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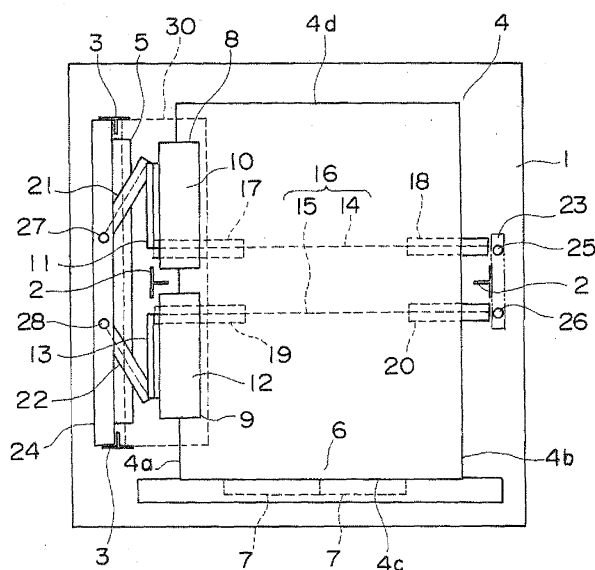
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(54) **ELEVATOR DEVICE**

(57) Rotating shafts of first and second driving sheaves are each disposed horizontally. First and second car suspending sheaves are disposed on a car, and first and second counterweight suspending sheaves are disposed on a counterweight. A main rope group that suspends the car and the counterweight has: a first main rope that is wound sequentially around the first car suspending sheave, the first driving sheave, and the first counterweight suspending sheave, and a second main rope that is wound sequentially around the second car

suspending sheave, the second driving sheave, and the second counterweight suspending sheave. The first driving machine, the first car suspending sheave, and the first counterweight suspending sheave, and the second driving machine, the second car suspending sheave, and the second counterweight suspending sheave, are respectively disposed at positions that are symmetrical in a vertically projected plane of a hoistway relative to a straight line that connects a pair of car guide rails that guide the car.

FIG. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to a traction elevator apparatus in which a car and a counterweight that are suspended inside a hoistway by a main rope are moved by a driving force from a driving apparatus.

BACKGROUND ART

[0002] Conventionally, elevators are known in which a driving apparatus that moves a car and a counterweight is disposed inside a hoistway (also known as "machine-roomless" elevators). In conventional machine-roomless elevators, the driving apparatus is mounted to an upper end portion of a counterweight guide rail that guides movement of the counterweight. The car and the counterweight are suspended inside the hoistway by a main rope that is wound around a driving sheave of the driving apparatus (See Patent Literature 1).

CITATION LIST

PATENT LITERATURE

[0003] [Patent Literature 1]
WO 03/020628

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] However, in conventional machine-roomless elevators of this kind, because the car and the counterweight are moved by a single driving apparatus, the driving apparatus is enlarged together with increases in elevator capacity. Thus, not only can overall reductions in elevator size not be achieved, but installation work and maintenance work for the driving apparatus also become time-consuming. Manufacturing costs are also increased due to the enlargement of the driving apparatus.

[0005] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus that enables size reductions, that can facilitate installation work and maintenance work, and that enables reductions in manufacturing costs.

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 apparatus inducing: a first driving machine that has a first driving sheave, and that is disposed such that a rotating shaft of the first driving sheave is horizontal a second driving machine that has a second driving sheave, and that is disposed such that a rotating shaft

of the second driving sheave is horizontal; a car and a counterweight that can be moved vertically inside a hoistway; a first car suspending sheave and a second car suspending sheave that are disposed on the car in common; a first counterweight suspending sheave and a second counterweight suspending sheave that are disposed on the counterweight in common; and a main rope group that has: a first main rope that is wound sequentially around the first car suspending sheave, the first driving sheave, and the first counterweight suspending sheave; and a second main rope that is wound sequentially around the second car suspending sheave, the second driving sheave, and the second counterweight suspending sheave, the main rope group suspending the car and the counterweight, the elevator apparatus being **characterized in that:** the first driving machine, the first car suspending sheave, and the first counterweight suspending sheave, and the second driving machine, the second car suspending sheave, and the second counterweight suspending sheave, are respectively disposed at positions that are symmetrical in a vertically projected plane of the hoistway relative to a straight line that connects a pair of car guide rails that guide the car.

