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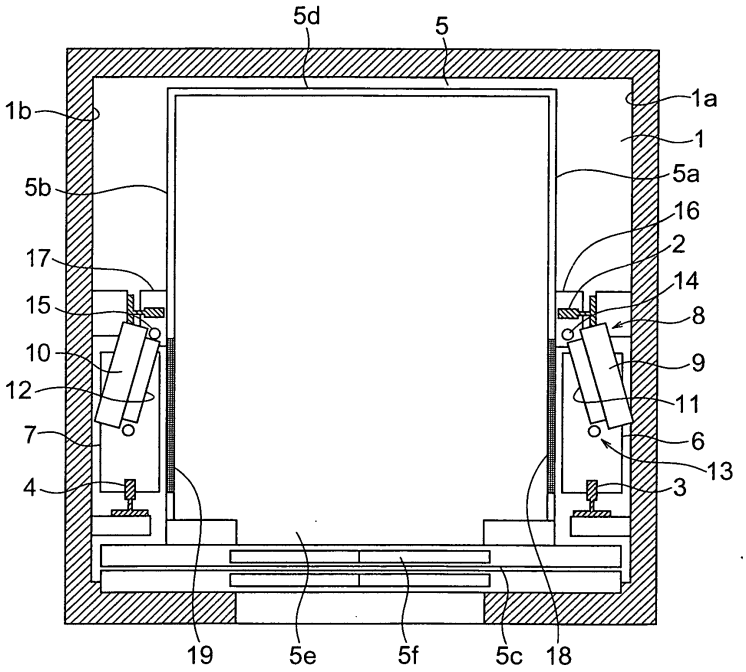
(54) ELEVATOR APPARATUS

(57) In an elevator apparatus, a car and first and second counterweights are raised and lowered inside a hoistway. A pair of car guide rails for guiding raising and lowering of the car are installed inside the hoistway. The car has mutually opposite first and second side surface portions. The car guide rails are installed so as to face the first and second side surface portions. The first and second counterweights are disposed in front of the car guide rails relative to a depth direction of the car. A first hoisting machine is disposed directly above the first counterweight. A second hoisting machine is disposed directly above the second counterweight.

FIG. 1



EP 1 693 330 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a traction-drive-type elevator apparatus in which a car and a counterweight suspended inside a hoistway by a main rope are raised and lowered by a driving apparatus.

BACKGROUND ART

[0002] In conventional elevator apparatuses such as that shown in Japanese Patent Laid-Open No. HEI 11-310372 (Gazette), for example, two counterweights are disposed on both sides of a car. These counterweights and the car are suspended inside a hoistway using a one-to-one (1:1) roping method, and are raised and lowered by two drive mechanisms.

[0003] However, in the above conventional elevator apparatuses, since the two counterweights are disposed behind car guide rails, when applied to observation elevators, it has not been possible to ensure a sufficient field of view behind the car if the counterweights are to be hidden from passengers inside the car. Consequently, an efficient arrangement of the counterweights that uses the space inside the hoistway more effectively has been sought.

DISCLOSURE OF THE INVENTION

[0004] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling counterweights to be arranged more efficiently by using space inside a hoistway more effectively.

[0005] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus including: a car having mutually opposite first and second side surface portions, the car being raised and lowered inside a hoistway; a pair of car guide rails installed inside the hoistway so as to face the first and second side surface portions, the car guide rails guiding raising and lowering of the car; a first counterweight disposed so as to face the first side surface portion in a plane projected vertically, the first counterweight being disposed in front of the car guide rail relative to a depth direction of the car, and the first counterweight being raised and lowered inside the hoistway; a second counterweight disposed so as to face the second side surface portion in a plane projected vertically, the second counterweight being disposed in front of the car guide rail relative to a depth direction of the car, and the second counterweight being raised and lowered inside the hoistway; a main rope group for suspending the car, the first counterweight, and the second counterweight inside the hoistway; and a driving apparatus having a drive sheave onto which the main rope group is wound, the driving apparatus being disposed directly above at least one of the first and second counterweights, and the driving apparatus raising and lowering the car, the first counterweight, and the second counterweight.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

Figure 1 is a plan showing an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a plan showing Figure 1 with a driving apparatus removed;
Figure 3 is a right side elevation showing part of Figure 1;
Figure 4 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention;
Figure 5 is a side elevation showing part of Figure 4;
Figure 6 is a front elevation showing a driving apparatus of an elevator apparatus according to Embodiment 3 of the present invention;
Figure 7 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention;
Figure 8 is a plan showing Figure 7 with a driving apparatus and a return sheave removed;
Figure 9 is a front elevation showing a counterweight from Figure 7; and
Figure 10 is a cross section showing part of an elevator apparatus according to Embodiment 5 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0007] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0008] Figure 1 is a plan showing an elevator apparatus according to Embodiment 1 of the present invention, and Figure 2 is a plan showing Figure 1 with a driving apparatus removed.

