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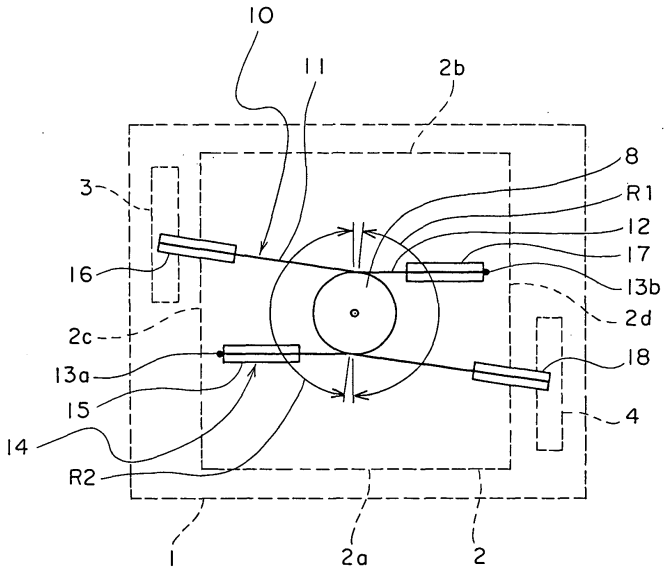
(54) ELEVATOR APPARATUS

(57) In an elevator apparatus, a first main rope that suspends a car and a first counterweight, and a second main rope that suspends the car and a second counterweight are included in a main rope group. A first car deflection pulley that directs the first main rope from a drive sheave toward the car, a first counterweight deflection pulley that directs the first main rope from the drive sheave toward the first counterweight, a second car deflection pulley that directs the second main rope from the drive sheave toward the car, and a second counterweight deflection pulley that directs the second main rope from the drive sheave toward the second counterweight are included in a deflection pulley group. Hanging positions of the car by the first and second main ropes are separated from each other when viewed from above.

FIG. 2



EP 1 801 061 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a traction elevator apparatus in which a car and a counterweight are suspended by a main rope group that is wound around a drive sheave of a driving machine.

BACKGROUND ART

[0002] In conventional elevator apparatuses, a hoisting machine having a thin motor as a driving source is disposed in an upper portion inside a hoistway. The hoisting machine is disposed such that a rotating shaft of a drive sheave is vertical. In addition, in order to prevent increases in approach angle of a main rope onto the drive sheave, the hoisting machine is disposed in a corner portion of the upper portion of the hoistway (see Patent Literature 1, for example).

[0003] Patent Document 1: JP 2001-48450 A

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] In order to reduce the number of permanent magnets used in the hoisting machine in conventional elevator apparatuses such as that described above, it is necessary to increase a diameter of the motor since it is necessary to generate required torque with fewer magnets. On the other hand, because the hoisting machine is disposed in the corner portion of the upper portion of the hoistway, the hoistingmachine interferes with the hoistway wall if the diameter of the motor is increased.

[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 driving machine to be reduced further in thickness without requiring space in a hoistway or machine room to be expanded even if a diameter of a motor of the driving machine is increased.

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 including: a driving machine having a drive sheave, the driving machine being disposed in an upper portion of a hoistway such that a rotating shaft of the drive sheave is vertical; a main rope group that is wound around the drive sheave; a car that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by a driving force from the driving machine; first and second counterweights that are suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by the driving force from the driving machine; and a deflection pulley group that is disposed in an upper portion of the hoistway so as to direct the main rope group from the drive sheave toward the car, the first counterweight, and the second counterweight, wherein: the main rope group includes a first main rope that suspends the car and the first counterweight, and a second main rope that suspends the car and the second counterweight; the deflection pulley group includes a first car deflection pulley that directs the first main rope from the drive sheave toward the car, a first counterweight deflection pulley that directs the first main rope from the drive sheave toward the first counterweight, a second car deflection pulley that directs the second main rope from the drive sheave toward the car, and a second counterweight deflection pulley that directs the second main rope from the drive sheave toward the second counterweight; and hanging positions of the car by the first and second main ropes are separated from each other when viewed from above.

[0007] According to another 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 such that a rotating shaft of the drive sheave is vertical; a main rope group that is wound around the drive sheave; a car that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by a driving force from the driving machine; a counterweight that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by the driving force from the driving machine; and a deflection pulley group that is disposed in an upper portion of the hoistway so as to direct the main rope group from the drive sheave toward the car and the counterweight, wherein: the main rope group includes a first main rope and a secondmain rope; the deflection pulley group includes a first car deflection pulley that directs the first main rope from the drive sheave toward the car, a first counterweight deflection pulley that directs the first main rope from the drive sheave toward the counterweight, a second car deflection pulley that directs the second main rope from the drive sheave toward the car, and a second counterweight deflection pulley that directs the second main rope from the drive sheave toward the counterweight; hanging positions of the car by the first and second main ropes are separated from each other when viewed from above; and hanging positions of the counterweight by the first and second main ropes are separated from each other when viewed from above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 is a front elevation showing an elevator apparatus according to Embodiment 1 of the present invention;

Figure 2 is a cross section taken along line II - II in Figure 1;

Figure 3 is a front elevation showing an elevator ap-

paratus according to Embodiment 2 of the present invention;

Figure 4 is a plan showing the elevator apparatus in Figure 3;

Figure 5 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention; and

Figure 6 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

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

Embodiment 1

[0010] Figure 1 is a front elevation showing an elevator apparatus according to Embodiment 1 of the present invention, and Figure 2 is a cross section taken along line II - II in Figure 1.

