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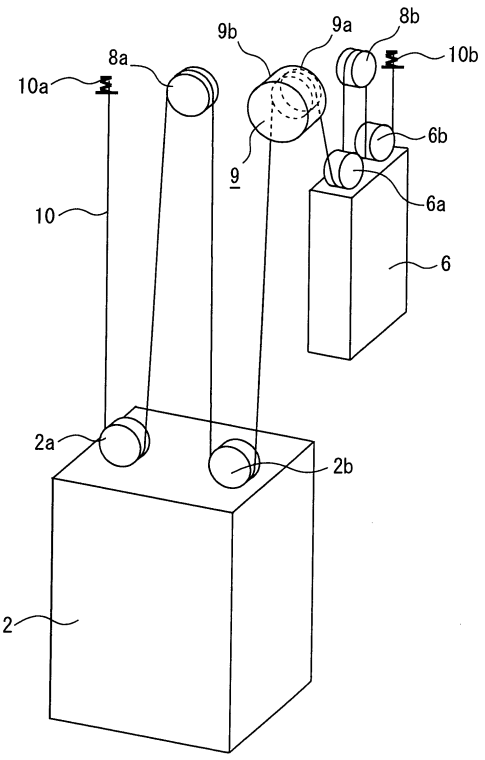
(54) ELEVATOR APPARATUS

(57) A high capacity of a space-saved elevator apparatus is realized by decreasing the size of a traction machine (9) and by simplifying the entire configuration. For this purpose, the traction machine (9) is arranged in an upper part of a clearance (5b) in which a counterweight (6) moves vertically, a reversing sheave (8a) for car above a car (2) is arranged between two car suspending sheaves (2a, 2b) provided on both sides above the car (2) on the vertically projected plane, and a reversing sheave (8b) for counterweight above the counterweight (6) is arranged between two counterweight suspending sheaves (6a, 6b) provided above the counterweight (6) on the vertically projected plane, by which the car (2) and the counterweight (6) are suspended in a 4:1 roping system.

Fig. 1



EP 1 754 680 A1

Description

Technical Field

[0001] The present invention relates to a traction elevator apparatus of a 4:1 roping system in which an elevator car and a counterweight are suspended by a main rope.

Background Art

[0002] For the recent elevator apparatus, in order to effectively utilize a building as far as possible, the vertically projected area of a machine room installed above an elevator shaft is made almost the same as the vertically projected area of the shaft, or equipment that has conventionally been installed in the machine room is arranged in the shaft to make the installation of machine room unnecessary, by which space saving is achieved. However, the space saving of elevator apparatus imposes a significant limitation on the layout and the installation position of equipment used, so that driving torque cannot be increased by installing a large-size traction machine, which results in a difficulty in increasing the capacity of elevator apparatus.

[0003] On the other hand, as a method for increasing the capacity of elevator apparatus, a method in which the capacity is increased by a roping system of main rope suspending the elevator car and the counterweight is conceivable in addition to a method in which the driving torque of traction machine is increased. For example, in "Elevator with Tow Sheave" described in Japanese Patent Laid-Open No. 2000-153975, a traction elevator apparatus in which the car and counterweight are suspended by a 4:1 roping system has been disclosed. In the case where the car and counterweight are suspended by a 4:1 roping system, the driving torque necessary for the traction machine can be decreased, for example, to one-fourth for a 1:1 roping system or to a half for a 2:1 roping system. Therefore, a high-capacity elevator apparatus can be realized without installing a large-size traction machine. In the 4:1 roping system, however, the travel distance of main rope increases significantly as compared with the travel distance of car, and hence the number of suspending sheaves and reversing sheaves for turning around the main rope increases, which poses a problem of highly complicated configuration and arrangement of suspending sheaves and reversing sheaves.

[0004] An object of the present invention is to provide a traction elevator apparatus in which a high capacity of an elevator apparatus in which space saving is achieved can be kept by decreasing the size of a traction machine and by simplifying the configuration.

