized, enabling traction in the second main ropes 15 to be improved more reliably.

Embodiment 4

[0032] Figure 6 is a front elevation showing part of an elevator apparatus according to Embodiment 4 of the present invention. In the figure, a rotatable deflection sheave 25 functioning as a contact angle increasing means around which the second main ropes 15 are wound is disposed in a vicinity of a drive sheave 11.

[0033] A deflection sheave 25 is disposed in upper portion inside the hoistway 1 between the drive sheave 11 and a return pulley 13. More specifically, a portion of second main ropes 15 between the drive sheave 11 and the return pulley 13 is wound around the deflection sheave 25.

[0034] The portion of the second main ropes 15 between the drive sheave 11 and the return pulley 13 is displaced downward by the deflection sheave 25. Thus, the contact angles of the second main ropes 15 on the drive sheave 11 and the return pulley 13 are both increased. The rest of the configuration is similar to that of Embodiment 1.

[0035] Thus, because the contact angle of the second main ropes 15 on the drive sheave 11 is increased by using the deflection sheave 25, traction can be improved.

[0036] Moreover, resin-coated ropes in which an outer layer coating body composed of a high-friction resin material is disposed on an outer peripheral portion can be used for ropes constituting the first and second main ropes 14 and 15. By using resin-coated ropes of this kind, a large traction force can be ensured with a reduced contact angle. Since resin-coated ropes enable flexibility to be increased more than simple steel ropes, diameters of the drive sheave 11 and the return pulley 13 can be reduced.

[0037] In the above examples, roller guiding apparatuses were used for the car guiding apparatuses 6 and the counterweight guiding apparatuses 7, but it is also possible to use sliding guide shoes.

[0038] In addition, in the above examples, the driving machine 9 and the return pulley 13 were supported by the guide rails 2 and 3, but they may also be supported by a building, for example, by supporting portions fixed to a beam fixed to the building, or by a hoistway wall, etc.

[0039] The driving machine 9 and the return pulley 13 may also be modularized as a driving machine unit by mounting them to a shared supporting platform 8. Thus, on-site installation can be simplified.

[0040] In the above examples, the return pulley 13 is disposed at a height equal to that of the drive sheave 11, but the return pulley 13 may also be disposed so as to be offset vertically relative to the drive sheave 11.

[0041] In the above examples, the diameter of the return pulley 13 and the diameter of the drive sheave 11 were equal, but the diameters may also be mutually-different if required.

[0042] In the above examples, the number of first main ropes 14 and the number of second main ropes 15 was equal, but the numbers may also be mutually-different if required.

[0043] Ropes having different cross-sectional constructions, or made of different materials, etc., may also be used for the first main ropes 14 and the second main ropes 15.

[0044] In addition, in the above examples, pulleys 21 and 22 and a timing belt 23 were combined as a synchronizing means, but the synchronizing means is not limited to these, and for example, sprockets and chains may also be combined.

[0045] In the above examples, a deflection sheave 25 was shown as the contact angle increasing means, but the contact angle increasing means may also be a guiding member for guiding the second main ropes 15 without rotating. In that case, it is preferable for a sliding surface for the second main ropes 15 on the guiding member to be constituted by a low-friction member.

[0046] In the above examples, main rope connecting portions 4c and 4d were disposed on a lower portion of a car 4, but they may also be disposed on between an upper portion and the lower portion, or on the upper portion, etc., provided that sufficient supporting strength can be ensured.

Claims

1. An elevator apparatus comprising:

   a driving machine having a drive sheave, the driving machine being disposed in an upper portion of a hoistway;
   a car having mutually opposite first and second side surface portions, the car being raised and lowered inside the hoistway by a driving force from the driving machine;
   a counterweight raised and lowered inside the hoistway by a driving force from the driving machine;
   a return pulley disposed above the second side surface portion;
   a first main rope including a first car end portion connected to the car near the first side surface portion and a first counterweight end portion connected to the counterweight, the first main rope being wound around the drive sheave, and suspending the car and the counterweight; and
   a second main rope including a second car end portion connected to the car near the second side surface portion and a second counterweight end portion connected to the counterweight, the second main rope being wound around the drive sheave and the return pulley, and suspending the car and the counterweight.