Moreover, in Figure 1, a hoisting zone is shown considerably shortened for simplification, but the actual hoisting zone is much longer than a height dimension of a car.

[0011] In the figures, a car 2, a first counterweight 3, and a second counterweight 4 are disposed inside a hoistway 1. The car 2, the first counterweight 3, and the second counterweight 4 are raised and lowered inside the hoistway 1. A car guide rail (not shown), a first counterweight guide rail (not shown), and a second counterweight guide rail (not shown) that guide the raising and lowering of the car 2, the first counterweight 3, and the second counterweight 4, respectively, are also installed inside the hoistway 1.

[0012] The car 2 has: a front surface 2a in which a car entrance is disposed; a back surface 2b opposite the front surface 2a; a first side surface 2c; and a second side surface 2d opposite the first side surface 2c. The first counterweight 3 is disposed so as to face the first side surface 2c when positioned level with the car 2. The second counterweight 4 is disposed so as to face the second side surface 2d when positioned level with the car 2.

[0013] The first counterweight 3 is disposed in a position that is closer to the back surface 2b than the front surface 2a when viewed from above. In addition, the second counterweight 4 is disposed in a position that is closer to the front surface 2a than the back surface 2b when viewed from above. In other words, the first and second counterweights 3 and 4 are disposed so as to be offset in a depth direction of the car 2 when viewed from above.

[0014] A machine room 5 is disposed in an upper portion of the hoistway 1. A driving machine (a hoisting machine) 6 that generates a driving force for raising and lowering the car 2 and the counterweights 3 and 4 is installed inside the machine room 5. The driving machine 6 has: a driving machine main body 7 that includes a motor and a brake; and a drive sheave 8 that is rotated by the driving machine main body 7.

[0015] A thin hoisting machine having a shorter axial dimension than an outside diameter dimension that is perpendicular to an axial direction is used for the driving machine 6. A permanent-magnet synchronous motor is used for the motor of the driving machine 6. In addition, the drive sheave 8 is rotated directly by the motor without a reduction gear.

[0016] The driving machine 6 is disposed such that a rotating shaft of the drive sheave 8 is vertical (also including generally vertical). The driving machine 6 is also disposed such that the drive sheave 8 is positioned below the driving machine main body 7. In addition, the driving machine 6 is disposed so as to overlap generally centrally with the car 2 when viewed from above. In other words, the driving machine 6 is disposed generally centrally inside the machine room 5.

[0017] A main rope group 10 that suspends the car 2 and the counterweights 3 and 4 is wound around the drive sheave 8. A plurality of first main ropes 11 (only one is shown in the figures) that suspend the car 2 and the first counterweight 3, and a plurality of second main ropes 12 (only one is shown in the figures) that suspend the car 2 and the second counterweight 4 are included in the main rope group 10.

[0018] The number of first main ropes 11 is equal to the number of second main ropes 12. The total number of main ropes contained in the main rope group 10 is determined by constraints such as main rope safety factors prescribed by law, etc. The number of first and second main ropes 11 and 12 is half the total number of main ropes, respectively.

[0019] A wind-around range R1 of the first main ropes 11 and a wind-around range R2 of the second main ropes 12 on the drive sheave 8 are centrosymmetric to each other relative to the rotating shaft of the drive sheave 8. The wind-around range R1 and the wind-around range R2 do not overlap in a circumferential direction of the drive sheave 8. Specifically, in this example, small regions are present at two circumferential positions on the drive sheave 8 where neither the first nor second main ropes 11 and 12 are wound around. Consequently, wind-around angles of the first and second main ropes 11 and 12 on the drive sheave 8 are less than 180 degrees, respectively.

[0020] A deflection pulley group 14 that directs the main rope group 10 from the drive sheave 8 toward the car 2 and the counterweight 3 and 4 is disposed in the machine room 5. A first car deflection pulley 15 that directs the first main ropes 11 from the drive sheave 8 toward the car 2, a first counterweight deflection pulley 16 that directs the first main ropes 11 from the drive sheave 8 toward the first counterweight 3, a second car deflection pulley 17 that directs the second main ropes 12 from the drive sheave 8 toward the car 2, and a second counterweight deflection pulley 18 that directs the second main ropes 12 from the drive sheave 8 toward the second counterweight 4 are included in the deflection pulley

group 14.

[0021] The deflection pulleys 15 through 18 are disposed such that rotating shafts thereof are horizontal. The deflection pulleys 15 through 18 are also disposed so as to overlap with the car 2 when viewed from above.

[0022] First and second hanging positions 13a and 13b of the car 2 by the first and second main ropes 11 and 12 are separated from each other in a width direction and a depth direction of the car 2 when viewed from above. The hanging positions 13a and 13b are also centrosymmetric to each other relative to a center of gravity of the car 2 when viewed from above. Here, if a plurality of first main ropes 11 are used, the first hanging position 13a is an action centre of forces from all of the first main ropes 11. The second hanging position 13b is similar.