[0005] Patent Document 1: Japanese Patent Laid-Open No. 2000-153975

Disclosure of the Invention

[0006] To achieve the above object, in the elevator apparatus in accordance with the present invention, a traction machine is arranged in an upper part of a clearance in which a counterweight moves vertically, a reversing sheave for car above a car is arranged between two car suspending sheaves provided on both sides above the car on the vertically projected plane, and a reversing sheave for counterweight above the counterweight is arranged between two counterweight suspending sheaves provided above the counterweight on the vertically projected plane, by which the car and the counterweight are suspended in a 4:1 roping system.

Brief Description of the Drawings

[0007]

Figure 1 is a general system view showing a first embodiment of an elevator apparatus in accordance with the present invention.
Figure 2 is a plan view showing a first embodiment of an elevator apparatus in accordance with the present invention.
Figure 3 is a front view showing a second embodiment of an elevator apparatus in accordance with the present invention.
Figure 4 is a plan view of showing a second embodiment of an elevator apparatus in accordance with the present invention.

Best Mode for Carrying Out the Invention

[0008] To explain the present invention in more detail, it will be explained with reference to the accompanying drawings. In each drawings, the same reference characters are applied to the same or corresponding elements, and the duplicated explanation thereof is appropriately simplified or omitted.

First embodiment

[0009] Figure 1 is a general system view showing a first embodiment of an elevator apparatus in accordance with the present invention, and Figure 2 is a plan view of Figure 1. In the figures, a car 2 moving vertically in an elevator shaft 1 having a substantially square-shaped transverse cross section is arranged on the shaft wall 1a side on which a doorway 3 that connects an elevator hall on each floor of a building to the shaft 1 is provided. The horizontal movement of the car 2 is restricted by a pair of car guide rails 4 erected so as to face to each other over the elevatable range of the car 2. Between shaft walls 1b and 1c facing to each other on both sides with the shaft wall 1a being held therebetween and both side surfaces of the car 2, clearances 5a and 5b are formed, respectively. Also, the car 2 is supported by a quadran-

gular prism shaped car frame (not shown) provided so as to surround the central portions of side surfaces and top and bottom surfaces of the car 2, and guide rollers (not shown) etc. provided on vertical frames of this car frame engage with the car guide rails 4 arranged on both sides of the car 2. And on a top frame (not shown) of the car frame, which is located above the car 2 and is provided from one side surface on the shaft wall 1b side to the other side surface on the shaft wall 1c side, two car suspending sheaves 2a and 2b are provided turnably at positions above the car 2 on one side surface side and the other side surface side. The two car suspending sheaves 2a and 2b are arranged so that the turning shafts thereof are perpendicular to the shaft wall 1a, and rope grooves formed in the outer peripheral surfaces of the sheaves lie substantially on a straight line on the vertically projected plane.

[0010] A counterweight 6 moving vertically in the elevator shaft 1 in the direction opposite to the car 2 is arranged at a position close to the shaft wall 1d side on the far side from the shaft wall 1a so as to move vertically in the clearance 5b on the shaft wall 1c side having a greater width than the clearance 5a formed on the shaft wall 1b side of the car 2. The counterweight 6 is arranged so that the horizontal movement thereof is restricted by a pair of counterweight guide rails 7 erected so as to face to each other over the elevatable range of the counterweight 6, and the end portion thereof on the shaft wall 1a side is located in a substantially middle portion in the front-to-back direction of the car 2. The counterweight 6 is supported by a quadrangular prism shaped counterweight frame (not shown), and guide shoes (not shown) etc. provided on vertical frames of the counterweight frame engage with the counterweight guide rails 7 arranged on the shaft wall 1a side and the shaft wall 1d side of the counterweight 6. On a top frame (not shown) of the counterweight frame, which is located above the counterweight 6 and is provided from the shaft wall 1a side to the shaft wall 1d side of the counterweight 6, two counterweight suspending sheaves 6a and 6b are provided turnably in end portions on the shaft wall 1a side and the shaft wall 1d side. The two counterweight suspending sheaves 6a and 6b are arranged so that the turning shafts thereof are parallel to the shaft wall 1a, and rope grooves formed in the outer peripheral surfaces of the counterweight suspending sheaves 6a and 6b lie substantially on a straight line on the vertically projected plane.