2. The elevator apparatus according to Claim 1, wherein the driving machine is a cylindrical hoisting machine having an axial length dimension that is greater than a diameter of the drive sheave.

3. The elevator apparatus according to Claim 1, wherein the driving machine is installed such that a rotating shaft of the drive sheave extends horizontally.

4. The elevator apparatus according to Claim 3, wherein the return pulley is installed such that a rotating shaft thereof extends parallel to the rotating shaft of the drive sheave.

5. The elevator apparatus according to Claim 3, wherein the driving machine is installed above the counterweight such that the rotating shaft of the drive sheave extends parallel to a depth direction of the car.

6. The elevator apparatus according to Claim 1, further comprising a synchronizing means for synchronizing rotation of the drive sheave and rotation of the return pulley.

7. The elevator apparatus according to Claim 6, wherein the synchronizing means includes a first pulley rotating together with the drive sheave, a second pulley rotating together with the return pulley, and an annular member wound around the first and second pulleys.

8. The elevator apparatus according to Claim 7, wherein the synchronizing means further comprises a tension adjusting mechanism for adjusting tension in the annular member.

9. The elevator apparatus according to Claim 1, further comprising a contact angle increasing means for increasing a contact angle of the second main rope on the drive sheave by displacing a portion of the second main rope between the drive sheave and the return pulley.

10. The elevator apparatus according to Claim 9, wherein the contact angle increasing means is a deflection sheave around which the second main rope is wound.

