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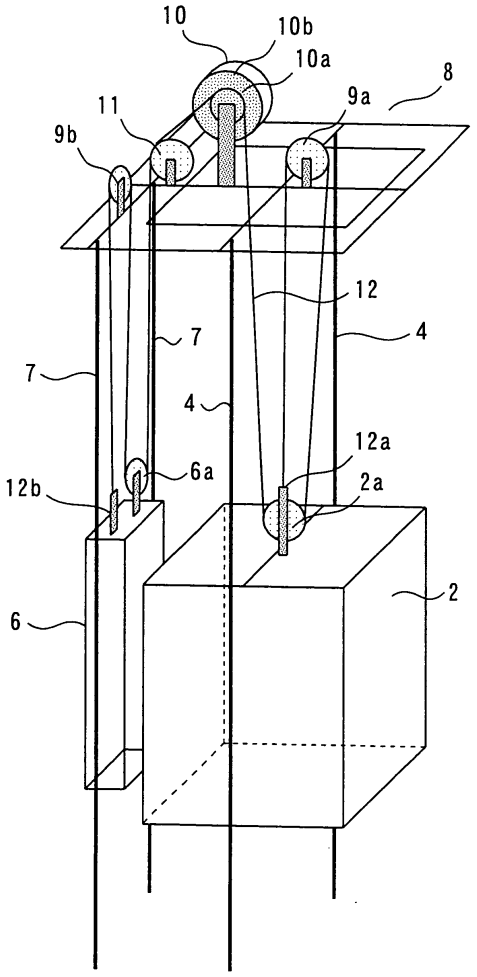
(54) ELEVATOR APPARATUS

(57) A high capacity of a space-saved elevator apparatus is realized by decreasing the size of a traction machine (10) and by simplifying the entire configuration. For this purpose, a reversing sheave (9a) for car, which has a turning shaft parallel with a car suspending sheave (2a) above a car (2) and also has rope grooves lying on a straight line with respect to the rope grooves of the car suspending sheave (2a) on the vertically projected plane, is arranged above the car (2); a reversing sheave (9b) for counterweight, which has a turning shaft parallel with a counterweight suspending sheave (6a) above a counterweight (6) and also has rope grooves lying on a straight line with respect to the rope grooves of the counterweight suspending sheave (6a) on the vertically projected plane, is arranged above the counterweight (6); and the traction machine (10) and a deflector sheave (11) are arranged at the top of a elevator shaft (1) so as to be aligned with the positions of the car suspending sheave (2a) and the counterweight suspending sheave (6a), by which the car (2) and the counterweight (6) are suspended in a 3:1 roping system.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a traction elevator apparatus of a 3:1 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 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 reversing sheave for car, which has a turning shaft parallel with a car suspending sheave above a car and also has rope grooves lying on a straight line with respect to the rope grooves of the car suspending sheave on the vertically projected plane, is arranged above the car; a reversing sheave for counterweight, which has a turning shaft parallel with a counterweight suspending sheave above a counterweight and also has rope grooves lying on a straight line with respect to the rope grooves of the counterweight suspending sheave on the vertically projected plane, is arranged above the counterweight; and a traction machine and a deflector sheave are arranged at the top of an elevator shaft so as to be aligned with the positions of the car suspending sheave and the counterweight suspending sheave, by which the car and the counterweight are suspended in a 3:1 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.

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 drawings, 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, slight clearances 5a and 5b are formed, respectively. Also, the car 2 is supported by a

quadrangular 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 so as to pass through the clearances 5a and 5b on both sides of the car 2, by which the car 2 is guided in the vertical direction. And on a top frame (not shown) of the car frame, which is located above the car 2 from the shaft wall 1b side to the shaft wall 1c side, a car suspending sheave 2a is provided turnably. The car suspending sheave 2a has a turning shaft that is parallel with the shaft wall 1a, and is arranged in a central part above the car 2.