[0011] Also, on a fixed element such as an elevator shaft beam arranged at the top of the elevator shaft 1, a reversing sheave 8a for car is turnably provided just above the car 2, and a reversing sheave 8b for counterweight is turnably provided just above the counterweight 6 respectively. The reversing sheave 8a for car is arranged so that the reversing sheave 8a for car has a turning shaft that is substantially parallel with the turning shafts of the car suspending sheaves 2a and 2b, which are perpendicular to the shaft wall 1a, being arranged between the car suspending sheaves 2a and 2b on the vertically projected plane, and rope grooves formed in the outer peripheral surface of the reversing sheave 8a lies substantially on a straight line with respect to the rope grooves formed in the outer peripheral surfaces of the car suspending sheaves 2a and 2b on the vertically projected plane. On the other hand, the reversing sheave 8b for counterweight is arranged so that it has a turning shaft that is substantially parallel with the turning shafts of the counterweight suspending sheaves 6a and 6b, and it is perpendicular to the turning shafts of the car suspending sheaves 2a and 2b and the reversing sheave 8a for car. Also, the reversing sheave 8b for counterweight is arranged between the counterweight suspending sheaves 6a and 6b, and is arranged so that rope grooves formed in the outer peripheral surface of the reversing sheave 8b lies substantially on a straight line with respect to the rope grooves formed in the outer peripheral surfaces of the counterweight suspending sheaves 6a and 6b on the vertically projected plane. Also, on the shaft wall 1c side of the top portion of the elevator shaft 1, namely, in the top portion of the shaft 1 in an upper part of the clearance 5b in which the counterweight moves vertically, there is provided a gearless traction machine 9 including a drive sheave 9a formed with a rope groove in the outer peripheral surface thereof and a motor section 9b having a diameter slightly larger than that of the drive sheave 9a. The gearless traction machine 9 is arranged so that the turning shaft of the drive sheave 9a, which has almost the same diameter as the diameters of the suspending sheaves and the reversing sheaves provided in the elevator shaft 1, is substantially parallel with the turning shaft of the car suspending sheaves 2a and 2b and the reversing sheave 8a for car, and the motor section 9b for driving the drive sheave 9a is located on the shaft wall 1a side of the drive sheave 9a. Also, the drive sheave 9a is arranged so that the rope grooves in the drive sheave 9a lies substantially on a straight line with respect to the rope grooves in the car suspending sheaves 2a and 2b and the reversing sheave 8a for car, and the end portion on the shaft wall 1b side thereof is located substantially just above the end portion on the shaft wall 1c side of the car suspending sheave 2b and the end portion on the shaft wall 1c side thereof is located substantially just above the end portion on the shaft wall 1a side of the counterweight suspending sheave 6a.

[0012] One end portion of a main rope 10 for suspending the car 2 and the counterweight 6, which are configured as described above, in a well bucket manner is elastically fixed to the top fixed element in the elevator shaft 1, which is located substantially just above the end portion on the shaft wall 1b side of the car suspending sheave 2a, via a car-side fixing member 10a. And the main rope 10 is set from the car-side fixing member 10a side to the car suspending sheave 2a, the reversing sheave 8a for car, the car suspending sheave 2b, the drive sheave 9a, the counterweight suspending sheave 6a, the reversing sheave 8b for counterweight, and the counterweight suspending sheave 6b in that order. The other end of the

main rope 10 is elastically fixed to the top fixed element in the elevator shaft 1, which is located substantially just above the end portion on the shaft wall 1d side of the counterweight suspending sheave 6b, via a counterweight-side fixing member 10b. That is to say, the car 2 and the counterweight 6 are suspended by the main rope 10 in a 4:1 roping system, and move vertically in the elevator shaft 1 at a speed of 1/4 of the rotational speed of the drive sheave 9a. The main rope 10 has properties of prolonged bending life and high traction ability so as to be set around the suspending sheaves and reversing sheaves and the drive sheave 9a each having a small diameter. As the main rope 10, for example, a rope in which a core wire made of a steel is coated with a resin to provide a high friction coefficient is used.