[0023] In an elevator apparatus of this kind, an approach angle of the main ropes 11 and 12 onto the drive sheave 8 is maximized in the main rope positioned furthest outside on the deflection pulleys 15 through 18. In regard to this, because the main rope group 10 is divided into first and second main ropes 11 and 12 in this example, the number of main ropes that are wound around each of the deflection pulleys 15 through 18 is halved (or approximately halved). Consequently, the approach angle onto the drive sheave 8 of the main rope positioned furthest outside on the deflection pulleys 15 through 18 can be reduced. In other words, the distance between the drive sheave 8 and the deflection pulleys 15 through 18 can be reduced.

[0024] Thus, the driving machine 6 can be disposed in the vicinity of the center of the machine room 5, and interference with wall portions of the machine room 5 is avoided even if the diameter of the motor of the driving machine 6 is increased, making it unnecessary to expand the space of the machine room 5. In other words, additional reductions in the thickness of the driving machine 6 can be achieved.

[0025] Since the wind-around range R1 of the first main ropes 11 and the wind-around range R2 of the second main ropes 12 on the drive sheave 8 are centrosymmetric to each other relative to the rotating shaft of the drive sheave 8, forces from the main ropes 11 and 12 acting radially on the drive sheave 8 cancel each other out. Thus, strength in the rotating shaft, bearings, and a frame body supporting the bearings, etc., of the drive sheave 8 can be reduced, enabling reductions in overall size and weight of the driving machine 6.

Embodiment 2

[0026] Next, Figure 3 is a front elevation showing an elevator apparatus according to Embodiment 2 of the present invention and Figure 4 is a plan showing the elevator apparatus in Figure 3. In this example, a driving machine 6 and a deflection pulley group 14 are disposed in an upper portion inside a hoistway 1. Specifically, the driving machine 6 and deflection pulleys 15 through 18 are disposed between a car 2 and a ceiling 1a of the hoistway 1 when the car 2 is stopped at an uppermost floor, in other words, the elevator apparatus in this example is a machine-roomless elevator.

[0027] The driving machine 6 is disposed such that a drive sheave 8 is positioned above a driving machine main body 7. The driving machine 6 is also disposed at a height equal to that of the deflection pulleys 15 through 18. In addition, the driving machine 6 is disposed in a vicinity of a center of the hoistway 1 when viewed from above.

[0028] First and second rope connecting portions 2e and 2f projecting outward in a width direction of the car 2 from first and second side surfaces 2c and 2d are disposed on the car 2. First and second main ropes 11 and 12 are connected to the first and second rope connecting portions 2e and 2f. The rest of the configuration is similar to that of Embodiment 1.

[0029] In an elevator apparatus of this kind, the driving machine 6 can be disposed in the vicinity of the center of the upper portion inside the hoistway 1. Consequently, it is not necessary to expand the space of the hoistway 1 even if the diameter of the motor of the driving machine 6 is increased. The driving machine 6 can also be reduced further in thickness. Thus, increases in vertical dimensions and horizontal dimensions of the hoistway 1 can be prevented.

[0030] Because the driving machine main body 7 is disposed under the drive sheave 8, maintenance inspection work on the driving machine main body 7 can be performed easily from on top of the car 2. In addition, because the rope connecting portions 2e and 2f are disposed on the car 2, the distance between the deflection pulleys 15 and 17 and the drive sheave 8 can be increased, enabling the approach angle of the main ropes 11 and 12 onto the drive sheave 8 to be reduced.

Embodiment 3

[0031] Next, Figure 5 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention. In this example, a second counterweight 4 is disposed in a position that is closer to a back surface 2b than a front surface 2a when viewed from above. Specifically, the first and second counterweights 3 and 4 are disposed at identical positions in a depth direction of the car 2 when viewed from above.

[0032] Thus, a wind-around range R1 of first main ropes 11 and a wind-around range R2 of second main ropes 12 on a drive sheave 8 are not centrosymmetric to each other relative to a rotating shaft of the drive sheave 8. However, the wind-around range R1 and the wind-around range R2 overlap with each other only partially in a circumferential direction on the drive sheave 8 (overlap range R3) . The overlap range R3 is less than one quarter (1/4) of the wind-around range R1 or the wind-around range R2. The rest of the configuration is similar to that of Embodiments 1 or 2.

[0033] In an elevator apparatus of this kind, because

the wind-around range R1 and the wind-around range R2 do not overlap with each other in a large portion in the circumferential direction of the drive sheave 8, forces from the main ropes 11 and 12 acting radially on the drive sheave 8 partially cancel each other out (in the large portion). Thus, strength in the rotating shaft, the bearings, and the frame body supporting the bearings, etc., of the drive sheave 8 can be reduced, enabling reductions in overall size and weight of the driving machine 6.

Embodiment 4

[0034] Next, Figure 6 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention. In the figure, a car 2 and a counterweight 21 are suspended by a main rope group 10 inside a hoistway 1. A back surface facing portion 21a that faces a back surface 2b when positioned level with the car 2, and a side surface facing portion 21b that faces a second side surface 2d when positioned level with the car 2 are disposed integrally on the counterweight 21. The side surface facing portion 21b is at a right angle relative to the back surface facing portion 21a. In other words, a horizontal shape of the counterweight 21 is an L shape.