[0010] A counterweight 6 moving vertically in the elevator shaft 1 in the direction opposite to the car 2 is arranged so as to move vertically in a clearance 5c formed between a shaft wall 1d on the far side facing to the shaft wall 1a with the car 2 being held therebetween and the car 2. That is to say, since a sufficient distance is not provided between the car 2 and the shaft wall 1d, the counterweight 6 has a construction that is longer in the width direction than in the front-to-back direction 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. Also, the counterweight 6 is supported by a substantially quadrangular prism shaped counterweight frame (not shown), and guide shoes (not shown) etc. provided on vertical frames of this counterweight frame engage with the counterweight guide rails 7 arranged on both sides of the counterweight 6, by which the counterweight 6 is guided in the vertical direction. On a top frame (not shown) of the counterweight frame, which is located above the counterweight 6, a counterweight suspending sheave 6a is provided turnably in an end portion on the shaft wall 1c side. The counterweight suspending sheave 6a has a turning shaft that is perpendicular to the turning shaft of the car suspending sheave 2a, which is substantially parallel with the lengthwise direction of the counterweight 6, and the counterweight suspending sheave 6a is arranged so that an end portion on the shaft wall 1c side thereof lies in a substantially middle portion in the width direction of the car 2.

[0011] Also, in a machine room 8 which is provided at the top of the elevator shaft 1 and has almost the same vertically projected area as the vertically projected area of the elevator shaft 1, a reversing sheave 9a for car is turnably provided just above the car 2, and a reversing sheave 9b for counterweight is turnably provided just above the counterweight 6. The reversing sheave 9a for car has a turning shaft that is substantially parallel with the turning shaft of the car suspending sheave 2a, and is arranged on the shaft wall 1a side from the car suspending sheave 2a so that rope grooves formed in the outer peripheral surface thereof lies substantially on a straight line with respect the rope grooves formed in the outer peripheral surface of the car suspending sheave 2a on the vertically projected plane. Also, an end portion on the shaft wall 1d side of the reversing sheave 9a for car is arranged so as to be located substantially just above a central part of the car suspending sheave 2a. On the other hand, the reversing sheave 9b for counterweight has a turning shaft that is substantially parallel with the turning shaft of the counterweight suspending sheave 6a and is perpendicular to the turning shafts of the car suspending sheave 2a and the reversing sheave 9a for car, and is arranged on the shaft wall 1b side from the counterweight suspending sheave 6a so that rope grooves formed in the outer peripheral surface thereof lies substantially on a straight line with respect the rope grooves formed in the outer peripheral surface of the counterweight suspending sheave 6a on the vertically projected plane. Also, in the machine room 8, there are provided a gearless traction machine 10 and a deflector sheave 11, the traction machine 10 including a drive sheave 10a formed with rope grooves in the outer peripheral surface and a motor section 10b that rotatively control the drive sheave 10a in an arbitrary direction and at an arbitrary speed. The drive sheave 10a of the gearless traction machine 10 has almost the same diameter as the diameters of the suspending sheaves and the reversing sheaves provided in the elevator shaft 1, and also has a turning shaft that is substantially parallel with the turning shafts of the car suspending sheave 2a and the reversing sheave 9a for car. Also, the drive sheave 10a is arranged on the shaft wall 1d side of the car suspending sheave 2a so that the rope grooves therein lies substantially on a straight line with respect to the rope grooves in the car suspending sheave 2a and the rope grooves in the reversing sheave 9a for car, and an end portion on the shaft wall 1a side thereof has a predetermined distance from an end portion on the shaft wall 1d side of the car suspending sheave 2a on the vertically projected plane. On the other hand, the deflector sheave 11 has a turning shaft that is substantially parallel with the turning shafts of the drive sheave 10a, the car suspending sheave 2a, and the reversing sheave 9a for car, and is arranged so that rope grooves formed in the outer peripheral surface thereof lies substantially on a straight line with respect to the rope grooves of the car suspending sheave 2a, the reversing sheave 9a for car, and the drive sheave 10a on the vertically projected plane. Also, an end portion on the shaft wall 1d side thereof is located substantially just above an end portion on the shaft wall 1c side of the counterweight suspending sheave 6a.

[0012] One end portion of a main rope 12 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 frame of the car frame, which supports the turning shaft of the car suspending sheave 2a, via a car-side fixing member 12a. The main rope 12 is set from the car-side fixing member 12a side to the reversing sheave 9a for car, the car suspending sheave 2a, the drive sheave 10a, the deflector sheave 11, the