[0009] In the figures, a pair of car guide rails 2, a pair of first counterweight guide rails 3, and a pair of second counterweight guide rails 4 are installed inside a hoistway 1. A car 5 is raised and lowered inside the hoistway 1 along the car guide rails 2. A first counterweight 6 is raised and lowered inside the hoistway along the first counterweight guide rails 3. A second counterweight 7 is raised and lowered inside the hoistway 1 along the second counterweight guide rails 4.

[0010] The car guide rails 2 are disposed such that an imaginary straight line connecting them extends parallel to a direction of frontage of the car 5 in a plane projected vertically. The first counterweight guide rails 3 are disposed such that an imaginary straight line connecting them extends parallel to a depth direction of the car 5. The second counterweight guide rails 4 are disposed such that an imaginary straight line connecting them ex-

tends parallel to a depth direction of the car 5.

[0011] The car 5 has: mutually opposite first and second side surface portions 5a and 5b; a front surface portion 5c in which a car entrance 5e is disposed; and a back surface portion 5d opposite the front surface portion 5c. The car guide rails 2 are installed inside the hoistway 1 so as to face the first and second side surface portions 5a and 5b, respectively. The car entrance 5e is opened and closed by a pair of car doors 5f.

[0012] The first counterweight 6 is disposed so as to face the first side surface portion 5a in a plane projected vertically. The first counterweight 6 is disposed between the first side surface portion 5a and a hoistway wall 1a opposite the first side surface portion 5a.

[0013] The second counterweight 7 is disposed so as to face the second side surface portion 5b in a plane projected vertically. The second counterweight 7 is disposed between the second side surface portion 5b and a hoistway wall 1b opposite the second side surface portion 5b.

[0014] The first and second counterweights 6 and 7 are disposed in front of the car guide rails 2 and behind the front surface portion 5c in a depth direction of the car 5.

[0015] A driving apparatus 8 for raising and lowering the car 5 and the first and second counterweights 6 and 7 is disposed in an upper portion inside the hoistway 1. Motors are mounted internally in the driving apparatus 8. The driving apparatus 8 includes: a first hoisting machine 9 disposed directly above the first counterweight 6; and a second hoisting machine 10 disposed directly above the second counterweight 7.

[0016] The first and second hoisting machines 9 and 10 are disposed so as to overlap with the first and second counterweights 6 and 7 and not to overlap with the car 5 in a plane projected vertically. The first hoisting machine 9 includes a motor and a first drive sheave 11. The second hoisting.machine 10 includes a motor and a second drive sheave 12.

[0017] A thin hoisting machine having an axial dimension smaller than a motor diameter is used for each of the hoisting machines 9 and 10. The hoisting machines 9 and 10 are disposed such that rotating shafts of the drive sheave 11 and 12 extend horizontally.

[0018] A main rope group 13 is wound around the first and second drive sheaves 11 and 12. The main rope group 13 includes: a first main rope 14 wound around the first drive sheave 11; and a second main rope 15 wound around the second drive sheave 12.

[0019] A first rope connecting portion 16 is disposed on an edge portion of a lower portion of the car 5 near the first side surface portion 5a. A second rope connecting portion 17 is disposed on an edge portion of a lower portion of the car 5 near the second side surface portion 5b.

[0020] A first end portion of the first main rope 14 is connected to the first rope connecting portion 16, and a second end portion of the first main rope 14 is connected to an upper portion of the first counterweight 6. A first end portion of the second main rope 15 is connected to the second rope connecting portion 17, and a second end portion of the second main rope 15 is connected to an upper portion of the second counterweight 7.