25 EFFECTS OF THE INVENTION

[0007] In an elevator apparatus according to the present invention, because the car and the counterweight are moved by driving forces from the first and second driving machines, loads that are applied to the first and second driving machines can be respectively reduced, enabling the first and second driving machines to be reduced in size. Overall reductions in the size of the elevator apparatus can thereby be achieved, also enabling installation work and maintenance work to be facilitated. Because the respective rotating shafts of the first and second driving sheaves are disposed horizontally, the first and second main ropes can be lowered directly to the car and the counterweight from the first and second driving sheaves, enabling the number of the sheaves that are disposed inside the hoistway to be reduced. In addition, because the first driving machine, the first car suspending sheave, and the first counterweight suspending sheave, and the second driving machine, the second car suspending sheave and the second counterweight suspending sheave, are respectively disposed at positions that are symmetrical in the vertically projected plane of the hoistway in relation to the straight line that connects the respective car guide rails, equipment of identical design can be used in two driving systems, enabling improvements in productivity to be achieved, and also enabling reductions in manufacturing costs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 is a configuration diagram that shows an

elevator according to Embodiment 1 of the present invention;

Figure 2 is a plan that shows an elevator apparatus from Figure 1;

Figure 3 is a horizontal cross section that shows the elevator apparatus from Figure 1;

Figure 4 is a plan that shows an elevator apparatus according to Embodiment 2 of the present invention; and

Figure 5 is a horizontal cross section that shows an elevator apparatus according to Embodiment 3 of the present invention.

DESCRIPTION OF EMBODIMENTS

[0009] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0010] Figure 1 is a configuration diagram that shows an elevator according to Embodiment 1 of the present invention. Figure 2 is a plan that shows an elevator apparatus from Figure 1. 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 disposed between the respective car guide rails 2, and a counterweight 5 is disposed between the respective counterweight guide rails 3. The car 4 is guided by the respective car guide rails 2 so as to be moved vertically, and the counterweight 5 is guided by the respective counterweight guide rails 3 so as to be moved vertically.

[0011] As shown in Figure 2, a straight line that connects the respective car guide rails 2 and a straight line that connects the respective counterweight guide rails 3 are perpendicular to each other in a vertically projected plane of the hoistway 1 (a projected plane that results from the hoistway 1 being projected parallel to the direction of movement of the car 4). In the vertically projected plane of the hoistway 1, the straight line that connects the respective counterweight guide rails 3 is a straight line that is parallel to a width direction of the hoistway 1.

[0012] The car 4 has: first and second side surface portions 4a and 4b that face each other between the respective car guide rails 2; a front surface portion 4c on which a car doorway 6 is disposed; and a back surface portion 4d that faces the front surface portion 4c. A pair of car doors 7 that open and close the car doorway 6 are disposed on the front surface portion 4c (Figure 2). The car 4 is disposed such that a width direction thereof is oriented in a width direction of the hoistway 1. A dimension of the car 4 in the width direction (a dimension between the first and second side surface portions 4a and 4b) is smaller than a dimension of the car 4 in the depth direction (a dimension between the front surface portion 4c and the back surface portion 4d).

[0013] The counterweight 5 faces the first side surface portion 4a of the car 4 in the vertically projected plane of

the hoistway 1. In other words, the counterweight 5 is disposed side by side with the car 4 in the width direction of the hoistway 1 in the vertically projected plane of the hoistway 1. A first car guide rail 2 of the respective car guide rails 2 is disposed in the space between the car 4 and the counterweight 5.

[0014] A first driving machine 8 and a second driving machine 9 that generate driving forces that move the car 4 and the counterweight 5 vertically are mounted to upper end portions of the respective counterweight guide rails 3 by means of a base 30 in common (Figure 2). The first and second driving machines 8 and 9 are disposed in an upper portion inside the hoistway 1. The first and second driving machines 8 and 9 are disposed so as to be spaced apart from each other in a depth direction of the hoistway 1.

[0015] The first and second driving machines 8 and 9 are disposed outside a region of the counterweight 5 in the vertically projected plane of the hoistway 1. A portion of each of the first and second driving machines 8 and 9 overlaps with a region of the car 4 in the vertically projected plane of the hoistway 1. The first and second driving machines 8 and 9 are disposed at an approximately identical height.

[0016] The first driving machine 8 has: a first driving machine main body 10 that includes a motor and a brake; and a first driving sheave 11 that is rotated by the first driving machine main body 10. The first driving machine 8 is disposed such that a rotating shaft of the first driving sheave 11 is horizontal. In this example, the rotating shaft of the first driving sheave 11 is disposed so as to be parallel to the width direction of the hoistway 1.

[0017] The second driving machine 9 has: a second driving machine main body 12 that includes a motor and a brake; and a second driving sheave 13 that is rotated by the second driving machine main body 12. The second driving machine 9 is disposed such that a rotating shaft of the second driving sheave 13 is horizontal. In this example, the rotating shaft of the second driving sheave 13 is disposed so as to be parallel to the width direction of the hoistway 1.

