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

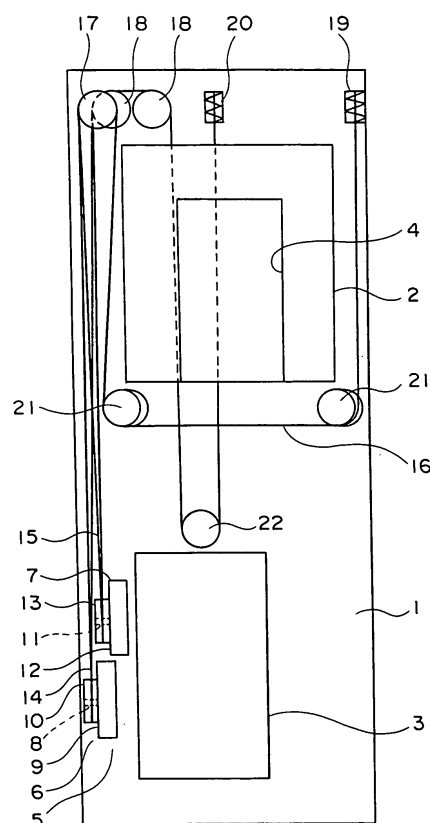
(72) Inventor: **IKEDA, Shiroh,**
c/o Mitsubishi Denki K.K.
Tokyo 1008310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **ELEVATOR APPARATUS**

(57) Provided within a hoistway is a driving force generating unit for generating a driving force for raising/lowering a car and a counterweight. The driving force generating unit has a thin-type first drive device including a first drive sheave, and a thin-type second drive device including a second drive sheave. A main rope body for suspending the car and the counterweight has a first main rope that is looped around the first drive sheave while bypassing the second drive sheave, and a second main rope that is looped around the second drive sheave while bypassing the first drive sheave. A part of the first drive device overlaps with a region of the second drive device on a vertical projection plane of the hoistway, while the first drive sheave is arranged outside the region of the second drive device on the vertical projection plane of the hoistway.

FIG. 1



Description

Technical Field

[0001] The present invention relates to an elevator apparatus having a car and a counterweight that are raised/lowered within a hoistway.

Background Art

[0002] In a conventional elevator apparatus, two thin-type hoisting machines may be provided in an upper portion within a hoistway to achieve increase in capacity. The thin-type hoisting machines face each other so as to sandwich a car on a vertical projection plane of the hoistway. Different suspending ropes are looped around traction sheaves of the thin-type hoisting machines, respectively.

Each of the suspending ropes is connected at one end thereof to the car, and at the other end thereof to a counterweight. The car and the counterweight are suspended within the hoistway by means of the suspending ropes, respectively.

[0003] In another conventional elevator apparatus, two thin-type hoisting machines may be arranged side by side in an upper portion within a hoistway such that axes of traction sheaves extend parallel to each other. In this case, a common suspending rope is looped around the traction sheaves of the thin-type hoisting machines, respectively. The suspending rope is connected at one end thereof to a car, and at the other end thereof to a counterweight. The suspending rope is looped around one of the traction sheaves, then around the other traction sheave, and around the aforementioned one of the traction sheaves again. In other words, the suspending rope is looped around each of the traction sheaves according to a full-wrap roping method (see Patent Document 1).

[0004] Patent Document 1 : JP 11-310372 A

Disclosure of the Invention

Problem to be solved by the Invention

[0005] However, in the elevator apparatus having the thin-type hoisting machines arranged so as to face each other, the thin-type hoisting machines are arranged apart from each other on the vertical projection plane of the hoistway. Therefore, a space for installing the two thin-type hoisting machines is required in a horizontal direction, so the horizontal cross-sectional area of the hoistway increases.

[0006] In the elevator apparatus having the thin-type hoisting machines arranged side by side, the suspending rope is looped around each of the traction sheaves according to the full-wrapping method. Therefore, a life of the suspending rope is short.

[0007] The present invention has been made to solve the problems as described above, and it is therefore an

object of the present invention to obtain an elevator apparatus which makes it possible to reduce a size of a hoistway and prolong a life of a main rope for suspending a car and a counterweight.