[0035] Hanging positions 22a and 22b of the counterweight 21 by first and second main ropes 11 and 12 are separated from each other when viewed from above. Specifically, the hanging position 22a of the counterweight 21 by the first main ropes 11 is disposed on the back surface facing portion 21a, and the hanging position of the counterweight 21 by the second main ropes 12 is disposed on the side surface facing portion 21b.

[0036] A wind-around range R1 of first main ropes 11 and a wind-around range R2 of second main ropes 12 on a drive sheave 8 overlap with each other only partially in a circumferential direction on the drive sheave 8 (overlap range R3). The overlap range R3 is less than one half (1/2) of the wind-around range R1 or the wind-around range R2. The rest of the configuration is similar to that of Embodiments 1 or 2.

[0037] In an elevator apparatus of this kind, because a shared counterweight 21 is suspended by the main ropes 11 and 12, one counterweight 21 is sufficient, enabling the number of parts such as counterweight guide rails, etc., to be reduced, and also enabling installation work to be facilitated.

[0038] Because the wind-around range R1 and the wind-around range R2 overlap with each other only partially in the circumferential direction of the drive sheave 8, forces from the main ropes 11 and 12 acting radially on the drive sheave 8 partially cancel each other out. Thus, strength in the rotating shaft, the bearings, and the frame body supporting the bearings, etc., of the drive sheave 8 can be reduced, enabling reductions in overall size and weight of the driving machine 6.

[0039] Moreover, in the above examples, an elevator apparatus using a one-to-one (1:1) roping method is shown, but the roping method is not limited thereto, and for example, the present invention can also be applied to an elevator apparatus using a two-to-one (2:1) roping method. For example, car suspension sheaves may also be mounted to a car, a counterweight suspension sheave mounted to a counterweight, main ropes wound around the car suspension sheaves and the counterweight suspension sheave, and end portions of the main ropes connected to rope end connecting portions that are disposed in an upper portion of a hoistway.

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 such that a rotating shaft of the drive sheave is vertical;
a main rope group that is wound around the drive sheave;
a car that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by a driving force from the driving machine;
first and second counterweights that are suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by the driving force from the driving machine; and
a deflection pulley group that is disposed in an upper portion of the hoistway so as to direct the main rope group from the drive sheave toward the car, the first counterweight, and the second counterweight,

characterized in that:

the main rope group includes a first main rope that suspends the car and the first counterweight, and a second main rope that suspends the car and the second counterweight;
the deflection pulley group includes a first car deflection pulley that directs the first main rope from the drive sheave toward the car, a first counterweight deflection pulley that directs the first main rope from the drive sheave toward the first counterweight, a second car deflection pulley that directs the second main rope from the drive sheave toward the car, and a second counterweight deflection pulley that directs the second main rope from the drive sheave toward the second counterweight; and
hanging positions of the car by the first and second main ropes are separated from each other when viewed from above.

2. An elevator apparatus comprising:

a driving machine having a drive sheave, the driving machine being disposed in an upper portion of a hoistway such that a rotating shaft of the drive sheave is vertical;
a main rope group that is wound around the drive sheave;
a car that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by a driving force from the driving machine;
a counterweight that is suspended inside the hoistway by the main rope group and raised and lowered inside the hoistway by the driving force from the driving machine; and
a deflection pulley group that is disposed in an upper portion of the hoistway so as to direct the main rope group from the drive sheave toward the car and the counterweight,

characterized in that:

the main rope group includes a first main rope and a second main rope;
the deflection pulley group includes a first car deflection pulley that directs the first main rope from the drive sheave toward the car, a first counterweight deflection pulley that directs the first main rope from the drive sheave toward the counterweight, a second car deflection pulley that directs the second main rope from the drive sheave toward the car, and a second counterweight deflection pulley that directs the second main rope from the drive sheave toward the counterweight;
hanging positions of the car by the first and second main ropes are separated from each other when viewed from above; and
hanging positions of the counterweight by the first and second main ropes are separated from each other when viewed from above.

3. The elevator apparatus according to either Claim 1 or Claim 2, **characterized in that** a wind-around range of the first main rope and a wind-around range of the second main rope on the drive sheave are centrosymmetric to each other relative to the rotating shaft of the drive sheave.

4. The elevator apparatus according to either Claim 1 or Claim 2, **characterized in that** a wind-around range of the first main rope and a wind-around range of the second main rope on the drive sheave overlap with each other only partially in a circumferential direction on the drive sheave.

5. The elevator apparatus according to either Claim 1 or Claim 2, **characterized in that** the hanging positions of the car by the first and second main ropes are centrosymmetric to each other relative to a center of gravity of the car when viewed from above.

6. The elevator apparatus according to either Claim 1 or Claim 2, **characterized in that** the driving machine and the deflection pulley group are disposed between the car and a ceiling of the hoistway when the car is stopped at an uppermost floor.

7. The elevator apparatus according to Claim 2, **characterized in that**:

the car has a front surface and a back surface on opposite sides from each other, and first and second side surfaces on opposite sides from each other;
a back surface facing portion that faces the back surface when positioned level with the car, and a side surface facing portion that faces one of the first and second side surfaces when positioned level with the car are disposed integrally on the counterweight; and
a hanging position of the counterweight by the first main rope is disposed on the back surface facing portion, and a hanging position of the counterweight by the second main rope is disposed on the side surface facing portion.