[0018] The first and second driving machines 8 and 9 are constituted by thin hoisting machines in which axial dimensions are smaller than radial dimension of the first and second driving machine main bodies 10 and 12 or radial dimensions of the first and second driving sheaves 11 and 13. The first and second driving machines 8 and 9 are respectively disposed such that the positions of the first and second driving sheaves 11 and 13 are closer to the counterweight 3 than the first and second driving machine main bodies 10 and 12 in the vertically projected plane of the hoistway 1.

[0019] A plurality of first main ropes 14 are wound around the first driving sheave 11, and a plurality of second main ropes 15 are wound around the second driving sheave 13. The car 4 and the counterweight 5 are suspended inside the hoistway 1 by a main rope group 16 that includes the first and second main ropes 14 and 15.

[0020] A pair of first car suspending sheaves 17 and 18 around which the first main ropes 14 are wound, and a pair of second car suspending sheaves 19 and 20 around which the second main ropes 15 are wound are disposed on a lower portion of the car 4. One of the first car suspending sheaves 17 and one of the second car suspending sheaves 19 are disposed below the first side surface portion 4a, and the other first car suspending sheave 18 and the other second car suspending sheave 20 are disposed below the second side surface portion 4b. The respective first car suspending sheaves 17 and 18 are disposed in common on a straight line that is parallel to the width direction of the car 4, and the respective second car suspending sheaves 19 and 20 are disposed in common on a straight line that is parallel to the width direction of the car 4. The respective rotating shafts of the respective first car suspending sheaves 17 and 18 and the respective second car suspending sheaves 19 and 20 are perpendicular to a straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1.

[0021] A first counterweight suspending sheave 21 around which the first main ropes 14 are wound, and a second counterweight suspending sheave 22 around which the second main ropes 15 are wound, are disposed on an upper portion of the counterweight 5. Respective rotating shafts of the first and second counterweight suspending sheaves 21 and 22 are inclined relative to a straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1.

[0022] Of the respective car guide rails 2, a first fixing member 23 is fixed to an upper end portion of the car guide rail 2 that is further away from the counterweight 3. A second fixing member 24 is fixed between the upper end portions of the respective counterweight guide rails 3. A first car rope fastening apparatus 25 to which first end portions of each of the first main ropes 14 are connected, and a second car rope fastening apparatus 26 to which first end portions of each of the second main ropes 15 are connected, are disposed on the first fixing member 23 in common. A first car counterweight fastening apparatus 27 to which second end portions of each of the first main ropes 14 are connected, and a second counterweight rope fastening apparatus 28 to which second end portions of each of the second main ropes 15 are connected, are disposed on the second fixing member 24 in common.

[0023] The first main ropes 14 are wound from the first car rope fastening apparatus 25, sequentially around the respective first car suspending sheaves 18 and 17, the first driving sheave 11 and the first counterweight suspending sheave 21, to reach the first counterweight rope fastening apparatus 27. The second main ropes 15 are wound from the second car rope fastening apparatus 26, sequentially around the respective second car suspending sheaves 20 and 19, the second driving sheave 13 and the second counterweight suspending sheave 22, to reach the second counterweight rope fastening appa-

ratus 28. In other words, the suspension method of the car 4 and the counterweight 5 by the main rope group 16 is a two-to-one (2:1) roping method.

[0024] The first and second driving machines 8 and 9 are constituted by apparatuses that are of identical design to each other. The respective first car suspending sheaves 17 and 18 and the respective second car suspending sheaves 19 and 20 are constituted by sheaves that are of identical design to each other, and the first counterweight suspending sheave 21 and the second counterweight suspending sheave 22 are also constituted by sheaves that are of identical design to each other. As shown in Figure 2, the first driving machine 8, the respective first car suspending sheaves 17 and 18, and the first counterweight suspending sheave 21, and the second driving machine 9, the respective second car suspending sheaves 19 and 20, and the second counterweight suspending sheave 22, are respectively disposed at positions that are symmetrical with respect to a straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1. The first car rope fastening apparatus 25 and the first counterweight rope fastening apparatus 27, and the second car rope fastening apparatus 26 and the second counterweight rope fastening apparatus 28, are respectively disposed at positions that are symmetrical with respect to the straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1.

[0025] Figure 3 is a horizontal cross section that shows the elevator apparatus from Figure 1. In the figure, a plurality of shared brackets (supporting members) 29 that are disposed so as to be spaced apart from each other in the height direction of the hoistway 1 are fixed inside the hoistway 1. One of the car guide rails 2 and the respective counterweight guide rails 3 are mounted to and supported by the shared brackets 29.

[0026] The shared brackets 29 have: a pair of facing portions 29a that are disposed at positions that are on opposite sides of the counterweight 5 in the depth direction of the hoistway 1; and a cross beam portion 29b that is fixed between the respective facing portions 29a, and that is passed through a space between the car 4 and the counterweight 5 in the vertically projected plane of the hoistway 1.