Means for solving the Problems

[0008] An elevator apparatus includes: a car and a counterweight that can be raised/lowered within a hoistway; a driving force generating unit having a thin-type first drive device, which includes a first drive sheave rotatable about a horizontally extending first rotational shaft, and a thin-type second drive device, which includes a second drive sheave rotatable about a second rotational shaft extending parallel to the first rotational shaft, and arranged outside both regions of the car and the counterweight on a vertical projection plane of the hoistway, for generating a driving force for raising/lowering the car and the counterweight within the hoistway; and a main rope body having a first main rope, which is looped around the first drive sheave while bypassing the second drive sheave, and a second main rope, which is looped around the second drive sheave while bypassing the first drive sheave, for suspending the car and the counterweight, characterized in that a part of the first drive device overlaps with a region of the second drive device on the vertical projection plane of the hoistway, while the first drive sheave is arranged outside the region of the second drive device on the vertical projection plane of the hoistway.

Brief Description of the Drawings

[0009]

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

Fig. 2 is a plan view showing the elevator apparatus of Fig. 1.

Fig. 3 is a lateral view showing an essential part of the elevator apparatus of Fig. 1.

Fig. 4 is a schematic diagram showing an elevator apparatus according to Embodiment 2 of the present invention.

Fig. 5 is a plan view showing the elevator apparatus of Fig. 4.

Fig. 6 is a lateral view showing an essential part of the elevator apparatus of Fig. 4.

Best Modes for carrying out the Invention

[0010] Preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

Embodiment 1

[0011] Fig. 1 is a schematic diagram showing an elevator apparatus according to Embodiment 1 of the present invention. Fig. 2 is a plan view showing the elevator apparatus of Fig. 1. Fig. 3 is a lateral view showing an essential part of the elevator apparatus of Fig. 1. Referring to the figures, a car 2 and a counterweight 3 are provided within a hoistway 1 such that they can be raised/lowered, respectively. A front face of the car 2 is provided with a car doorway 4. The car 2 and the counterweight 3 are arranged side by side within the hoistway 1 in a depth direction thereof (direction perpendicular to the front face of the car 2 on a horizontal plane) on a vertical projection plane of the hoistway 1. That is, the elevator apparatus according to Embodiment 1 of the present invention is designed as an elevator apparatus of a counterweight back fall type with a structure in which the counterweight 3 is raised/lowered on a back face side of the car 2.

[0012] A driving force generating unit 5 for generating a driving force for raising/lowering the car 2 and the counterweight 3 is provided in a lower portion within the hoistway 1. The driving force generating unit 5 is arranged outside regions of the car 2 and the counterweight 3, respectively, on the vertical projection plane of the hoistway 1. In this example, the driving force generating unit 5 is arranged between an inner wall surface of the hoistway 1 and the car 2 on the vertical projection plane of the hoistway 1 (Fig. 2). The driving force generating unit 5 has a first hoisting machine (first drive device) 6, and a second hoisting machine (second drive device) 7 arranged above the first hoisting machine 6.

[0013] The first hoisting machine 6 has a first drive device body 9 including a horizontally extending first rotational shaft 8, and a first drive sheave 10 provided on the first rotational shaft 8 to be rotatable about the first rotational shaft 8. The first drive sheave 10 is rotated integrally with the first rotational shaft 8 owing to a driving force of the first drive device body 9. The first hoisting machine 6 is a flat, thin-type hoisting machine having a radial dimension that is larger than an axial dimension.

[0014] The second hoisting machine 7 has a second drive device body 12 including a horizontally extending second rotational shaft 11, and a second drive sheave 13 provided on the second rotational shaft 11 to be rotatable about the second rotational shaft 11. The second drive sheave 13 is rotated integrally with the second rotational shaft 11 owing to a driving force of the second drive device body 12. The second hoisting machine 7 is a flat, thin-type hoisting machine having a radial dimension that is larger than an axial dimension.

[0015] The first hoisting machine 6 and the second hoisting machine 7 are arranged within the hoistway 1 such that the first rotational shaft 8 and the second rotational shaft 11 extend parallel to each other. The first hoisting machine 6 and the second hoisting machine 7 are arranged offset from each other in an axial direction

of the first and the second rotational shafts 8, 11. Further, a part of the first hoisting machine 6 overlaps with a region of the second hoisting machine 7 on the vertical projection plane of the hoistway 1. Still further, the first drive sheave 10 is arranged outside the region of the second hoisting machine 7 on the vertical projection plane of the hoistway 1. That is, the first hoisting machine 6 is arranged offset from the second hoisting machine 7 on the vertical projection plane of the hoistway 1 such that the first drive sheave 10 is located outside the region of the second hoisting machine 7.