[0013] According to the first embodiment of the elevator apparatus in accordance with the present invention, since the car 2 and the counterweight 6 are suspended in the 4:1 roping system, even if the diameter of the drive sheave 9a is made one-fourth of the case of 1:1 roping system or a half of the case of 2:1 roping system, almost the same level of driving torque can be obtained. Therefore, the size of the gearless traction machine 9 can be decreased. For example, the diameter of the drive sheave 9a can be decreased to about 200 mm, and the diameter of the motor section 9b can be decreased to about 300 mm. In the case where the size of the gearless traction machine 9 is decreased in this manner, even in a space-saved elevator apparatus, the gearless traction machine 9 can be arranged in a top part of the elevator shaft 1 so that the turning shaft of the drive sheave 9a is perpendicular to the shaft wall 1a. Specifically, the gearless traction machine 9 can be installed so as to be aligned with the positions of the car suspending sheave 2b provided on the top frame of car frame and the counterweight suspending sheave 6a provided on the top frame of counterweight frame. Therefore, the length of the main rope 10 and the number of suspending sheaves etc. are made at a minimum, by which the 4:1 roping system can be configured, and also a fixed element for supporting the car suspending sheaves 2a and 2b need not be installed newly on the car 2, so that the configuration can be made simple. In the first embodiment, the elevator apparatus without a machine room has been described. However, it is a matter of course that even in an elevator apparatus provided with a machine room above the elevator shaft 1, the same effects can be achieved. Also, even if the turning shaft of the drive sheave 9a is arranged so as to have a predetermined angle with respect to the turning shafts of the car suspending sheaves 2a and 2b and the reversing sheave 8a for car so that the position of the drive sheave 9a of the gearless traction machine 9 is aligned with the car suspending sheave 2b and the counterweight suspending sheave 6a, the same effects as those of the first embodiment can be achieved.

Second embodiment

[0014] Figure 3 is a front view showing a second embodiment of an elevator apparatus in accordance with the present invention, and Figure 4 is a plan view of Figure 3. In Figures 3 and 4, on the top frame of the car frame (not shown) supporting the elevator car 2, the two car suspending sheaves 2a and 2b are provided turnably at positions above the car 2 on one side surface side and the other side surface side. Also, on the fixed element at the top of the elevator shaft 1, two reversing sheaves 8c and 8d for car are turnably provided just above the car 2. The reversing sheaves 8c and 8d for car each have a turning shaft that is substantially parallel with the turning shafts of the car suspending sheaves 2a and 2b, which are perpendicular to the shaft wall 1a, and are arranged between the car suspending sheaves 2a and 2b on the vertically projected plane. Also, rope grooves formed in the outer peripheral surfaces of the reversing sheaves 8c and 8d for car are arranged so as to lie substantially on a straight line with respect to the rope grooves formed in the outer peripheral surfaces of the car suspending sheaves 2a and 2b.

[0015] On the other hand, on the top frame of the counterweight frame (not shown) supporting the counterweight 6, the two counterweight suspending sheaves 6a and 6b are provided turnably on the shaft wall 1a side and the shaft wall 1d side of the counterweight 6. The two counterweight suspending sheaves 6a and 6b each have a turning shaft that is substantially parallel with the turning shaft of the reversing sheave 8b for counterweight provided at the top of the elevator shaft 1, and the turning shafts of the counterweight suspending sheaves 6a and 6b are arranged so as to be perpendicular to the turning shafts of the car suspending sheaves 2a and 2b and the reversing sheaves 8c and 8d for car. Also, the reversing sheave 8b for counterweight is arranged between the counterweight suspending sheaves 6a and 6b on the vertically projected plane, and also rope grooves formed in the outer peripheral surface of the reversing sheave 8b for counterweight is arranged so as to lie substantially on a straight line with respect to the rope grooves formed in the outer peripheral surfaces of the counterweight suspending sheaves 6a and 6b.

[0016] Also, the gearless traction machine 9 arranged on the shaft wall 1c side in a top part of the elevator shaft 1 is arranged so that the turning shaft thereof is substantially parallel with the car suspending sheaves 2a and 2b and the reversing sheaves 8c and 8d for car. Further, the gearless traction machine 9 is arranged so that the rope grooves in the drive sheave 9a lies substantially on a straight line with respect to the rope grooves in the car suspending sheaves 2a and 2b and the reversing sheaves 8c and 8d for car, the end portion on the shaft wall 1b side is located substantially just above the end portion on the shaft wall 1c side of the car suspending sheave 2b, and the end portion on the shaft wall 1c side is located substantially just above the end portion on the

shaft wall 1a side of the counterweight suspending sheave 6a.