[0021] The car 5 and the first counterweight 6 are suspended inside the hoistway 1 by the first main rope 14 using a one-to-one (1:1) ropingmethod. The car 5 and the second counterweight 7 are suspended inside the hoistway 1 by the second main rope 15 using a one-to-one (1:1) roping method.

[0022] An imaginary straight line joining a point of suspension of the car 5 by the first main rope 14 and a point of suspension of the car 5 by the second main rope 15 passes through a center of gravity of the car 5 in a plane projected vertically. In other words, the car 5 is suspended substantially at its center of gravity.

[0023] Openable and closable first and second inspection openings 18 and 19 are disposed on the first and second side surface portions 5a and 5b, respectively, of the car 5. The first and second hoisting machines 9 and 10 are disposed in positions enabling maintenance inspection from inside the car 5 through the first and second inspection openings 18 and 19, respectively. Specifically, the first and second hoisting machines 9 and 10 are disposed so as to face the first and second side surface portions 5a and 5b when the car 5 is moved to an uppermost portion inside the hoistway 1.

[0024] The car guide rails 2, the counterweight guide rails 3 and 4, the counterweights 6 and 7, the driving apparatus 8, and the main rope group 13 are disposed with bilateral symmetry relative to a center line in a direction of frontage of the car 5 in a plane projected vertically.

[0025] Figure 3 is a right side elevation showing part of Figure 1. A supporting platform 20 is fixed to an upper portion of the car guide rails 2 and the first counterweight guide rails 3. The first hoisting machine 9 is mounted onto the supporting platform 20. The second hoisting machine 10 is also supported on a similar supporting platform on an opposite side of the car 5.

[0026] A control apparatus (control board) 21 for controlling operation of the driving apparatus 8 is disposed above the first hoisting machine 9. In Figures 1 and 2, depiction of the control apparatus 21 is omitted. The load of the first hoisting machine 9 and the control apparatus 21 is supported by the car guide rails 2 and the first counterweight guide rails 3 through the supporting platform 20.

[0027] The control apparatus 21 is disposed in a position enabling maintenance inspection from inside the car 5 through the first inspection opening 18. Specifically, the control apparatus 21 is disposed so as to face the first side surface portion 5a when the car 5 is moved to an uppermost portion inside the hoistway 1.

[0028] Operating modes of the first and second hoisting machines 9 and 10 by the control apparatus 21 include: a first mode in which a driving force is generated

in both of the first and second hoisting machines 9 and 10; and a second mode in which a driving force from is generated only in the first hoisting machine 9. In the second mode, a brake on the second hoisting machine 10 is released, and the second drive sheave 12 idles.

[0029] The operating modes of the control apparatus 21 are switched so as to correspond to loads inside the car 5. The first mode may be used during a state of no load or full load, for example, since the difference in load between the car 5 and the first and second counterweights 6 and 7 is great. The second mode may be used during a state of half load, since the difference in load between the car 5 and the first and second counterweights 6 and 7 is small.

[0030] In an elevator apparatus of this kind, since a counterweight is divided into first and second counterweights 6 and 7 and disposed in a narrow space in front' of the car guide rails 2, space inside the hoistway 1 can be used more effectively to dispose the counterweights 6 and 7 more efficiently. Since the counterweights 6 and 7 are not visible from inside the car 5 even if portions of the first and second side surface portions 5a and 5b behind the car guide rails 2 are made transparent, a field of view can be widened when applied to observation elevators.

[0031] Because two hoisting machines 9 and 10 are used for the driving apparatus 8, the respective hoisting machines 9 and 10 can be reduced in size enabling installation space to be reduced. Moreover, because thin hoisting machines are used for the hoisting machines 9 and 10, the first and second hoisting machines 9 and 10 can be disposed between the first and second side surface portions 5a and 5b and the hoistway walls 1a and 1b, enabling a vertical dimension of the hoistway 1 to be reduced.

[0032] In addition, because the first and second hoisting machines 9 and 10 are operated so as to be switched between a first mode and a second mode so as to correspond to the loads inside the car 5, power can be saved.

[0033] Because the control apparatus 21 is disposed above the driving apparatus 8, space inside the hoistway 1 can be used more effectively, and maintenance inspection work on the driving apparatus 8 and the control apparatus 21 can be performed at an identical location, enabling work efficiency to be improved.

[0034] Because the inspection openings 18 and 19 are disposed in the first and second side surface portions 5a and 5b, maintenance inspection work on the first and second counterweights 6 and 7, the driving apparatus 8, and the control apparatus 21 can be performed from inside the car 5, enabling work efficiency to be improved.