[0027] A central portion of the cross beam portion 29b is bent so as to protrude toward the counterweight 5. The cross beam portion 29b is thereby disposed between the car 4 and the counterweight 5 so as to avoid the first and second car suspending sheaves 17 and 19, and the first and second counterweight suspending sheaves 21 and 22, respectively, in the vertically projected plane of the hoistway 1. The respective counterweight guide rails 3 are separately mounted to the respective facing portions 29a, and one of the car guide rails 2 is mounted to the central portion of the cross beam portion 29b.

[0028] Next, operation will be explained. The first and second driving machines 8 and 9 are driven synchronously with each other under control from a controlling

apparatus (not shown) that is disposed inside the hoistway 1. The first and second driving sheaves 11 and 13 are thereby rotated synchronously with each other to move the car 4 and the counterweight 5 vertically.

[0029] In an elevator apparatus of this kind, because the car 4 and the counterweight 5 are moved by the driving forces from the first and second driving machines 8 and 9, the loads that are applied to the first and second driving machines 8 and 9 can be respectively reduced, enabling the first and second driving machines 8 and 9 to be reduced in size. Overall reductions in the size of the elevator apparatus can thereby be achieved, also enabling installation work and maintenance work to be facilitated. Because the respective rotating shafts of the first and second driving sheaves 11 and 13 are disposed horizontally, the first and second main ropes 14 and 15 can be lowered directly to the car 4 and the counterweight 5 from the first and second driving sheaves 11 and 13, enabling the number of the sheaves that are disposed inside the hoistway 1 to be reduced. In addition, because the first driving machine 8, the respective first car suspending sheaves 17 and 18, and the first counterweight suspending sheave 21, and the second driving machine 9, the respective second car suspending sheaves 19 and 20, and the second counterweight suspending sheave 22, are respectively disposed at positions that are symmetrical with respect to a straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1, equipment of identical design can be used in two driving systems, enabling improvements in productivity to be achieved, and also enabling reductions in manufacturing costs.

Embodiment 2

[0030] Figure 4 is a plan that shows an elevator apparatus according to Embodiment 2 of the present invention. In the figure, a groove 41 that is parallel to car guide rails 2 is disposed on a portion of a counterweight 5 near a car 4. Specifically, the groove 41 is disposed on the counterweight 5 so as to face a first side surface portion 4a of the car 4, and is parallel to a direction of movement of the car 4. At least a portion of a shared bracket (not depicted in Figure 4) that supports one car guide rail 2 of the respective car guide rails 2 that is closer to the counterweight 5 is disposed inside the groove 41 in a vertically projected plane of a hoistway 1. The rest of the configuration is similar to that of Embodiment 1.

[0031] In an elevator apparatus of this kind, because the groove 41 that is parallel to the direction of movement of the car 4 is disposed on the counterweight 5, and at least a portion of the shared bracket that supports one of the car guide rails 2 is disposed inside the groove 41, thicknesses of portions of the counterweight 5 that are positioned on two sides of the groove 41 can be increased in a state in which the counterweight 5 avoids the shared bracket. Height dimensions of the counterweight 5 can thereby be reduced, enabling reductions in height dimen-

sions of the hoistway 1.

Embodiment 3

[0032] Figure 5 is a horizontal cross section that shows an elevator apparatus according to Embodiment 3 of the present invention. In the figure, respective rotating shafts of first and second driving sheaves 11 and 13 are each inclined in opposite directions to each other at identical angles with respect to a straight line that connects respective car guide rails 2 in a vertically projected plane of a hoistway 1.

[0033] The first driving sheave 11 is disposed such that a first end portion in a radial direction overlaps with an end portion of one first car suspending sheave 17 and a second end portion in the radial direction overlaps with an end portion of a first counterweight suspending sheave 21 in the vertically projected plane of the hoistway 1. The second driving sheave 13 is disposed such that a first end portion in a radial direction overlaps with an end portion of one second car suspending sheave 19 and a second end portion in the radial direction overlaps with an end portion of a second counterweight suspending sheave 22 in the vertically projected plane of the hoistway 1. The amount of protrusion of the first and second counterweight suspending sheaves 21 and 22 from the region of the counterweight 5 is thereby reduced in the vertically projected plane of the hoistway 1.

[0034] A cross beam portion 29b of a shared bracket 29 is constituted by a rectilinear member that is not bent. The cross beam portion 29b is disposed parallel to a depth direction of the hoistway 1. The cross beam portion 29b is disposed in a space between the first and second counterweight suspending sheaves 21 and 22 and the first and second car suspending sheaves 17 and 19 in the vertically projected plane of the hoistway 1.