[0017] The main rope 10 for suspending the car 2 and the counterweight 6, which are configured as described above, in a well bucket manner is set from the car-side fixing member 10a side to the car suspending sheave 2a, the reversing sheaves 8c and 8d for car, the car suspending sheave 2b, the drive sheave 9a, the counterweight suspending sheave 6a, the reversing sheave 8b for counterweight, and the counterweight suspending sheave 6b in that order.

[0018] According to the second embodiment of the elevator apparatus in accordance with the present invention, even in the case where the width of the car 2 is very great as compared with the diameters of the suspending sheaves and the reversing sheaves, an elevator apparatus of a 4:1 roping system with a simple configuration can be realized. Other configuration and effects of this embodiment are the same as those of the first embodiment.

Industrial Applicability

[0019] As described above, according to the elevator apparatus of a 4:1 roping system in accordance with the present invention, the size of the traction machine can be decreased, and the entire configuration can be simplified. Therefore, even in a space-saved elevator apparatus, a high capacity can be achieved easily.

Claims

1. An elevator apparatus of a 4:1 roping system comprising:

   a car which moves vertically in an elevator shaft;
   two car suspending sheaves provided turnably on both sides above the car;
   a reversing sheave for car, which is provided turnably above the car in a top part of the elevator shaft and is arranged between the two car suspending sheaves on the vertically projected plane;
   a counterweight moving vertically in a clearance formed between a shaft wall on one side of the car and the car;
   two counterweight suspending sheaves provided turnably above the counterweight;
   a reversing sheave for counterweight, which is provided turnably above the counterweight in a top part of the elevator shaft and is arranged between the two counterweight suspending sheaves on the vertically projected plane; and
   a traction machine having a turnable drive sheave, the traction machine being provided in an upper part of the clearance, in which the counterweight moves vertically, in a top part of the elevator shaft.

2. The elevator apparatus of a 4:1 roping system according to claim 1, **characterized in that** the two car suspending sheaves and the reversing sheave for car and the drive sheave are arranged so that the turning shafts thereof are parallel with each other, and rope grooves in these sheaves are arranged on a straight line on the vertically projected plane.

3. The elevator apparatus of a 4:1 roping system according to claim 1 or 2, **characterized in that** the counterweight suspending sheaves and the reversing sheave for counterweight are arranged so that the turning shafts thereof are perpendicular to the turning shaft of the car suspending sheaves and the reversing sheave for car, and rope grooves in the counterweight suspending sheaves and the reversing sheave for counterweight are arranged on a straight line on the vertically projected plane.

4. The elevator apparatus of a 4:1 roping system according to any one of claims 1 to 3, **characterized in that** the two car suspending sheaves are provided on a top frame of a car frame for supporting the car.

5. The elevator apparatus of a 4:1 roping system according to any one of claims 1 to 4, **characterized by** being provided with a plurality of reversing sheaves for car.

6. The elevator apparatus of a 4:1 roping system according to any one of claims 1 to 5, **characterized in that** as a main rope for suspending the car and the counterweight, a rope in which the surface thereof is formed of a resin to provide a high friction coefficient is used.

7. The elevator apparatus of a 4:1 roping system according to any one of claims 1 to 6, **characterized in that** the traction machine is provided in a top part of the elevator shaft.