[0035] Moreover, operating modes of the control apparatus 21 are not limited to the above first and second modes.

[0036] The respective first and second main ropes 14 and 15 are not limited to a particular number of ropes.

[0037] In addition, in Embodiment 1, the load of the driving apparatus 8 and the control apparatus 21 was borne by the guide rails 2, 3, and 4, but may also be borne by a supporting beam fixed to a building, for example.

[0038] In Embodiment 1, two counterweights were used, but it is also possible to use three or more counterweights.

Embodiment 2

[0039] Next, Figure 4 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention, and Figure 5 is a side elevation showing part of Figure 4.

[0040] In the figures, first and second guide ropes 22 and 23 for guiding raising and lowering of first and second counterweights 6 and 7 are installed inside a hoistway 1. The first and second guide ropes 22 and 23 are disposed under tension inside the hoistway 1 so as to extend in a raising and lowering direction of the first and second counterweights 6 and 7, in other words, in a vertical direction. Upper end portions of the first and second guide ropes 22 and 23 are connected to a supporting platform 20. Lower end portions of the first and second guide ropes 22 and 23 are connected to a lower portion inside the hoistway 1. A tension imparting means (not shown) for imparting tension to the guide ropes 22 and 23 is disposed in a lower portion inside the hoistway 1.

[0041] Guiding apertures through which the first and second guide ropes 22 and 23 pass are disposed in the first and second counterweights 6 and 7. Only one each of the respective first and second counterweight guide rails 3 and 4 is used. The rest of the configuration is similar to that of Embodiment 1.

[0042] In an elevator apparatus of this kind, because first and second guide ropes 22 and 23 are used, a portion of the counterweight guide rails 3 and 4 can be eliminated. Since the counterweight guide rails 3 and 4 are configured by joining together a plurality of rails in a vertical direction, if a portion of the counterweight guide rails 3 and 4 can be eliminated, the number of parts can be reduced and the time spent on installation can also be reduced significantly, enabling costs to be reduced.

[0043] By eliminating a portion of the counterweight guide rails 3 and 4, overall installation space for the elevator apparatus can also be reduced.

Embodiment 3

[0044] Next, Figure 6 is a front elevation showing a driving apparatus of an elevator apparatus according to Embodiment 3 of the present invention. In the figure, a plurality of main ropes 14 are wound around a first drive sheave 11. Each of the main ropes 14 is configured by twisting a plurality of strands together. The plurality of main ropes 14 wound around the first drive sheave 11 have directions of lay (twisting) of the strands that differ from each other. The rest of the configuration is similar to that of Embodiment 2, and a plurality of main ropes 15 having directions of lay (twisting) of the strands that differ

from each other are also wound around the second drive sheave 12.

[0045] Thus, by constituting the main ropes 14 and 15 suspending each of the counterweights 6 and 7 by a combination of two types of wire rope having mutually-different directions of lay, rotational torque making the main ropes 14 and 15 themselves rotate is cancelled out, and even if the raising and lowering of the counterweights 6 and 7 is guided by the guide ropes 22 and 23, swinging of the counterweights 6 and 7 is suppressed, enabling the counterweights 6 and 7 to be raised and lowered stably.

[0046] Moreover, it is preferable to make the number of wire ropes having a left lay and the number of wire ropes having a right lay equal in number in the main ropes suspending a single counterweight.

Embodiment 4

[0047] Next, Figure 7 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention, Figure 8 is a plan showing Figure 7 with a driving apparatus and a return sheave removed, and Figure 9 is a front elevation showing a counterweight from Figure 7.

[0048] In the figures, a first counterweight 6 is guided so as to be raised and lowered inside a hoistway 1 by a plurality of first guide ropes 22 (in this case two) disposed under tension inside the hoistway 1. A pair of guiding grooves 6a into which the first guide ropes 22 are inserted are disposed in first and second end portions in a width direction of the first counterweight 6.

[0049] A second counterweight 7 is guided so as to be raised and lowered inside the hoistway 1 by a plurality of second guide ropes 23 (in this case two) disposed under tension inside the hoistway 1. A pair of guiding grooves 7a into which the second guide ropes 23 are inserted are disposed in first and second end portions in a width direction of the second counterweight 7.