[0016] A plurality of first main ropes 14 are looped around the first drive sheave 10. A plurality of second main ropes 15 are looped around the second drive sheave 13. A main rope body 16 has the first main ropes 14 and the second main ropes 15. The car 2 and the counterweight 3 are suspended within the hoistway 1 by means of the main rope body 16.

[0017] A car-side return pulley 17 and a pair of counterweight-side return pulleys 18 around which the main rope body 16 is looped, respectively, are provided in an upper portion within the hoistway 1. The car-side return pulley 17 and the counterweight-side return pulleys 18 are arranged above the driving force generating unit 5. A car-side rope fastening device 19 to which one end of the main rope body 16 is connected and a counterweight-side rope fastening device 20 to which the other end of the main rope body 16 is connected are provided in the upper portion within the hoistway 1.

[0018] A pair of car suspending pulleys 21 around which the main rope body 16 is looped are provided on a lower portion of the car 2. A counterweight suspending pulley 22 around which the main rope body 16 is looped is provided on an upper portion of the counterweight 3.

[0019] Each of the first main ropes 14 is connected at one end thereof to the car-side rope fastening device 19, and at the other end of the first main ropes 14 to the counterweight-side rope fastening device 20. Each of the first main ropes 14, which extends from the car-side rope fastening device 19 to the counterweight-side rope fastening device 20, is sequentially looped around the respective car suspending pulleys 21, the car-side return pulley 17, the first drive sheave 10, the respective counterweight-side return pulleys 18, and the counterweight suspending pulley 22. That is, the first main ropes 14 are stretched within the hoistway 1 while bypassing the second drive sheave 13. Since the second hoisting machine 7 is arranged offset from the first hoisting machine 6, the first main ropes 14 looped around the first drive sheave 10 are prevented from interfering with the second hoisting machine 7.

[0020] Each of the second main ropes 15 is connected at one end thereof to the car-side rope fastening device 19, and at the other end of the second main ropes 15 to the counterweight-side rope fastening device 20. Each of the second main ropes 15, which extends from the car-side rope fastening device 19 to the counterweight-side rope fastening device 20, is sequentially looped

around the respective car suspending pulleys 21, the car-side return pulley 17, the second drive sheave 13, the respective counterweight-side return pulleys 18, and the counterweight suspending pulley 22. That is, the respective second main ropes 15 are stretched within the hoistway 1 while bypassing the first drive sheave 10.

[0021] That is, the car 2 and the counterweight 3 are suspended within the hoistway 1 by means of the first main ropes 14 and the second main ropes 15, which are looped around the respective sheaves according to a 2:1 roping method.

[0022] A control device (not shown) for controlling operation of an elevator is electrically connected to the driving force generating unit 5. The first hoisting machine 6 and the second hoisting machine 7 are controlled by the control device such that the first drive sheave 10 and the second drive sheave 13 rotate in synchronization with each other.

[0023] Next, an operation will be described. The first drive sheave 10 and the second drive sheave 13 are rotated in synchronization with each other owing to the control of the first hoisting machine 6 and the second hoisting machine 7 by the control device. Thus, the, respectively, first main ropes 14, respectively, and the second main ropes 15, respectively, are moved, so the car 2 and the counterweight 3 are raised/lowered within the hoistway 1.

[0024] In the elevator apparatus constructed as described above, the main rope body 16 for suspending the car 2 and the counterweight 3 has the first main ropes 14 looped around the first drive sheave 10 of the first hoisting machine 6 while bypassing the second drive sheave 13 of the second hoisting machine 7, and the second main ropes 15 looped around the second drive sheave 13 while bypassing the first drive sheave 10. The part of the first hoisting machine 6 overlaps with the region of the second hoisting machine 7 on the vertical projection plane of the hoistway 1, and the first drive sheave 10 is arranged outside the region of the second hoisting machine 7. Therefore, parts of spaces, respectively, for installing the first hoisting machine 6 and the second hoisting machine 7 are partially shared in a horizontal direction, so the horizontal cross-sectional area of the hoistway 1 can be reduced. Accordingly, the hoistway 1 can be reduced in size. The second hoisting machine 7 does not intersect a vertical space of the first drive sheave 10, so the first main ropes 14 can be prevented from interfering with the second hoisting machine 7. Thus, the number of sheaves for turning the first main ropes 14 can also be prevented from increasing. Further, the first main ropes 14 and the second main ropes 15 are looped around the first drive sheave 10 and the second drive sheave 13 according to a normal single-lap roping method (which is not the full-wrap roping method), so the life of each of the first main ropes 14 and the second main ropes 15 can also be prolonged.