counterweight suspending sheave 6a, and the reversing sheave 9b for counterweight in that order. The other end of the main rope 12 is elastically fixed to the top frame of the counterweight frame, which supports the counterweight 6, via a counterweight-side fixing member 12b. The main rope 12 is arranged so that a portion leading from the car-side fixing member 12a to the end portion on the shaft wall 1d side of the reversing sheave 9a for car, a portion leading from the end portion on the shaft wall 1d side of the deflector sheave 11 to the end portion on the shaft wall 1c side of the counterweight suspending sheave 6a, and a portion leading from the end portion on the shaft wall 1b side of the reversing sheave 9b for counterweight to the counterweight-side fixing member 12b are in a substantially vertical direction. Also, a portion of the main rope 12 leading from the end portion on the shaft wall 1a side of the reversing sheave 9a for car to the end portion on the shaft wall 1a side of the car suspending sheave 2a and a portion of the main rope12 leading from the end portion on the shaft wall 1d side of the car suspending sheave 2a to the end portion on the shaft wall 1a side of the drive sheave 10a are arranged so as to have a predetermined angle with respect to a vertical plane having the turning shaft of the car suspending sheave 2a so as to be symmetrical with respect to this plane.

[0013] Thus, the car 2 and the counterweight 6 are suspended by the main rope 12 in a 3:1 roping system, and move vertically in the elevator shaft 1 at a speed of 1/3 of the rotational speed of the drive sheave 10a. The main rope 12 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 10a each having a small diameter. As the main rope 12, 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.

[0014] 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 3:1 roping system, even if the diameter of the drive sheave 10a is made 1/3 of the case of 1:1 roping system or 1/1.5 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 10 can be decreased. By decreasing the size of the gearless traction machine 10 in this manner, the gearless traction machine 10 and the deflector sheave 11 can be installed in the machine room 8 having almost the same vertically projected area as that of the elevator shaft 1. Specifically, the gearless traction machine 10 and the deflector sheave 11 can be installed so as to be aligned with the positions of the car suspending sheave 2a 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 12 and the number of suspending sheaves etc. are made at a minimum, by which the 3:1 roping system can be configured, and also a fixed element for supporting the car suspending sheave 2a need not be installed newly on the car 2, so that the configuration can be made simple. In the first embodiment, there has been described the case where the machine room 8 having almost the same vertically projected area as that of the elevator shaft 1 is installed at the top of the elevator shaft 1. However, it is a matter of course that by installing the gearless traction machine 10, the deflector sheave 11, and the like in the elevator shaft 1 like a machine room less elevator apparatus, the same effects as those of the first embodiment can be achieved. Also, even if the turning shaft of the drive sheave 10a is arranged so as to have a predetermined angle with respect to the turning shafts of the car suspending sheave 2a and the reversing sheave 9a for car so that the positions of the drive sheave 10a of the gearless traction machine 10 and the deflector sheave 11 are aligned with the positions of the car suspending sheave 2a and the counterweight suspending sheave 6a, the same effects as those of the first embodiment can be achieved.

Industrial Applicability

[0015] As described above, according to the elevator apparatus of a 3:1 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 3:1 roping system comprising:

   a car which moves vertically in an elevator shaft;
   a car suspending sheave provided turnably above the car;
   a reversing sheave for car, which is provided turnably above the car at the top of the elevator shaft, has a turning shaft parallel with the turning shaft of the car suspending sheave, and is arranged so that the rope grooves thereof lies on a straight line with respect to the rope grooves of the car suspending sheave on the vertically projected plane;
   a counterweight moving vertically in the elevator shaft in a direction opposite to the car;
   a counterweight suspending sheave provided turnably above the counterweight;
   a reversing sheave for counterweight, which is provided turnably above the counterweight at the top of the elevator shaft, has a turning shaft parallel with the turning shaft of the counterweight suspending sheave, and is arranged so that the rope grooves thereof lies on a straight

line with respect to the rope grooves of the counterweight suspending sheave on the vertically projected plane;
a traction machine which is provided at the top of the elevator shaft and has a turnable drive sheave; and
a deflector sheave which is provided at the top of the elevator shaft, has a turning shaft parallel with the turning shaft of the drive sheave, and is arranged so that the rope grooves thereof lies on a straight line with respect to the rope grooves of the drive sheave on the vertically projected plane.

2. The elevator apparatus of a 3:1 roping system according to claim 1, **characterized in that** the counterweight moves vertically in a clearance formed between a far-side shaft wall and the car.

3. The elevator apparatus of a 3:1 roping system according to claim 1 or 2, **characterized in that** the counterweight suspending sheave and the reversing sheave for counterweight are arranged so that the turning shafts thereof are perpendicular to the turning shafts of the car suspending sheave and the reversing sheave for car.