Fig. 1

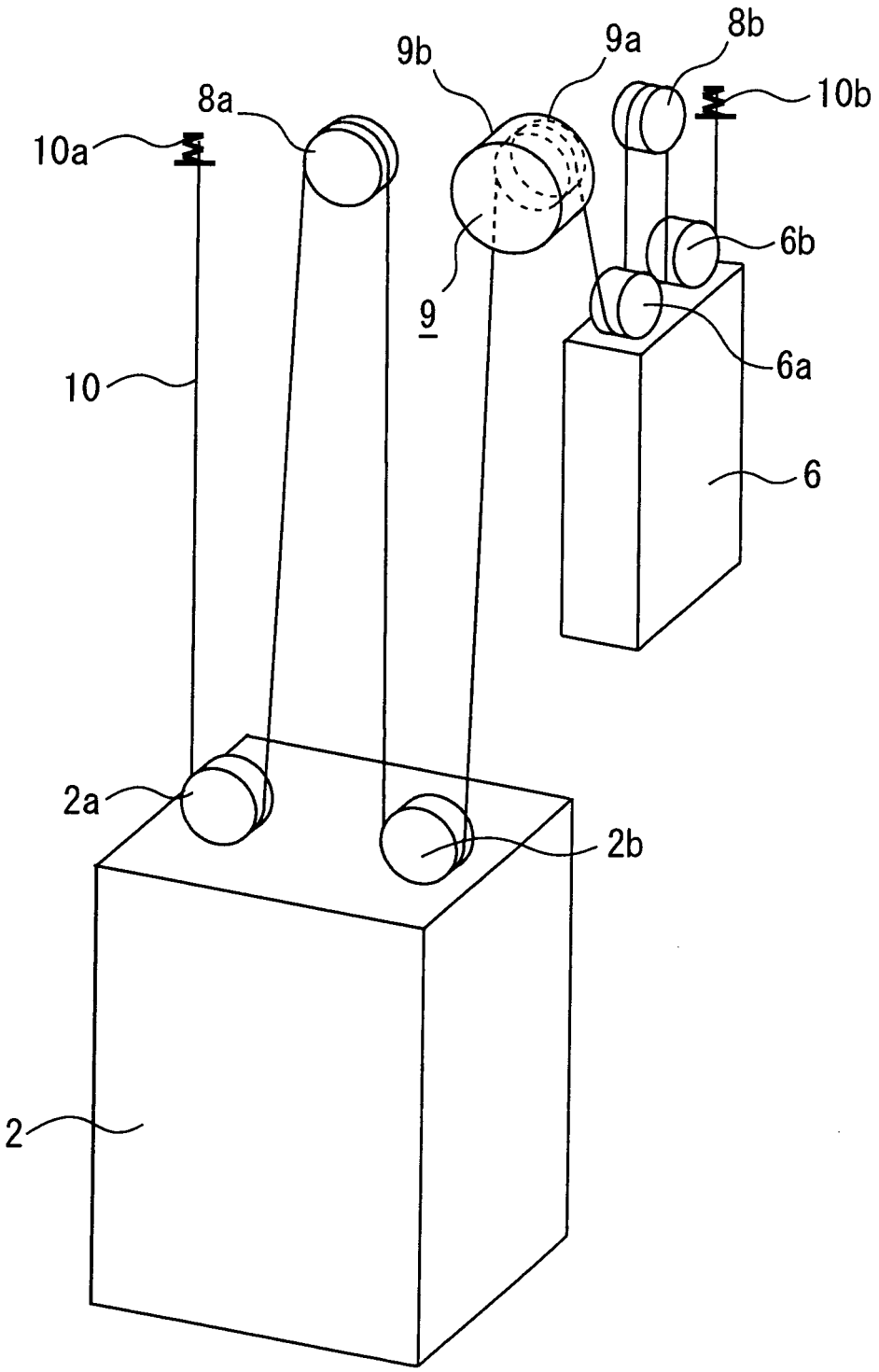


Fig. 2

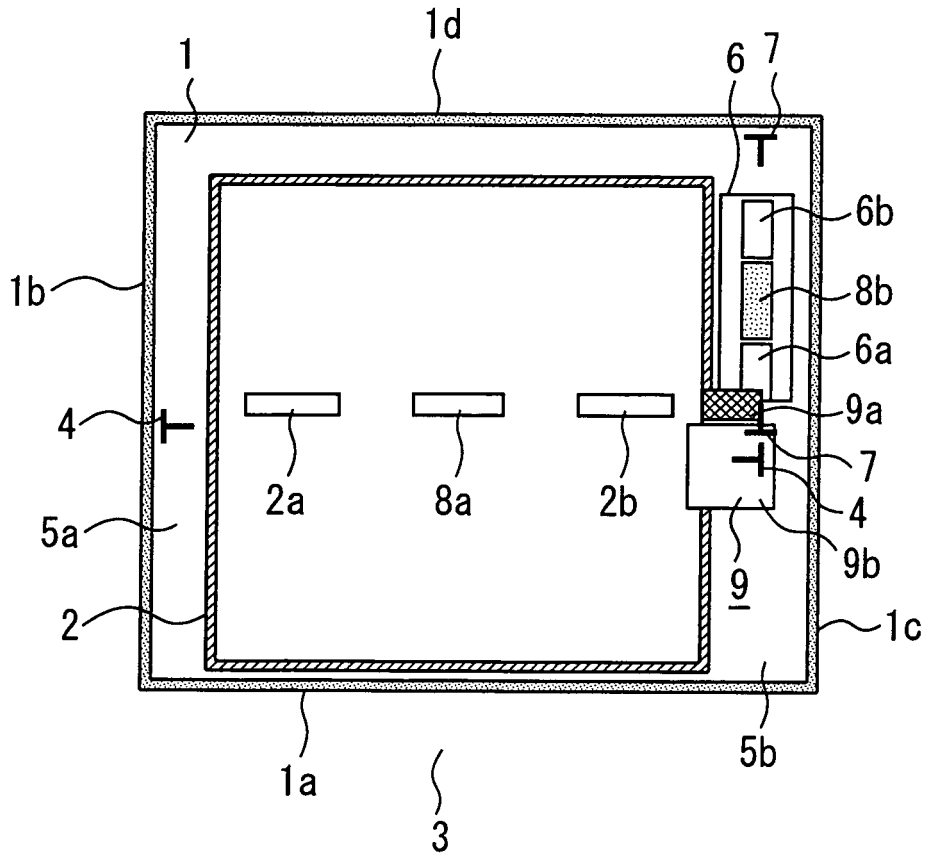