[0035] The first car rope fastening apparatus 25, the respective first car suspending sheaves 17 and 18, and the first counterweight rope fastening apparatus 27 are disposed in common on a common straight line that is parallel to the straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1. The second car rope fastening apparatus 26, the respective second car suspending sheaves 19 and 20, and the second counterweight rope fastening apparatus 28 are disposed in common on a straight line that is parallel to the straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1. The rest of the configuration is similar to that of Embodiment 1.

[0036] In an elevator apparatus of this kind, because the respective rotating shafts of the first and second driving sheaves 11 and 13 are inclined with respect to the straight line that connects the respective car guide rails 2 in the vertically projected plane of the hoistway 1, the distance between the first car suspending sheaves 17 near the counterweight 5 and the first counterweight suspending sheave 21, and the distance between the sec-

ond car suspending sheaves 19 near the counterweight 5 and the second counterweight suspending sheave 22, can respectively be widened in the width direction of the hoistway 1 without widening the distance between the car 4 and the counterweight 5. A cross beam portion 29b that remains a rectilinear member can be disposed between the car 4 and the counterweight 5 in the vertically projected plane of the hoistway 1. Consequently, the shared bracket 29 can be easily prepared, enabling manufacturing costs to be further reduced.

REFERENCE SIGNS LIST

[0037] 1 hoistway; 2 car guide rail; 4 car; 5 counterweight; 8 first driving machine; 9 second driving machine; 11 first driving sheave; 13 second driving sheave; 14 first main rope; 15 second main rope; 16 main rope group; 17, 18 first car suspending sheave; 19, 20 second car suspending sheave; 21 first counterweight suspending sheave; 22 second counterweight suspending sheave; 41 groove.

Claims

1. An elevator apparatus comprising:

a first driving machine that has a first driving sheave, and that is disposed such that a rotating shaft of the first driving sheave is horizontal;
 a second driving machine that has a second driving sheave, and that is disposed such that a rotating shaft of the second driving sheave is horizontal;
 a car and a counterweight that can be moved vertically inside a hoistway;
 a first car suspending sheave and a second car suspending sheave that are disposed on the car in common;
 a first counterweight suspending sheave and a second counterweight suspending sheave that are disposed on the counterweight in common;
 and
 a main rope group that has:

a first main rope that is wound sequentially around the first car suspending sheave, the first driving sheave, and the first counterweight suspending sheave; and
 a second main rope that is wound sequentially around the second car suspending sheave, the second driving sheave, and the second counterweight suspending sheave,

the main rope group suspending the car and the counterweight,
 the elevator apparatus being **characterized in that:**

the first driving machine, the first car suspending sheave, and the first counterweight suspending sheave, and the second driving machine, the second car suspending sheave, and the second counterweight suspending sheave, are respectively disposed at positions that are symmetrical in a vertically projected plane of the hoistway relative to a straight line that connects a pair of car guide rails that guide the car.

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

a groove that is parallel to a direction of movement of the car is disposed on the counterweight; and
 at least a portion of a supporting member that supports a car guide rail that is closer to the counterweight among the car guide rails is disposed inside the groove in the vertically projected plane of the hoistway.

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

respective rotating shafts of the first and second driving sheaves are inclined relative to a straight line that connects each of the car guide rails in the vertically projected plane of the hoistway.