[0025] Although the driving force generating unit 5 is provided in the lower portion within the hoistway 1 in the

foregoing example, it is also appropriate that the driving force generating unit 5 be provided in the upper portion within the hoistway 1. In this case, the first hoisting machine 6 is arranged above the second hoisting machine 7 and offset from the second hoisting machine 7 such that the first drive sheave 10 is arranged outside the region of the second hoisting machine 7 on the vertical projection plane of the hoistway 1.

10 Embodiment 2

[0026] Fig. 4 is a schematic diagram showing an elevator apparatus according to Embodiment 2 of the present invention. Fig. 5 is a plan view showing the elevator apparatus of Fig. 4. Fig. 6 is a lateral view showing an essential part of the elevator apparatus of Fig. 4. Referring to the figures, the car 2 and the counterweight 3 are arranged side by side within the hoistway 1 in a width direction (direction of a frontage of the car doorway 4) of the hoistway 1 on the vertical projection plane of the hoistway 1. That is, the elevator apparatus according to Embodiment 2 of the present invention is designed as an elevator apparatus of a counterweight lateral fall type with a structure in which the counterweight 3 is raised/lowered on a lateral face side of the car 2.

[0027] The driving force generating unit 5 is arranged outside the regions of the car 2 and the counterweight 3 on the vertical projection plane of the hoistway 1. In this example, the driving force generating unit 5 is arranged between the region of the car 2 and the region of the counterweight 3 on the vertical projection plane of the hoistway 1. The driving force generating unit 5 has the second hoisting machine 7, and a flat, thin-type first hoisting machine 31, which is arranged below the second hoisting machine 7 and has a radial dimension that is larger than an axial dimension.

[0028] The first hoisting machine 31 has a first drive device body 33 including a horizontally extending first rotational shaft 32, and a first drive sheave 34 provided on the first rotational shaft 32 to be rotatable about the first rotational shaft 32. The first drive sheave 34 is rotated integrally with the first rotational shaft 32 owing to a driving force of the first drive device body 33.

[0029] The first hoisting machine 31 is arranged within the hoistway 1 such that the first rotational shaft 32 extends parallel to the second rotational shaft 11. The second hoisting machine 7 is arranged within a region of the first hoisting machine 31 on the vertical projection plane of the hoistway 1.

[0030] The first drive sheave 34 has a larger outer diameter than the second drive sheave 13. A part of the first drive sheave 34 overlaps with a region of the second drive sheave 13 on the vertical projection plane of the hoistway 1. In addition, the second drive sheave 13 is arranged between radial ends of the first drive sheave 34 on the vertical projection plane of the hoistway 1. In this example, the second drive sheave 13 is arranged within a region of the first drive sheave 34 on the vertical

projection plane of the hoistway 1.

[0031] The first main ropes 14 are looped around the first drive sheave 34 while bypassing the second drive sheave 13. Since the second drive sheave 13 is arranged between the radial ends of the first drive sheave 34 on the vertical projection plane of the hoistway 1, the first main ropes 14 looped around the first drive sheave 34 are prevented from interfering with the second drive sheave 13.

[0032] The control device controls the first hoisting machine 31 and the second hoisting machine 7 such that each of the first main ropes 14 and each of the second main ropes 15 move in synchronization with each other. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0033] In the elevator apparatus constructed as described above, the first drive sheave 34 is larger in outer diameter than the second drive sheave 13, the part of the first drive sheave 34 overlaps with the region of the second drive sheave 13 on the vertical projection plane of the hoistway 1, and the second drive sheave 13 is arranged between the radial ends of the first drive sheave 34 on the vertical projection plane of the hoistway 1. Therefore, the first hoisting machine 31 and the second hoisting machine 7 can be prevented from interfering with the main rope body 16 without increasing the number of sheaves for turning the main rope body 16. Parts of the regions of the first drive sheave 34 and the second drive sheave 13, respectively, are partially shared in the horizontal direction on the vertical projection plane of the hoistway 1, so the horizontal cross-sectional area of the hoistway 1 can further be reduced. Accordingly, the hoistway 1 can further be reduced in size.

[0034] The second hoisting machine 7 is arranged within the region of the first hoisting machine 31 on the vertical projection plane of the hoistway 1, so the area of a common portion of the first hoisting machine 31 and the second hoisting machine 7 in the horizontal direction can further be increased. Thus, the horizontal cross-sectional area of the hoistway 1 can further be reduced, and the hoistway 1 can further be reduced in size.