Fig. 3

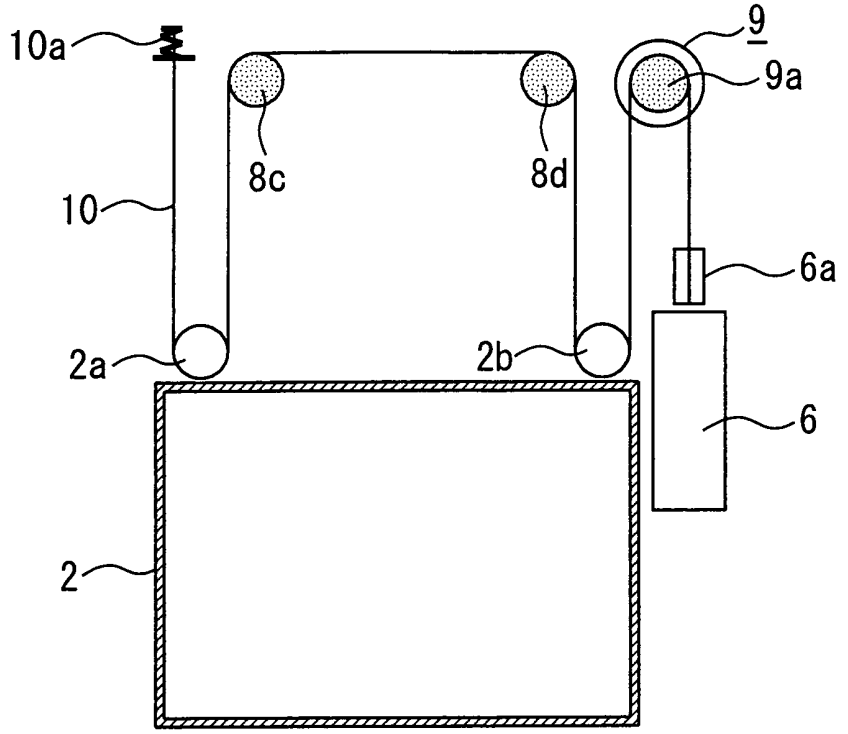
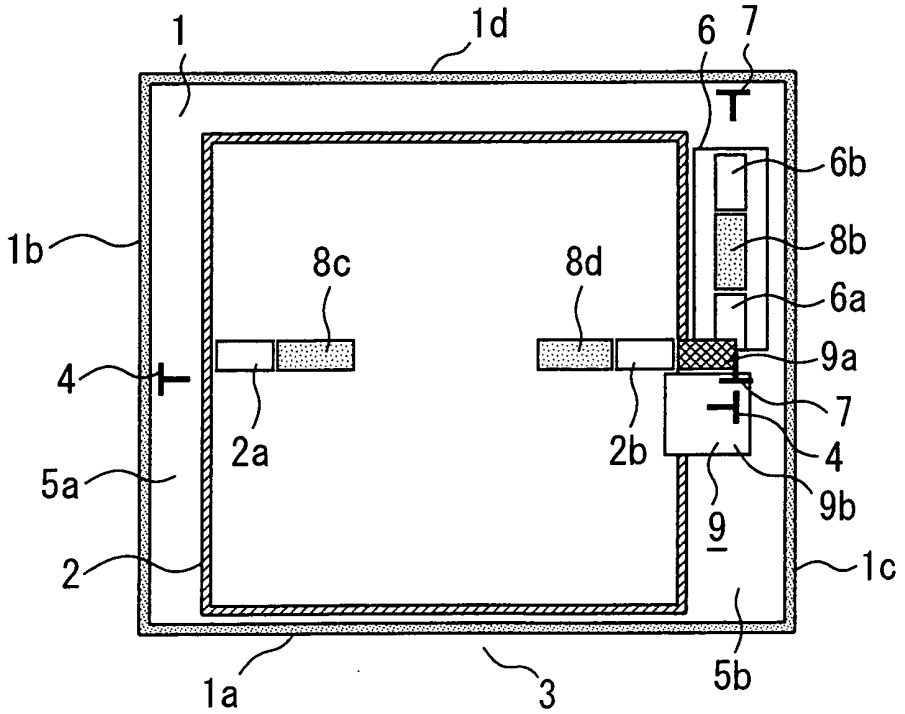