FIG. 1

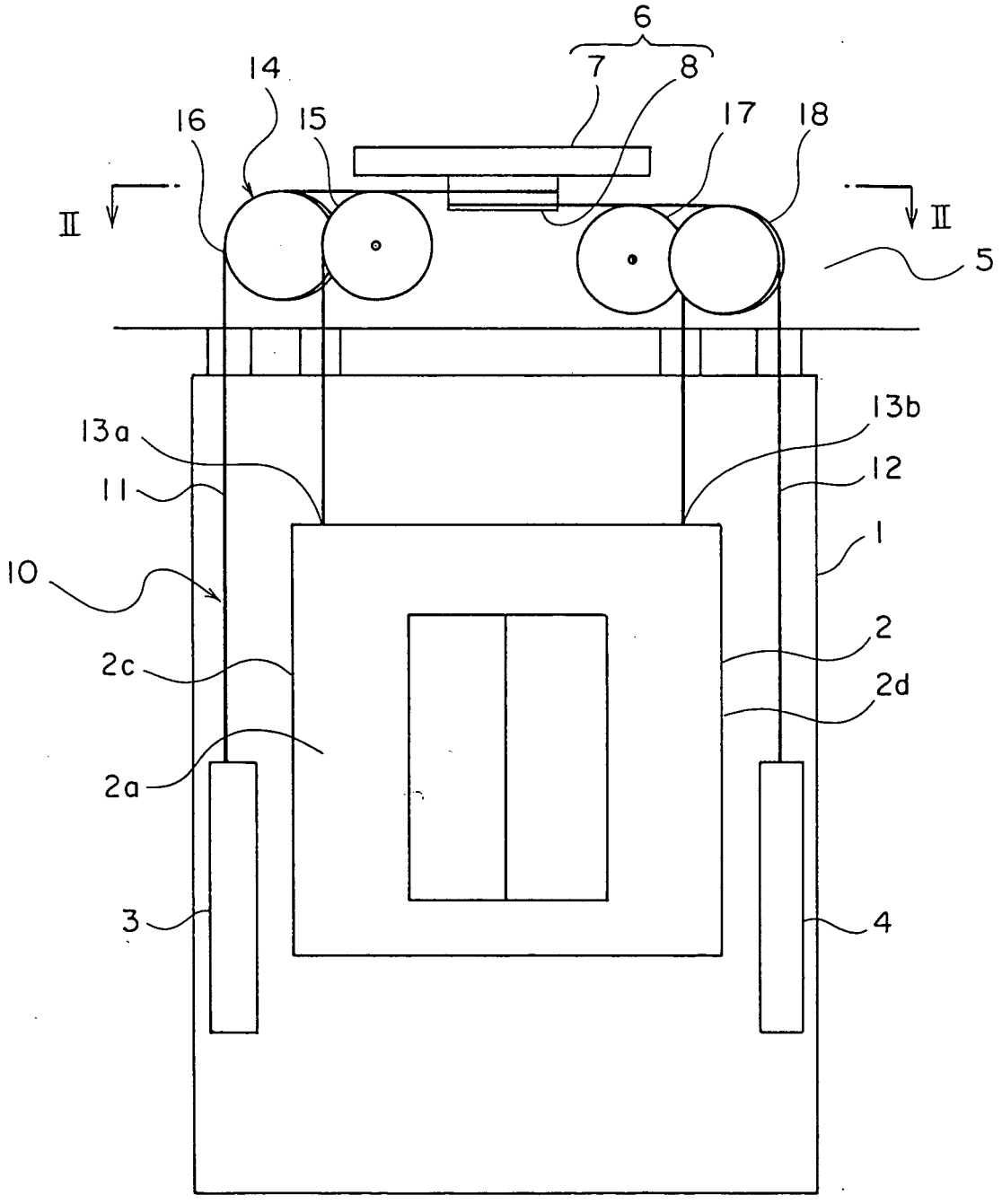


FIG. 2

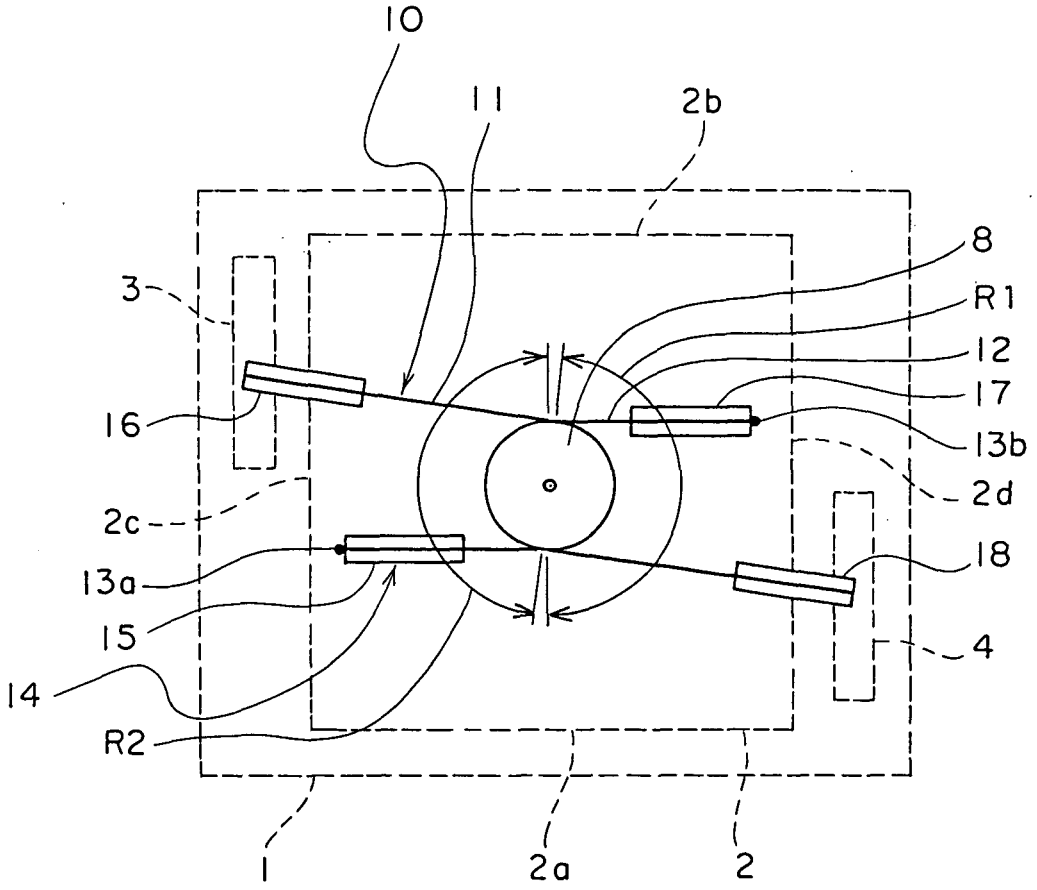


FIG. 3

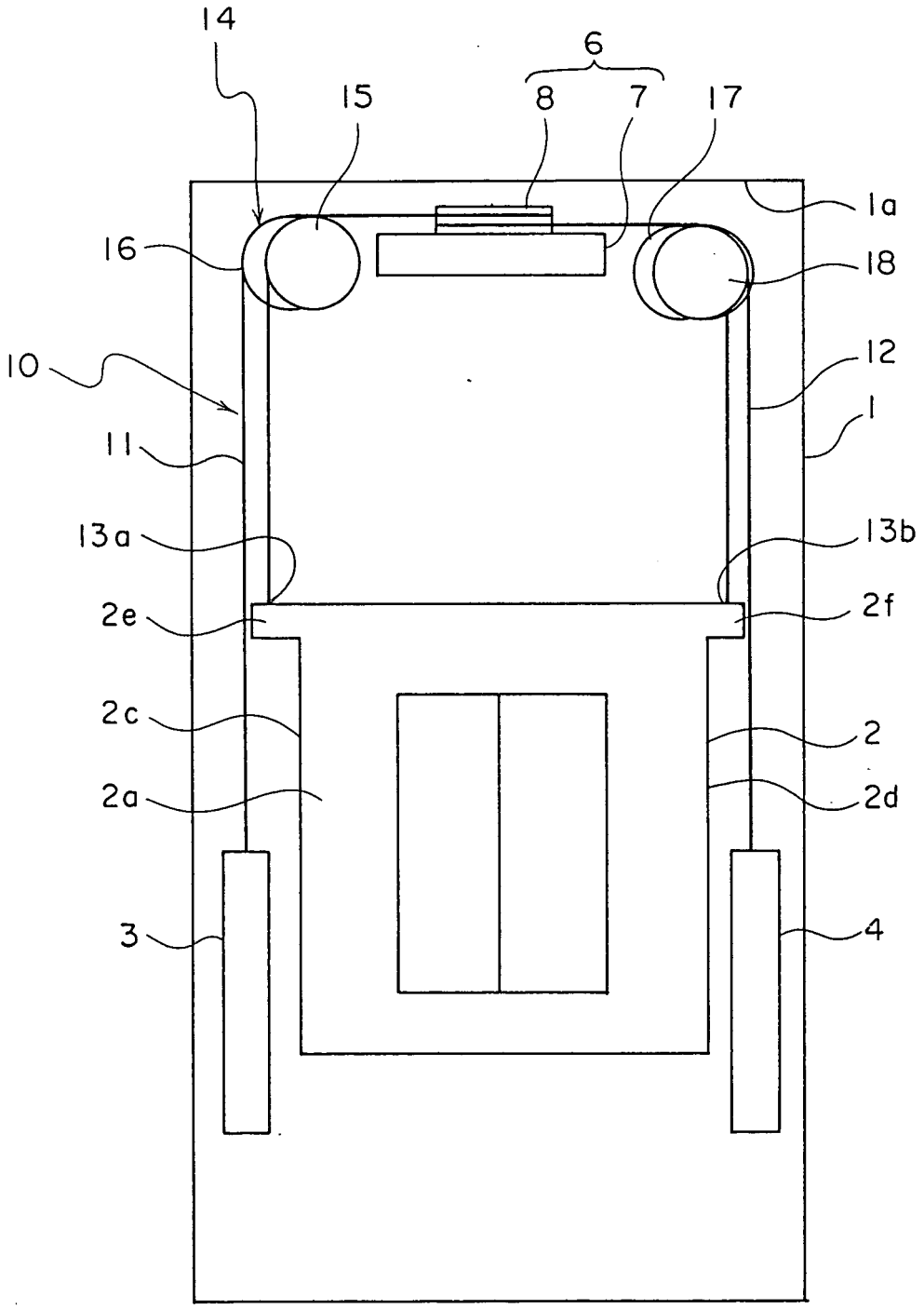


FIG. 4

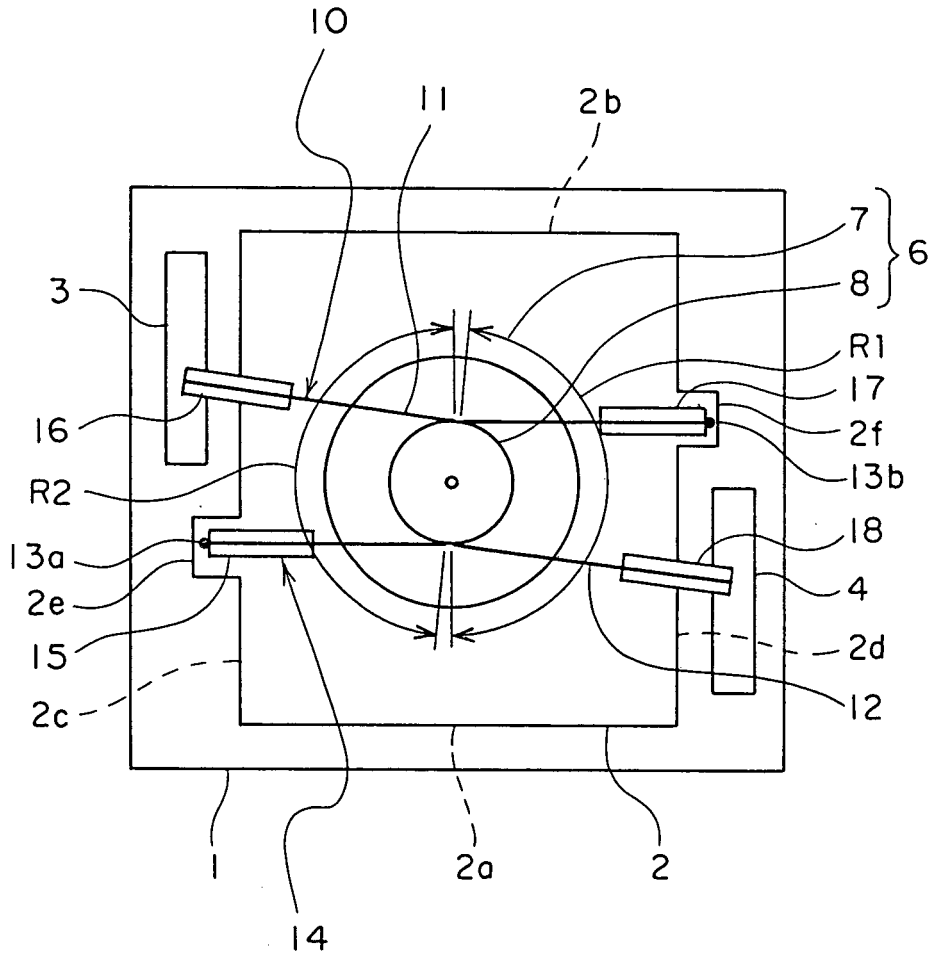


FIG. 5

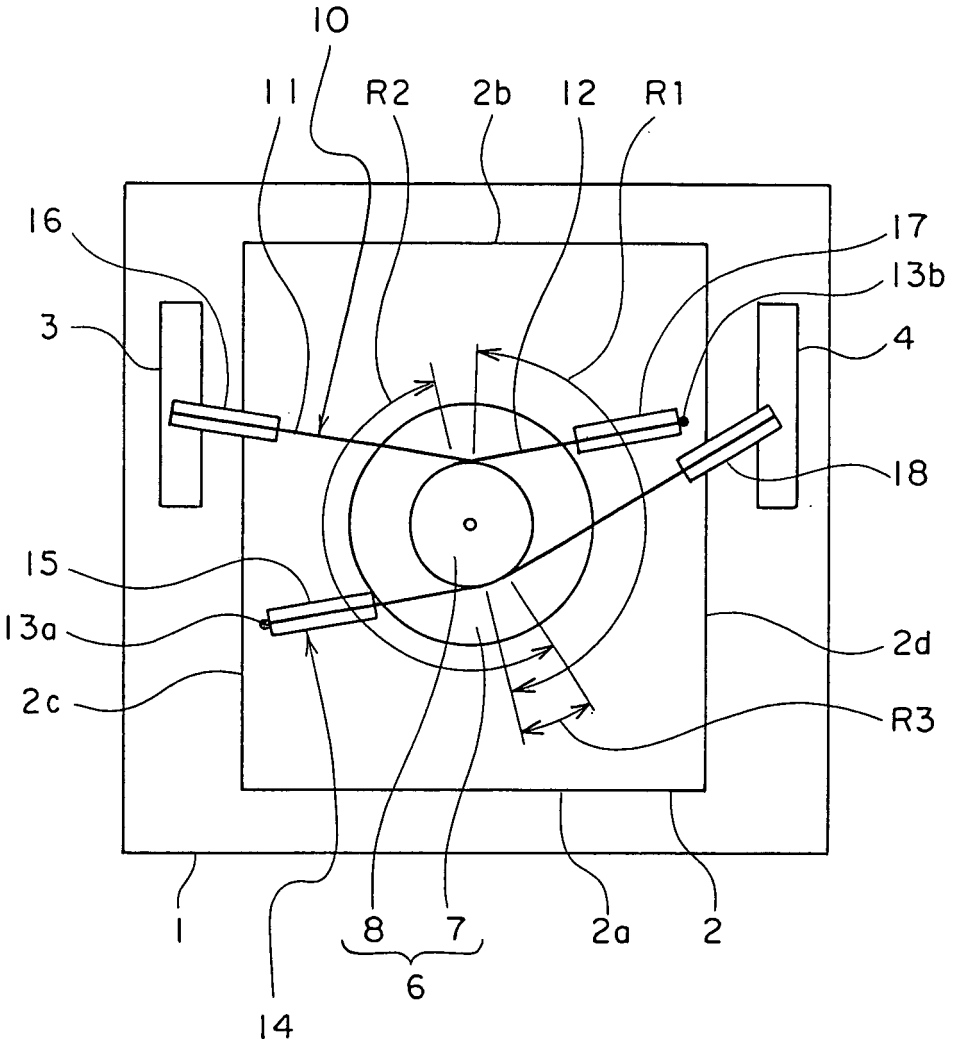
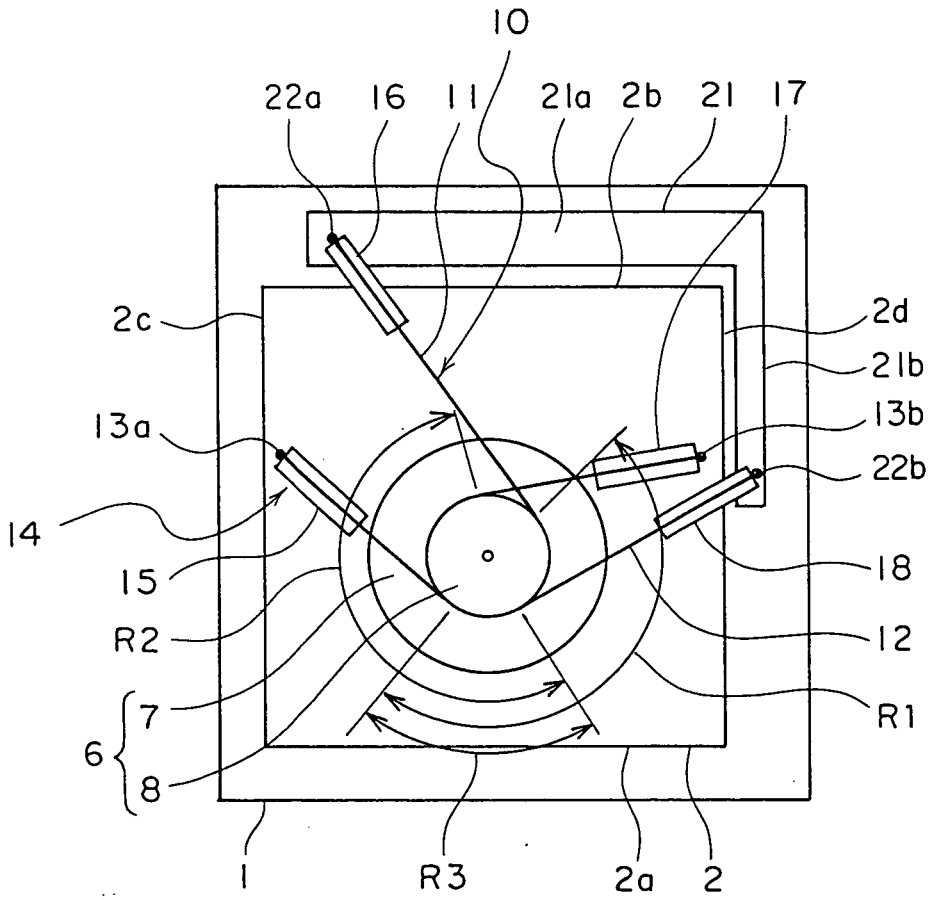


FIG. 6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R2
R1
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R3
2a