[0035] Although the driving force generating unit 5 is provided in the lower portion within the hoistway 1 in the foregoing example, it is also appropriate that the driving force generating unit 5 be provided in the upper portion within the hoistway 1. In this case, the first hoisting machine 31 is arranged above the second hoisting machine 7.

[0036] Although the car 2 and the counterweight 3 are suspended according to the 2:1 roping method in the foregoing embodiments, respectively, of the present invention, it is also appropriate that the car 2 and the counterweight 3 be suspended according to a 1:1 roping method. In this case, the main rope body 16 is directly connected at one end of the main rope body 16 and the other end of the main rope body 16 to the car 2 and the counterweight 3, respectively.

Claims

1. An elevator apparatus, **characterized by** comprising:

a car and a counterweight that can be raised/ lowered within a hoistway;

a driving force generating unit having a thin-type first drive device, which includes a first drive sheave rotatable about a horizontally extending first rotational shaft, and a thin-type second drive device, which includes a second drive sheave rotatable about a second rotational shaft extending parallel to the first rotational shaft, and arranged outside both regions of the car and the counterweight on a vertical projection plane of the hoistway, for generating a driving force for raising/lowering the car and the counterweight within the hoistway; and

a main rope body having a first main rope, which is looped around the first drive sheave while bypassing the second drive sheave, and a second main rope, which is looped around the second drive sheave while bypassing the first drive sheave, for suspending the car and the counterweight, **characterized in that**

a part of the first drive device overlaps with a region of the second drive device on the vertical projection plane of the hoistway, while the first drive sheave is arranged outside the region of the second drive device on the vertical projection plane of the hoistway.

2. An elevator apparatus, **characterized by** comprising:

a car and a counterweight that can be raised/ lowered within a hoistway;

a driving force generating unit having a thin-type first drive device, which includes a first drive sheave rotatable about a horizontally extending first rotational shaft, and a thin-type second drive device, which includes a second drive sheave rotatable about a second rotational shaft extending parallel to the first rotational shaft, and arranged outside both regions of the car and the counterweight on a vertical projection plane of the hoistway, for generating a driving force for raising/lowering the car and the counterweight within the hoistway; and

a main rope body having a first main rope, which is looped around the first drive sheave while bypassing the second drive sheave, and a second main rope, which is looped around the second drive sheave while bypassing the first drive sheave, for suspending the car and the counterweight, **characterized in that:**

the first drive sheave has an outer diameter larg-

er than an outer diameter of the second drive sheave; and
a part of the first drive sheave overlaps with a region of the second drive sheave on the vertical projection plane of the hoistway, while the second drive sheave is arranged between radial ends of the first drive sheave on the vertical projection plane of the hoistway.

3. The elevator apparatus according to Claim 2, **characterized in that** the second drive device is arranged within a region of the first drive device on the vertical projection plane of the hoistway.