FIG. 1

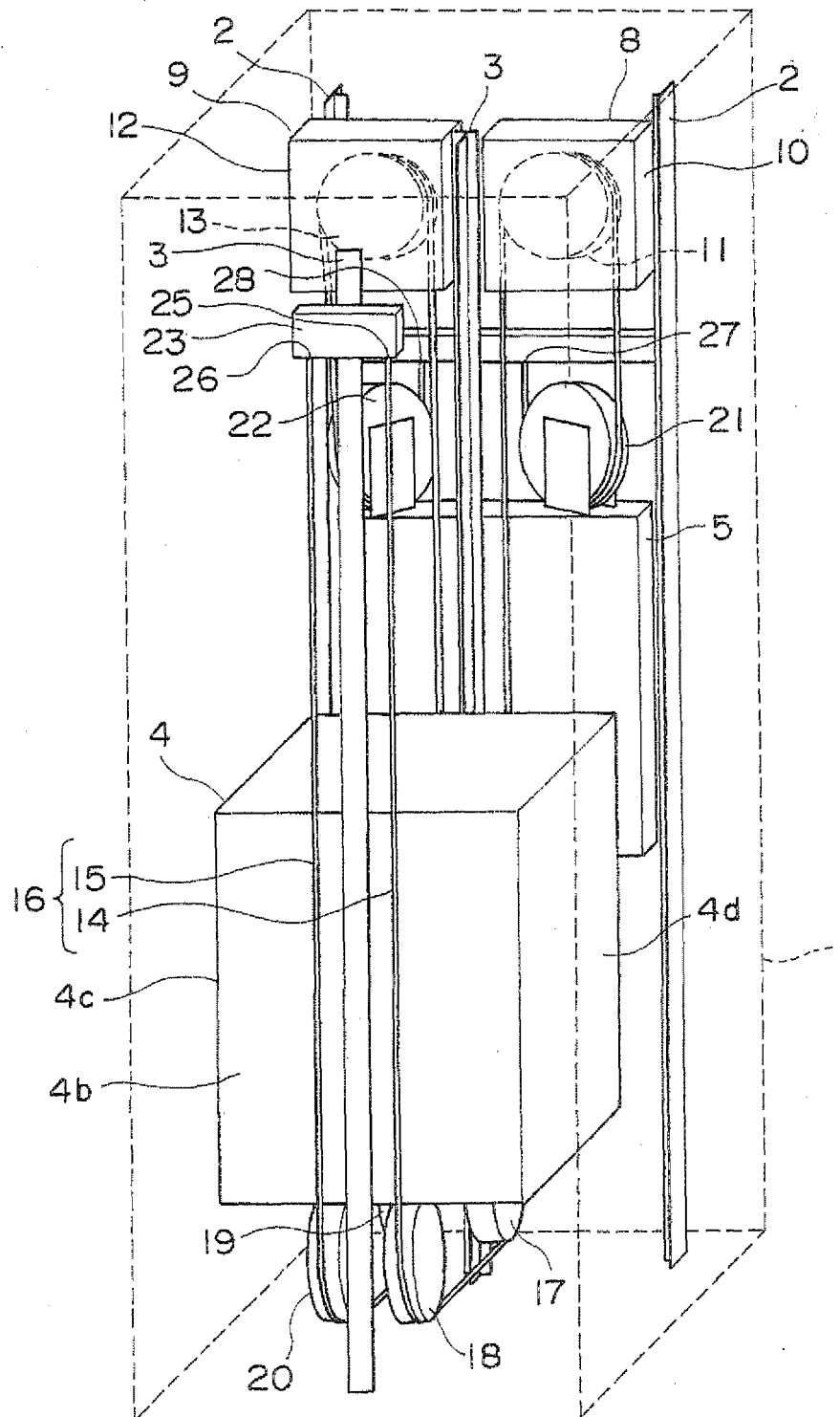


FIG. 2

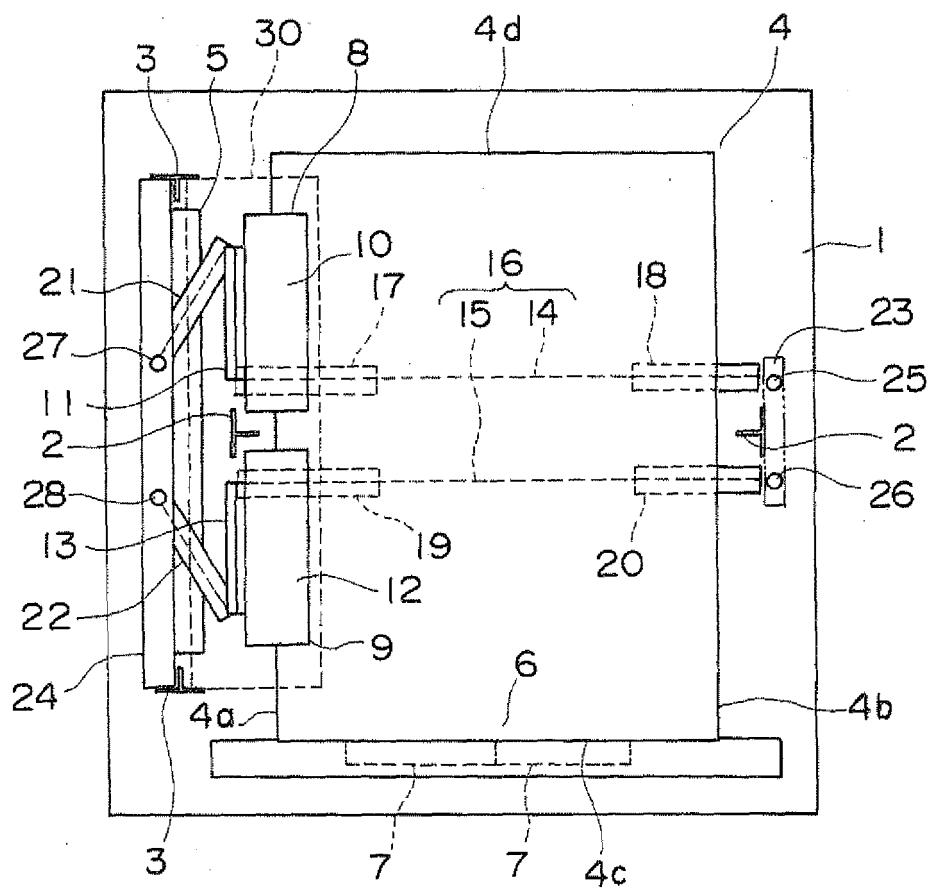


FIG. 3

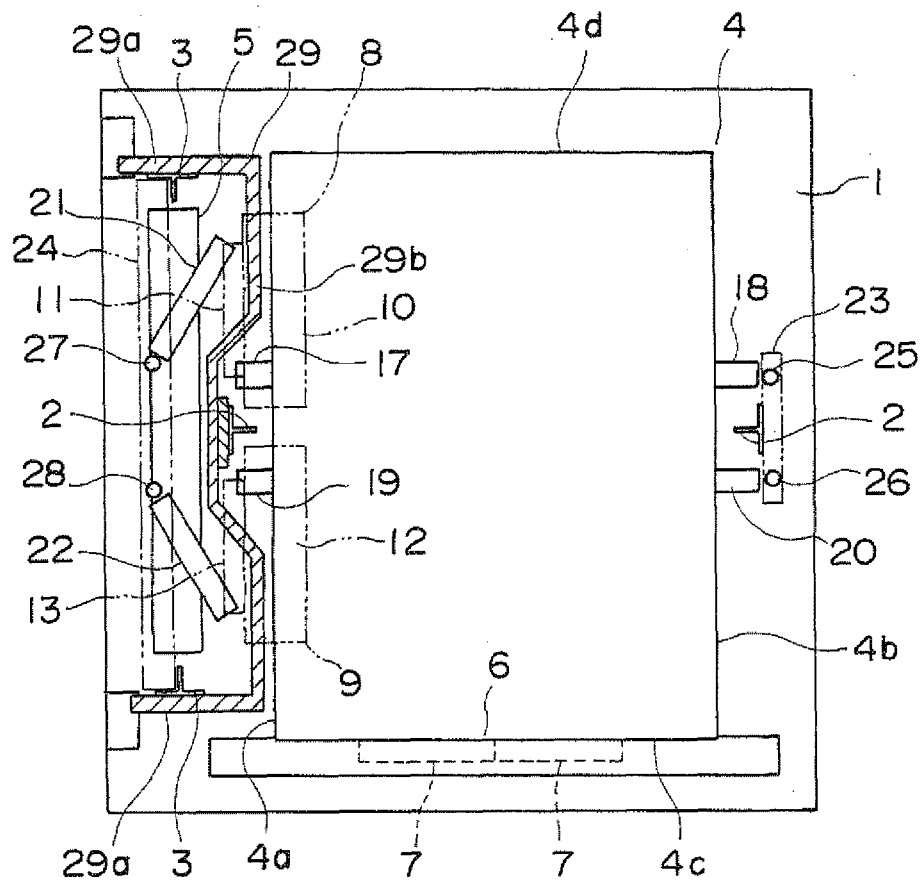


FIG. 4

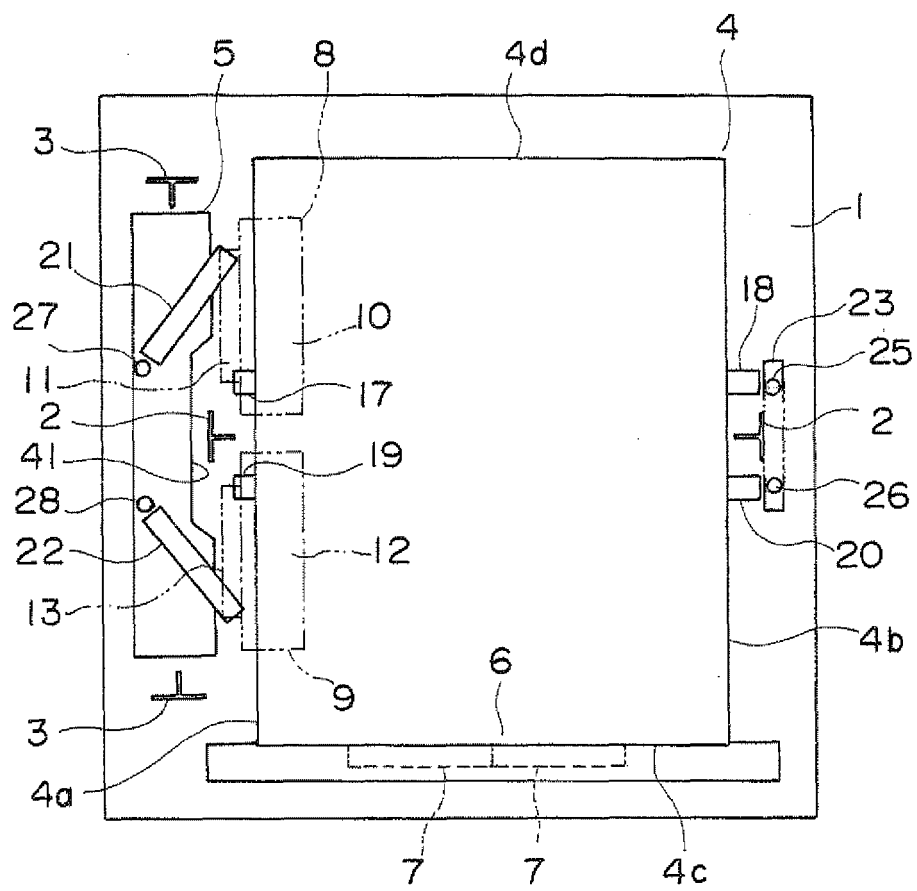
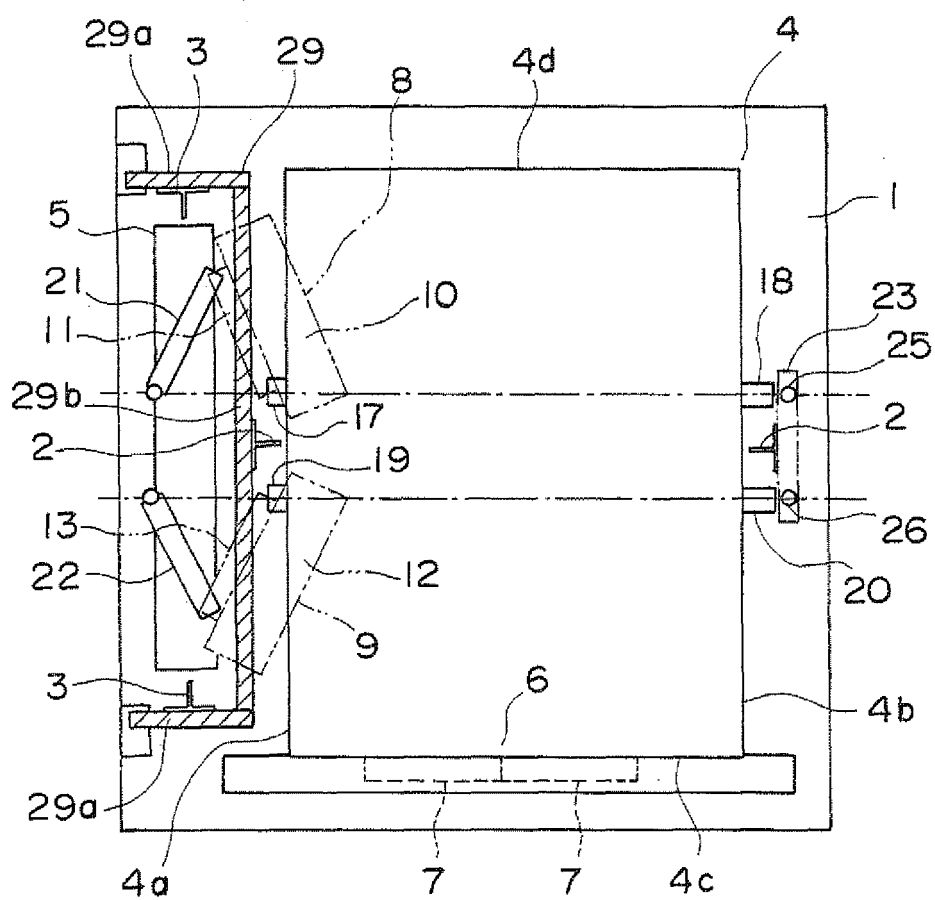


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064157

A. CLASSIFICATION OF SUBJECT MATTER

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)

B66B7/06

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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	WO 2007/069311 A1 (Mitsubishi Electric Corp.), 21 June 2007 (21.06.2007), paragraphs [0092] to [0098]; fig. 10 & EP 1961688 A & CN 101291867 A	1, 3 2
X	WO 2007/122702 A1 (Mitsubishi Electric Corp.), 01 November 2007 (01.11.2007), paragraphs [0008] to [0027]; fig. 1 to 2 & EP 2019072 A1 & CN 101155745 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
14 January, 2010 (14.01.10)Date of mailing of the international search report
26 January, 2010 (26.01.10)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/064157

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 105492/1987 (Laid-open No. 9972/1989) (Mitsubishi Electric Corp.), 19 January 1989 (19.01.1989), description, page 7, lines 1 to 3; fig. 5 (Family: none)	2

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 03020628 A [0003]