FIG. 1

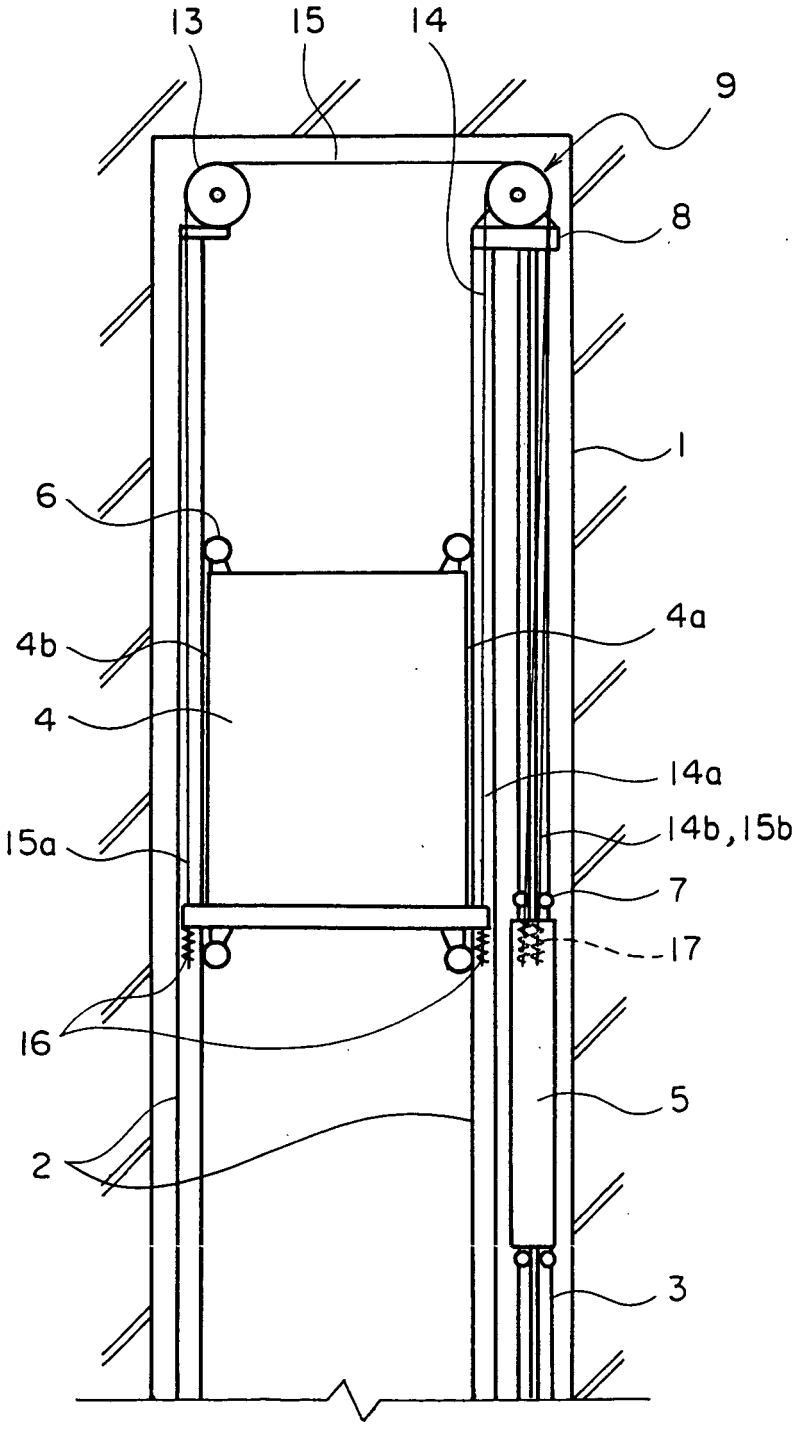


FIG. 2

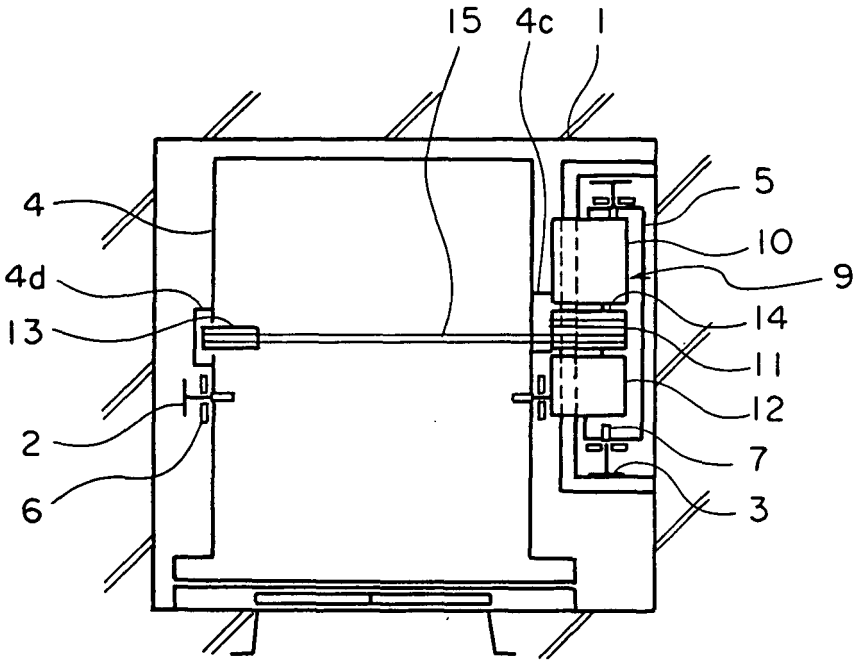


FIG. 3

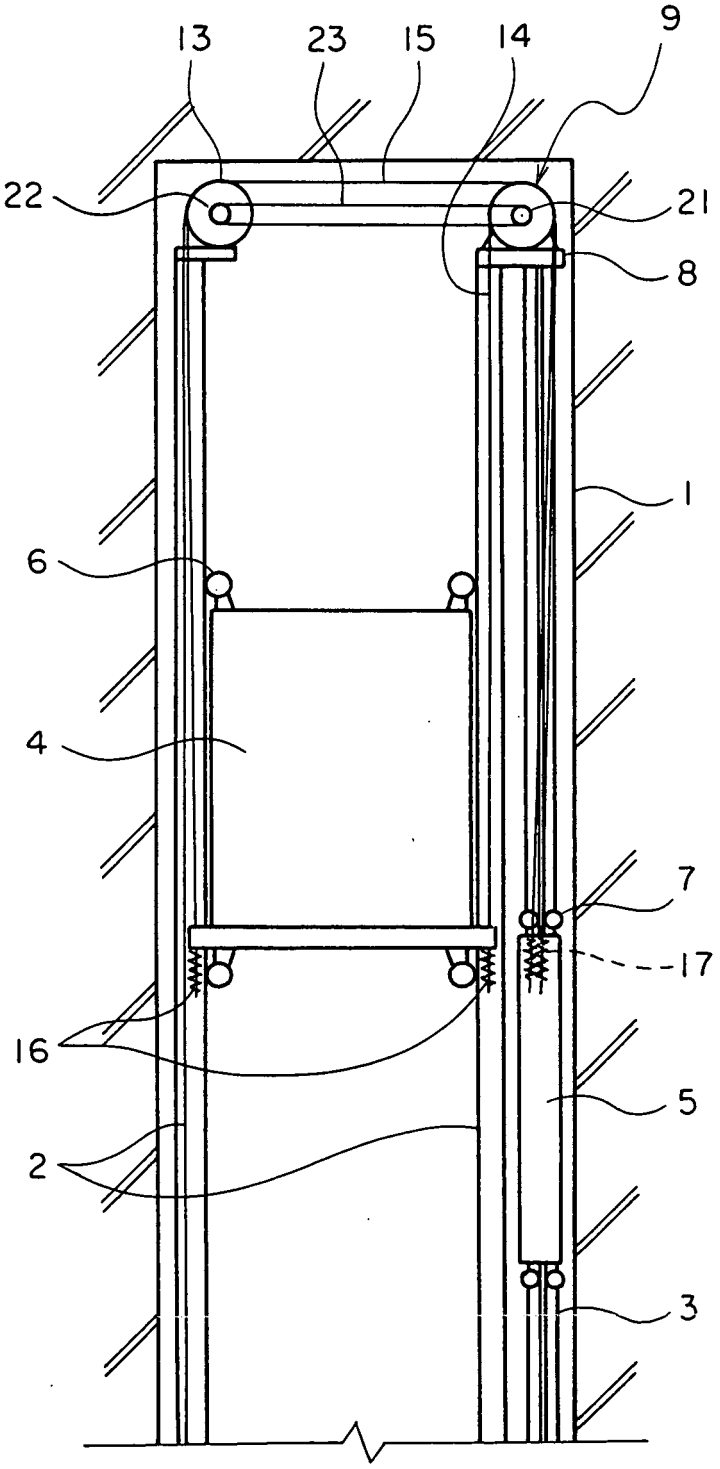


FIG. 4

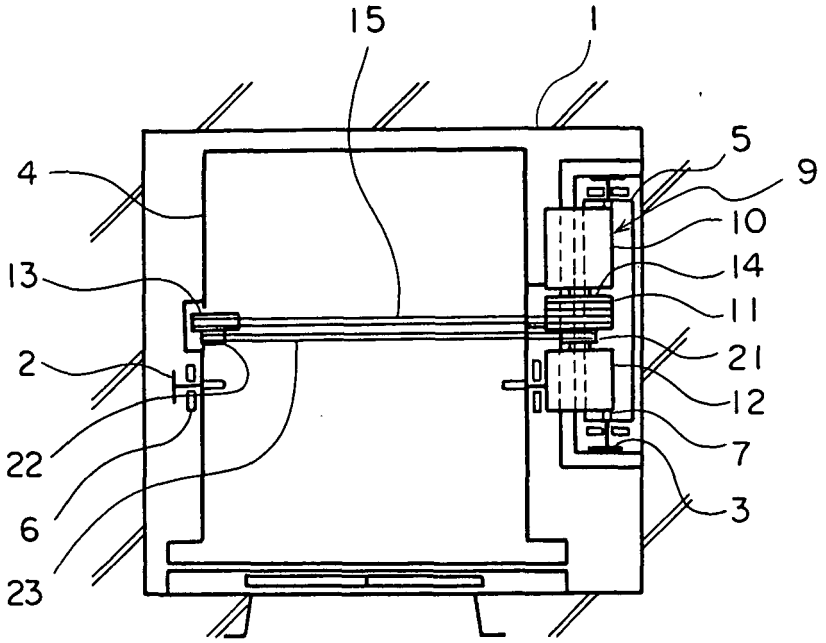


FIG. 5

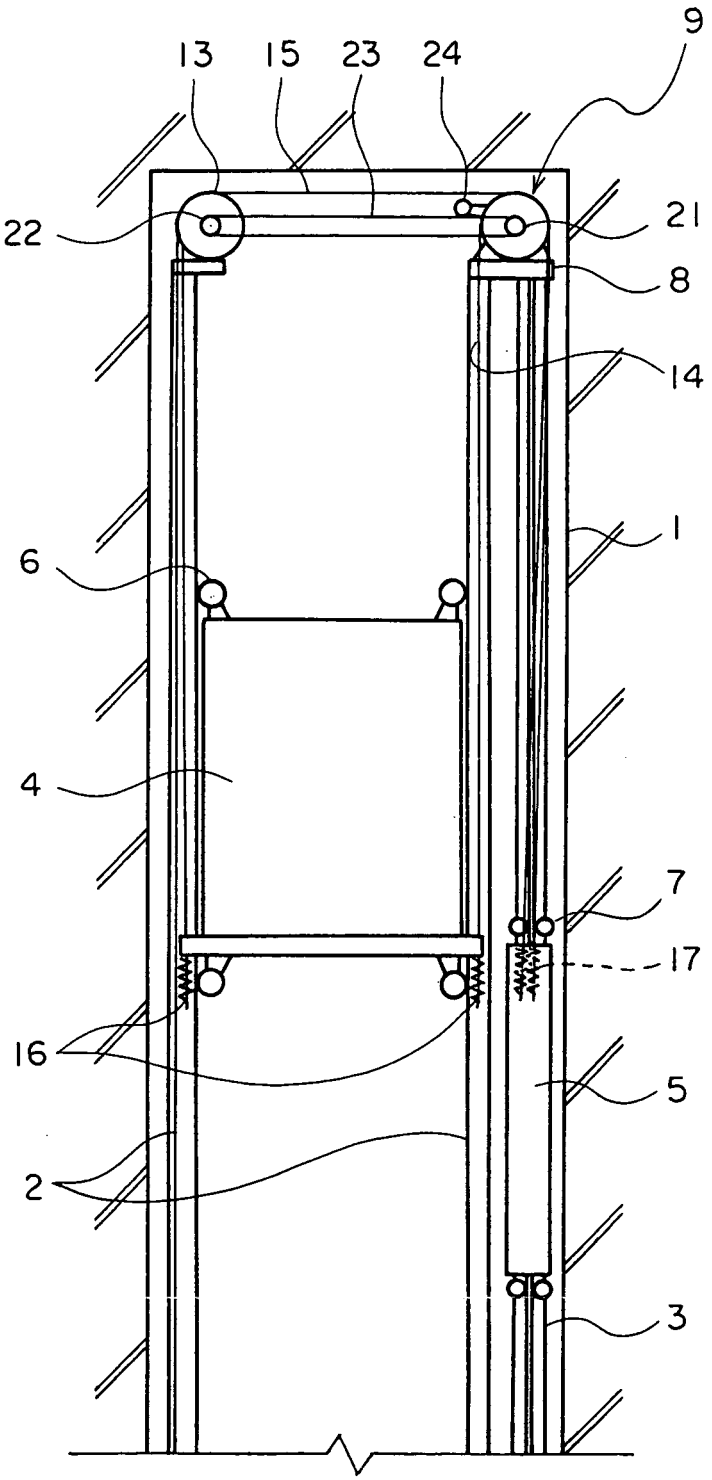
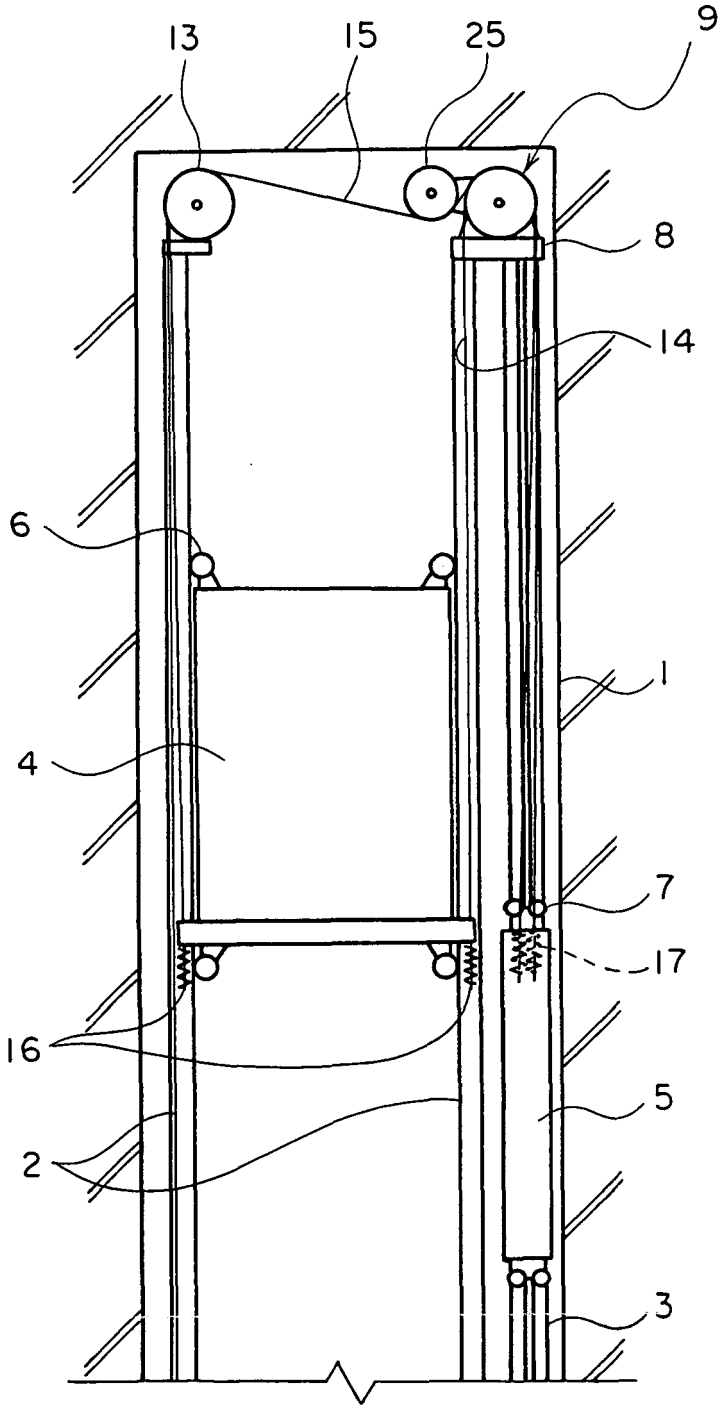


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/15881

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B7/06

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)
Int.Cl[7] B66B7/00-B66B11/08

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	1996-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Toroku Jitsuyo Shinan Koho	1994-2004

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 A	JP 11-246145 A (Toshiba Corp.), 14 September, 1999 (14.09.99), Par. Nos. [0045] to [0047]; Fig. 7 (Family: none)	1-4 5-10
Y A	WO 03/043922 A1 (INVENTION AG.), 30 May, 2003 (30.05.03), Description, page 16, line 6 to page 7, line 12; Fig. 5 (Family: none)	1-7 8-10
Y A	JP 2002-145556 A (Mitsubishi Electric Corp.), 22 May, 2002 (22.05.02), Par. Nos. [0020] to [0021]; Figs. 3 to 4 (Family: none)	1-7 8-10

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Date of the actual completion of the international search 30 August, 2004 (30.08.04)	Date of mailing of the international search report 14 September, 2004 (14.09.04)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/15881

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 11-21045 A (Hitachi, Ltd.), 26 January, 1999 (26.01.99), Par. No. [0006]; Fig. 1 (Family: none)	1-10

Form PCT/ISA/210 (continuation of second sheet) (July 1998)