[0050] A plurality of stoppers 24 for restricting horizontal swinging of the first and second counterweights 6 and 7 by engaging the first and second counterweights 6 and 7 are installed inside the hoistway 1. The stoppers 24 are each constituted by a rigid body made of a metal, etc., for example, and are fixed to hoistway walls 1a and 1b by means of mounting members such as brackets, etc.

[0051] Leading end portions of the stoppers 24 are inserted inside the guiding grooves 6a and 7a. Normally, clearance is disposed between the stoppers 24 and the guiding grooves 6a and 7a, permitting swinging of the counterweights 6 and 7 within a range of the clearance. The stoppers 24, as shown in Figure 9, are disposed at a distance from each other in a vertical direction.

[0052] A rotatable return sheave 25 is installed directly above the second counterweight 7. A second main rope 15 is wound around the return sheave 25. In other words, in Embodiment 1, two hoisting machines 9 and 10 were used, but in Embodiment 4, only one hoisting machine 9 is used. The rest of the configuration is similar to that of Embodiment 1.

[0053] In an elevator apparatus of this kind, because the raising and lowering of the counterweights 6 and 7 is guided only by the guide ropes 22 and 23 without using counterweight guide rails, time spent on installation can be reduced significantly and costs can be reduced.

[0054] Because stoppers 24 are used, even if a building is shaken by an earthquake, etc., horizontal swinging of the counterweights 6 and 7 can be restricted, and the counterweights 6 and 7 can be prevented from colliding with the car 5 or hoistway equipment, etc.

[0055] In addition, since there need only be a certain amount of clearance between the stoppers 24 and the counterweights 6 and 7, and it is also not necessary for the stoppers 24 to be disposed continuously over an entire hoisting zone of the counterweights 6 and 7, the stoppers 24 can be configured more inexpensively than counterweight guide rails.

[0056] Because the driving apparatus 8 is configured by a single hoisting machine 9, and only a return sheave 25 is disposed near the second counterweight 7, costs can be reduced and control can be simplified.

Embodiment 5

[0057] Next, Figure 10 is a cross section showing part of an elevator apparatus according to Embodiment 5 of the present invention. In this example, a plurality of guide ropes 22 (in this case six) are disposed under tension so as to surround a counterweight 6. In other words, the guide ropes 22 are disposed not only on first and second end portions in a width direction of the counterweight 6, but also on first and second sides in a thickness direction (on a side near a car 5 and on an opposite side from the car 5). Upper end portions of the guide ropes 22 are connected to a supporting platform fixed to car guide rails, or to a supporting beam fixed to a building, etc.

[0058] By surrounding the counterweight 6 with the guide ropes 22 in this manner, horizontal swinging of the counterweight 6 can be suppressed by a simple construction.

[0059] Moreover, in Embodiment 5, guide ropes 22 are disposed on two sides in a thickness direction of the counterweight 6, but the method of arrangement of the guide ropes 22 is not limited to this. For example, the number of guide ropes 22 on the opposite side from the car 5 may be fewer than those on the side near the car 5, or the guide ropes 22 on the opposite side from the car 5 may also be eliminated.

Claims

1. An elevator apparatus comprising:

a car having mutually opposite first and second side surface portions, the car being raised and

lowered inside a hoistway;
a pair of car guide rails installed inside the hoistway so as to face the first and second side surface portions, the car guide rails guiding raising and lowering of the car;
a first counterweight disposed so as to face the first side surface portion in a plane projected vertically, the first counterweight being disposed in front of the car guide rail relative to a depth direction of the car, and the first counterweight being raised and lowered inside the hoistway;
a second counterweight disposed so as to face the second side surface portion in a plane projected vertically, the second counterweight being disposed in front of the car guide rail relative to a depth direction of the car, and the second counterweight being raised and lowered inside the hoistway;
a main rope group for suspending the car, the first counterweight, and the second counterweight inside the hoistway; and
a driving apparatus having a drive sheave onto which the main rope group is wound, the driving apparatus being disposed directly above at least one of the first and second counterweights, and the driving apparatus raising and lowering the car, the first counterweight, and the second counterweight.

2. The elevator apparatus according to Claim 1, wherein the first and second counterweights are disposed behind a front surface portion of the car relative to a depth direction of the car.