4. The elevator apparatus of a 3:1 roping system according to claim 3, **characterized in that** the drive sheave and the deflector sheave are arranged so that the turning shafts thereof are parallel with the turning shafts of the car suspending sheave and the reversing sheave for car, and the rope grooves thereof lie on a straight line with respect to the rope grooves of the car suspending sheave and the reversing sheave for car on the vertically projected plane.

5. The elevator apparatus of a 3:1 roping system according to any one of claims 1 to 4, **characterized in that** the car suspending sheave is provided on a top frame of a car frame, which supports the car.

6. The elevator apparatus of a 3:1 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 3:1 roping system according to any one of claims 1 to 6, **characterized in that** the traction machine is provided in the elevator shaft.

Fig. 1

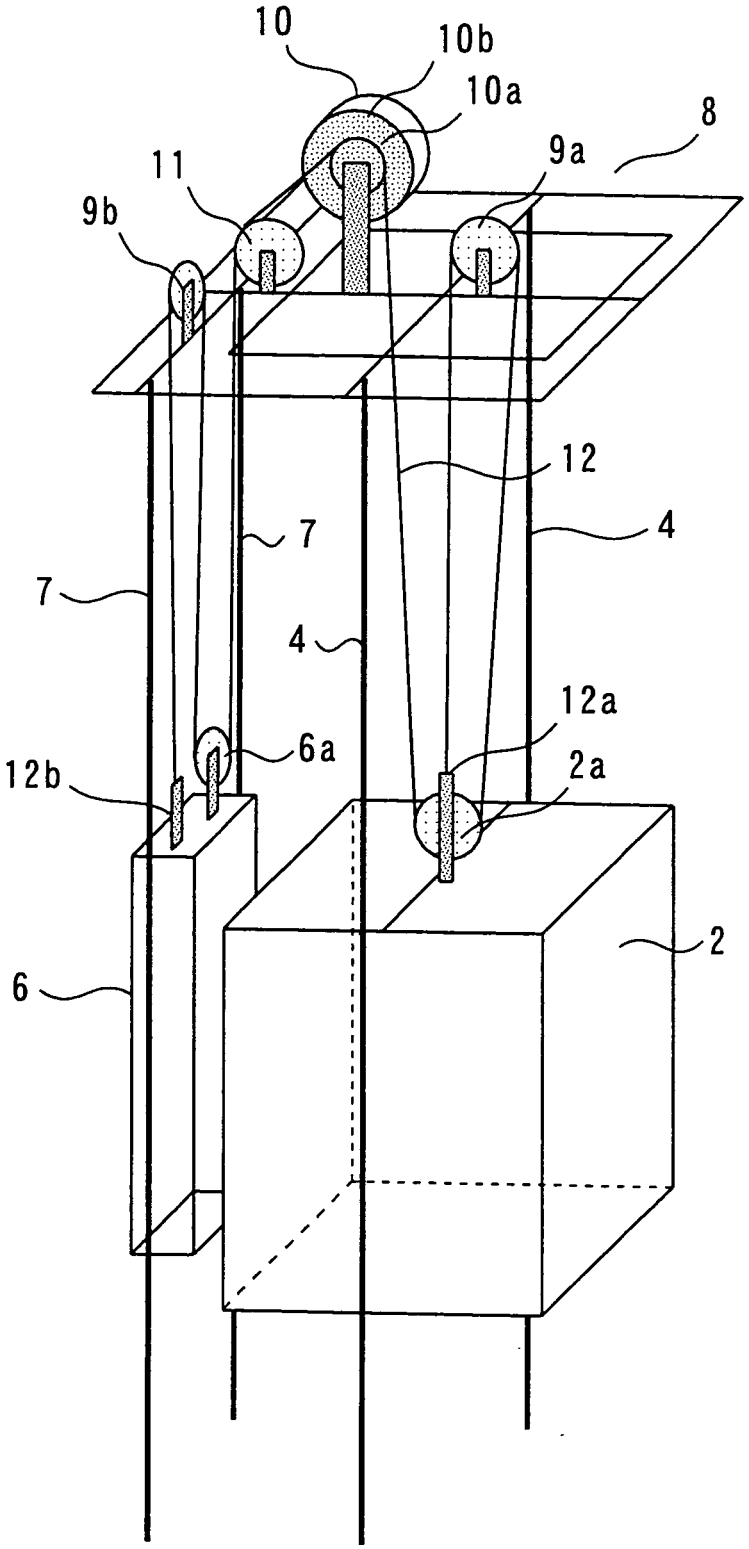