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FIG. 1

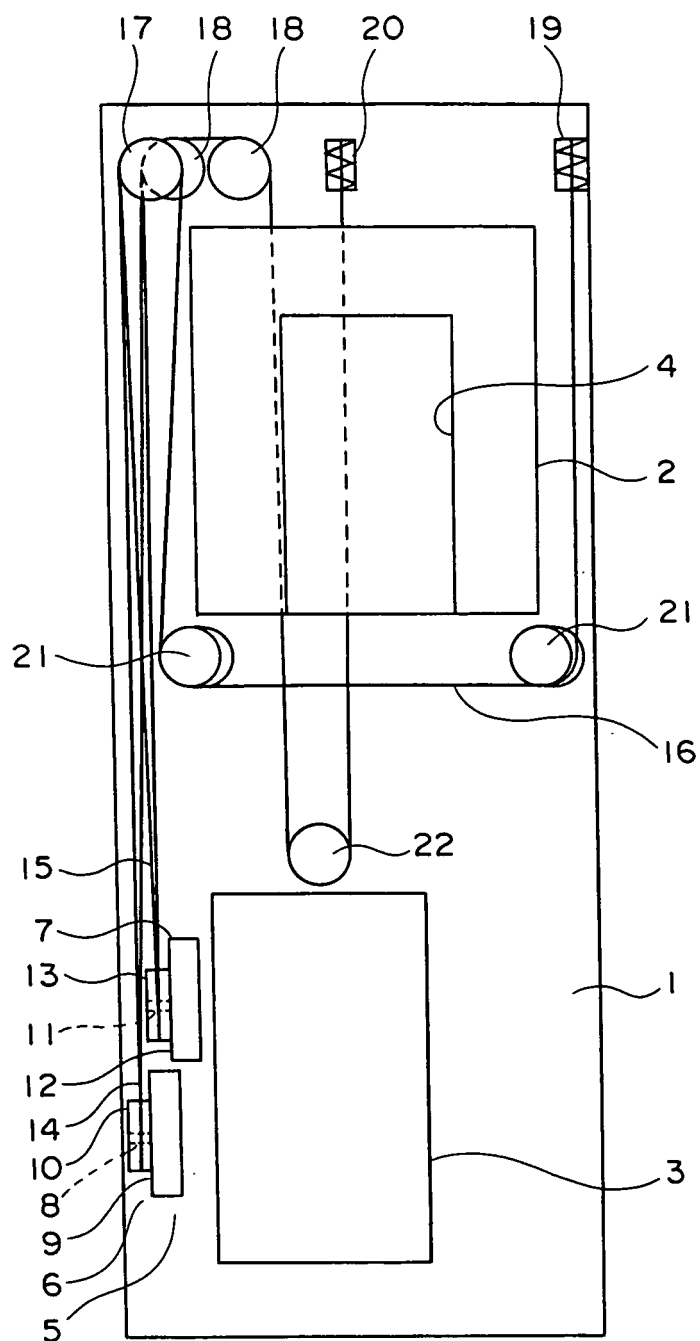


FIG. 2

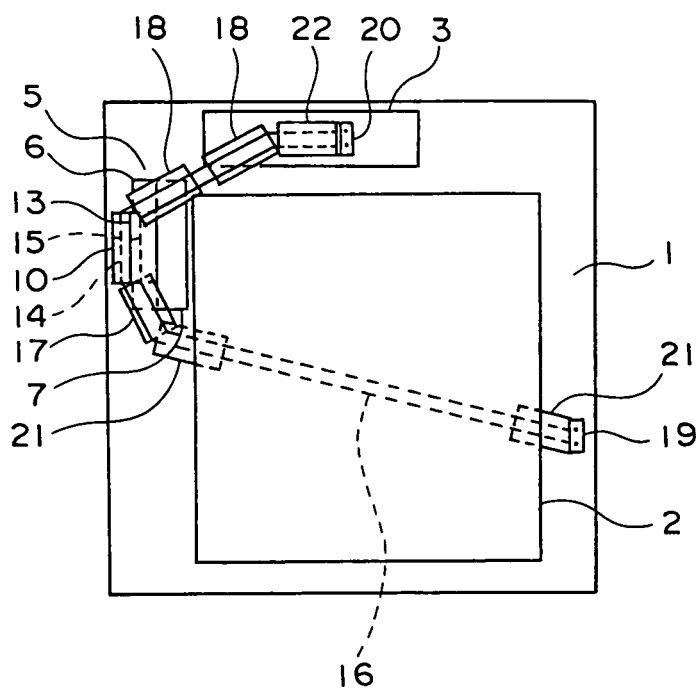


FIG. 3

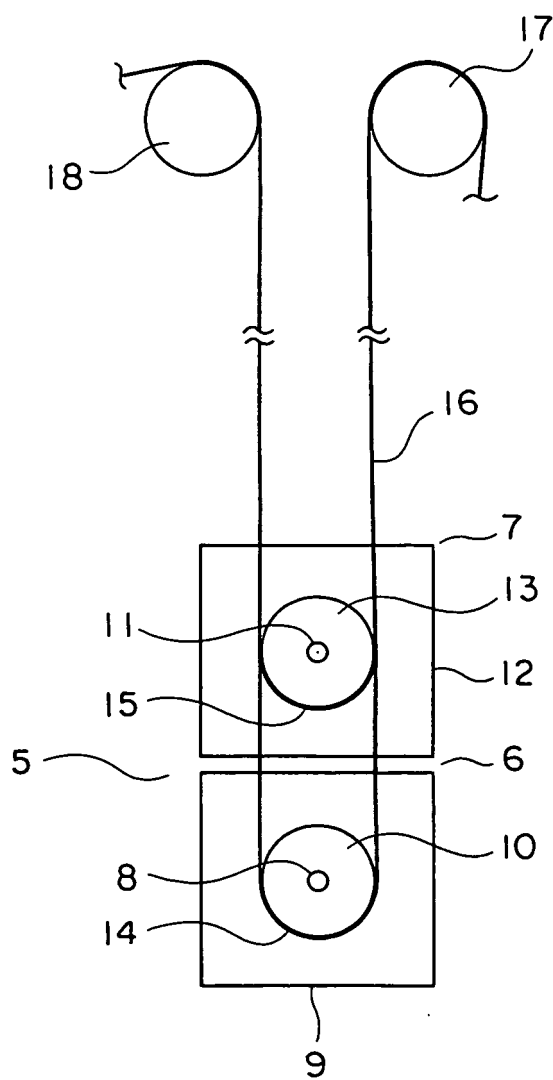


FIG. 4

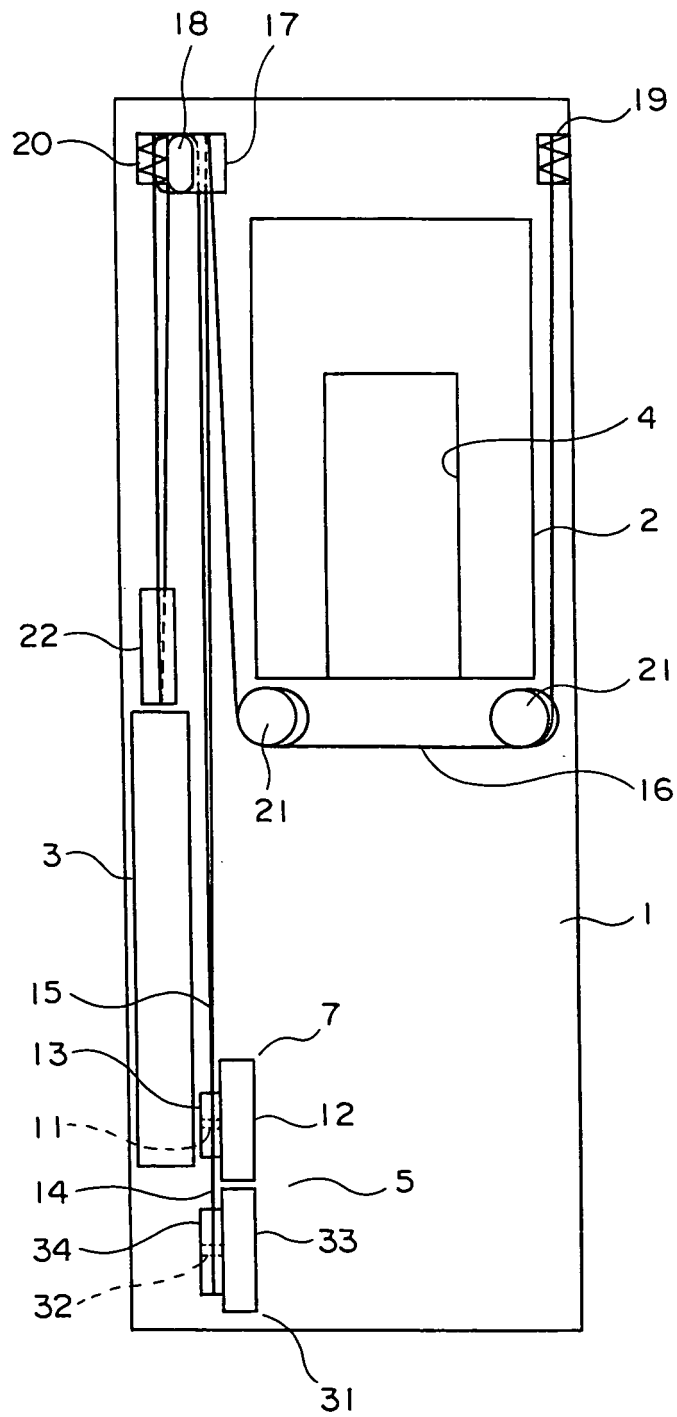


FIG. 5

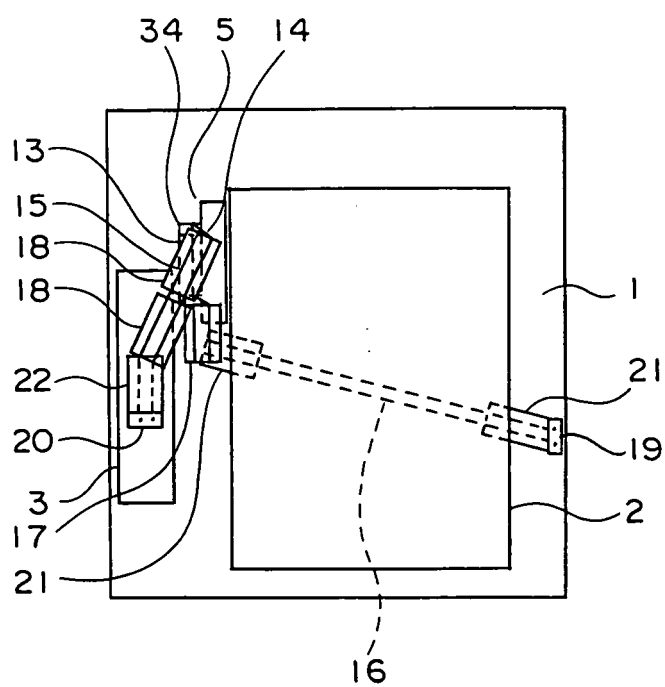
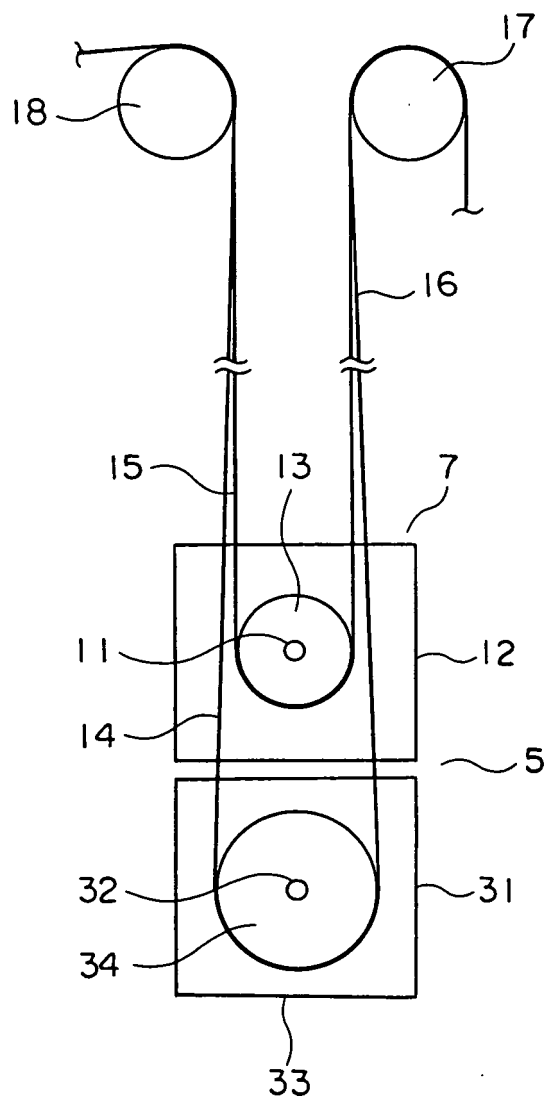


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/019513

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ B66B7/06, B66B11/08		
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 1996-2005 Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2004/071926 