3. The elevator apparatus according to Claim 1, wherein the driving apparatus is a thin hoisting machine having an axial dimension smaller than a motor diameter.

4. The elevator apparatus according to Claim 1, wherein the driving apparatus comprises a first hoisting machine disposed directly above the first counterweight, and a second hoisting machine disposed directly above the second counterweight.

5. The elevator apparatus according to Claim 4, wherein the first and second hoisting machines are operated in response to a load inside the car so as to be switched between a first mode in which a driving force is generated in both of the first and second hoisting machines, and a second mode in which a driving force is generated in only one of the first and second hoisting machines.

6. The elevator apparatus according to Claim 1, further comprising a control apparatus installed on an upper portion of the driving apparatus, the control apparatus controlling operation of the driving apparatus.

7. The elevator apparatus according to Claim 1, wherein an openable and closable inspection opening is disposed in at least one of the first and second side surface portions, and the driving apparatus is disposed at a position enabling maintenance inspection from inside the car through the inspection opening.

8. The elevator apparatus according to Claim 1, further comprising first and second guide ropes disposed under tension inside the hoistway, the first and second guide ropes guiding raising and lowering of the first and second counterweights, respectively.

9. The elevator apparatus according to Claim 8, wherein the main rope group includes a first main rope for suspending the first counterweight, and a second main rope for suspending the second counterweight, the first and second main ropes each including two types of wire rope having mutually-different directions of lay.

10. The elevator apparatus according to Claim 8, further comprising stoppers fixed inside the hoistway, the stoppers engaging with the first and second counterweights to restrict horizontal displacement of the first and second counterweights.