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015051

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-B66B7/12

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 2004/022471 A1 (Mitsubishi Electric Corp.), 18 March, 2004 (18.03.04), Pay attention to abstract; Figs. 1 to 2 (Family: none)	1-7
A	WO 03/074409 A1 (Mitsubishi Electric Corp.), 12 September, 2003 (12.09.03), Pay attention to description; page 6, line 14 to page 9, line 9; Figs. 4 to 5 & EP 1481935 A1	1-7
A	JP 5-70058 A (Hitachi Building System Eng. & Service Co., Ltd.), 23 March, 1993 (23.03.93), Pay attention to Par. Nos. [0007] to [0009]; Figs. 1 to 3 (Family: none)	1-7

☒ 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
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Date of the actual completion of the international search	Date of mailing of the international search report
11 July, 2005 (11.07.05)	26 July, 2005 (26.07.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015051

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 2002-68641 A (Mitsubishi Electric Corp.), 08 March, 2002 (08.03.02), Pay attention to Par. Nos. [0035] to [0038]; Figs. 5 to 6 (Family: none)	1-7
A	JP 50-9703 Y1 (Hitachi Zosen Corp.), 25 March, 1975 (25.03.75), Pay attention to column 2, lines 5 to 24; Figs. 1 to 2 (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001048450 A **[0003]**