A1 (Mitsubishi Electric Corp.), 26 August, 2004 (26.08.04), Abstract; Fig. 4	1
A	Abstract; Fig. 5 (Family: none)	2-3
A	WO 01/42121 A (Mitsubishi Electric Corp.), 14 June, 2001 (14.06.01), Description, page 15, lines 20 to 26; Fig. 11 & EP 1151955 A1	1
A	JP 9-165163 A (Kone OY), 24 June, 1997 (24.06.97), Abstract; Figs. 1 to 2 & EP 0749931 A2 & CN 1143042 A & FI 953154 A & US 5823298 A	1-3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 26 September, 2005 (26.09.05)		Date of mailing of the international search report 11 October, 2005 (11.10.05)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/019513

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	Par. Nos. [0039] to [0041]; Fig. 3 & EP 0953538 A2 & CN 1233583 A & US 6247557 B1	2-3
A	JP 2004-51250 A (Hitachi, Ltd.), 19 February, 2004 (19.02.04), Abstract; Figs. 1 to 2 & CN 1467150 A & US 2004/007428 A1	1
A	JP 35-5563 B1 (Teruya TSURUSAWA), 21 May, 1960 (21.05.60), Page 1, left column, lines 36 to 43, right column, lines 12 to 15; Fig. 1 (Family: none)	2-3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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