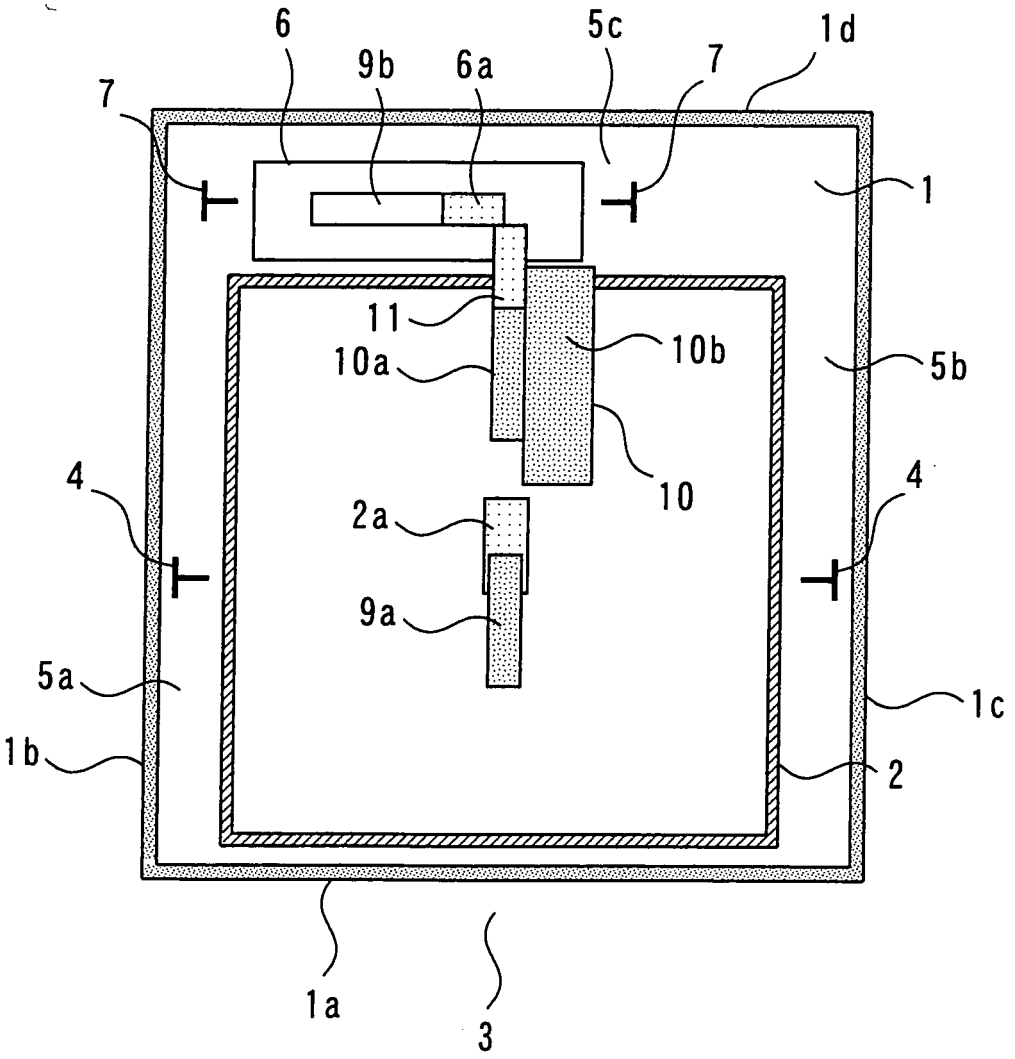


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/007980

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.
Y Y	JP 2004-83231 A (Mitsubishi Electric Corp.), 18 March, 2004 (18.03.04), Par. Nos. [0011] to [0037]; Figs. 1 to 5 Par. Nos. [0038] to [0046]; Figs. 6 to 7 & CN 1478718 A	1-7 2
Y	JP 2001-302138 A (Mitsubishi Electric Corp.), 31 October, 2001 (31.10.01), Par. Nos. [0020] to [0025]; Fig. 1 (Family: none)	1-7
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	5

☒ 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.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/007980

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-155526 A (Mitsubishi Electric Corp.), 03 June, 2004 (03.06.04), Par. No. [0042] (Family: none)	6
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

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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