10a
9
9a
8c
8d
10
6a
2a
2b
6
2

Fig. 4


1
1d
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6b
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5a
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9
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1c
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/007979

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	1996-2005
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.
X Y	WO 03/064309 A1 (Mitsubishi Electric Corp.), 07 August, 2003 (07.08.03), Description, page 10, line 7 to page 12, line 13; Figs. 7 to 10 & US 2004/0168861 A1 & EP 1471026 A1	1,5,7 2-4,6
Y	JP 57-24313 B2 (Tokyo Shibaura Electric Co., Ltd.), 24 May, 1982 (24.05.82), Column 3, line 18 to column 4, line 26; column 6, lines 2 to 15; Figs. 3 to 12 & JP 50-138549 A	2-4
Y	JP 2004-155526 A (Mitsubishi Electric Corp.), 03 June, 2004 (03.06.04), Par. No. [0042] (Family: none)	6

☒ 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 07 March, 2005 (07.03.05)	Date of mailing of the international search report 22 March, 2005 (22.03.05)
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/JP2004/007979

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-83231 A (Mitsubishi Electric Corp.), 18 March, 2004 (18.03.04), Par. Nos. [0011] to [0037]; Figs. 1 to 5 & CN 1478718 A	2-3 1,4-7
A	JP 2000-153975 A (KONE CORP.), 06 June, 2000 (06.06.00), Par. Nos. [0024] to [0027]; Figs. 1 to 2 & FI 982403 A & WO 00/27739 A1 & AU 1163200 A & NO 20012217 A & BR 9915046 A & EP 1127024 A1 & US 2002/0000348 A1	1-7
A	WO 02/059028 A2 (KONE CORP.), 01 August, 2002 (01.08.02), & FI 4928 U1 & EP 1353869 A & CN 1466541 A & US 2004/0035645 A1	1-7
A	JP 2000-63057 A (Meidensha Corp.), 29 February, 2000 (29.02.00), Par. Nos. [0018] to [0019]; Fig. 2 (Family: none)	1-7

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000153975 A **[0003] [0005]**