FIG. 1

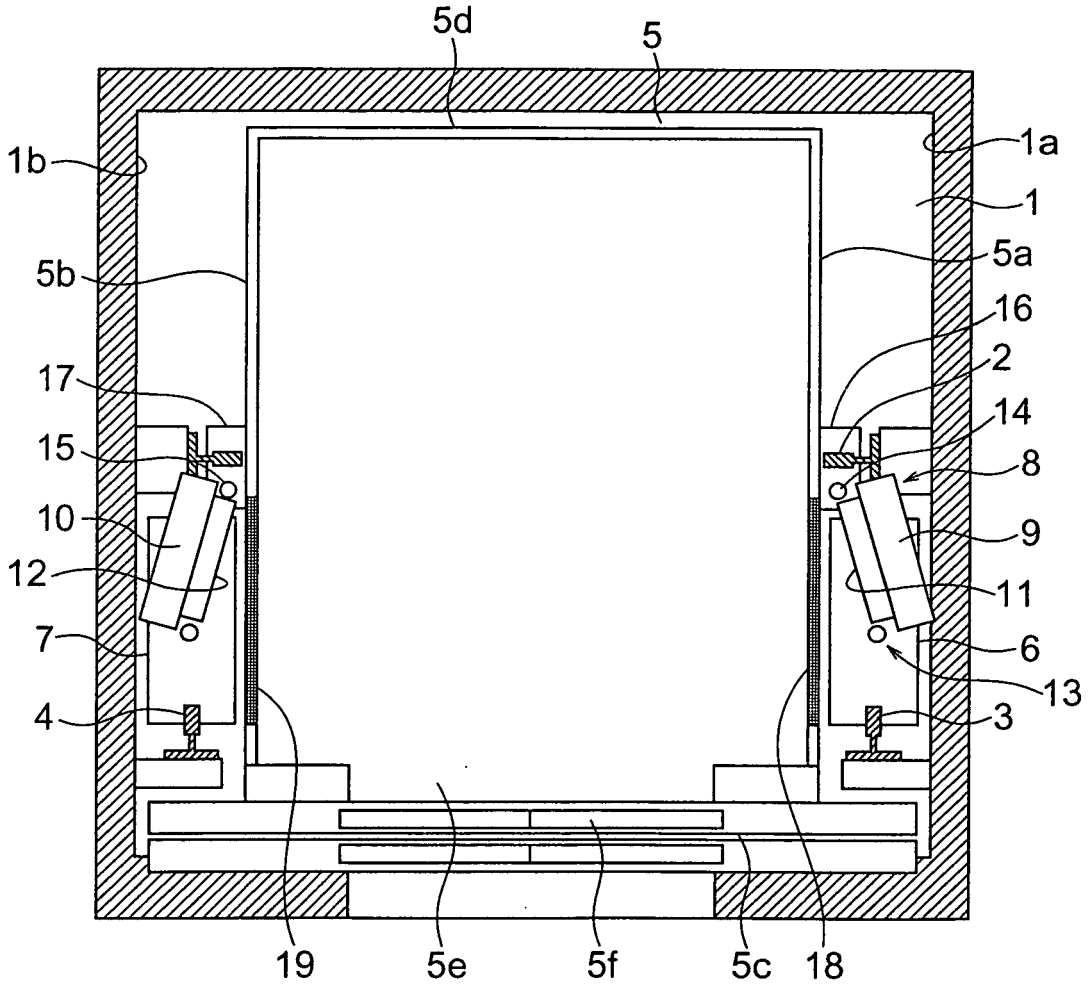


FIG. 2

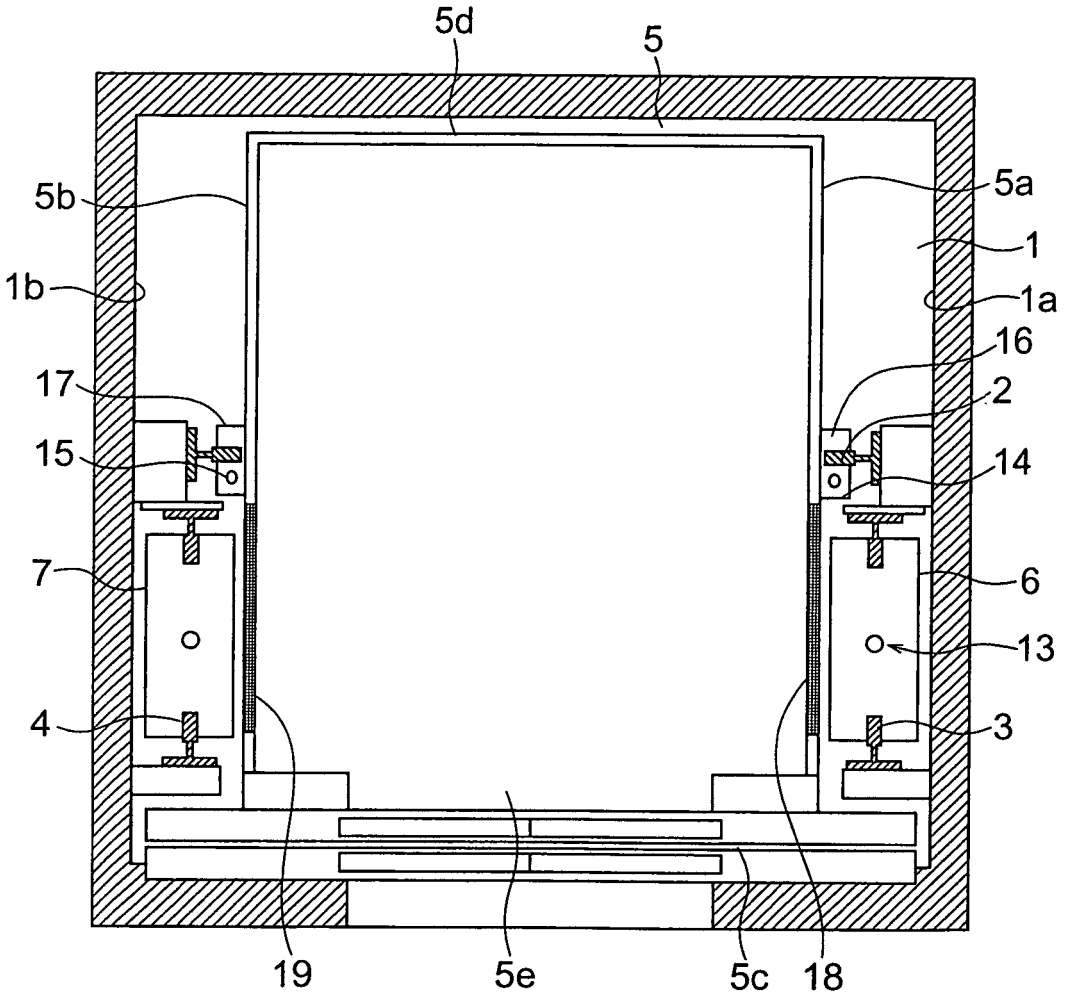


FIG. 3

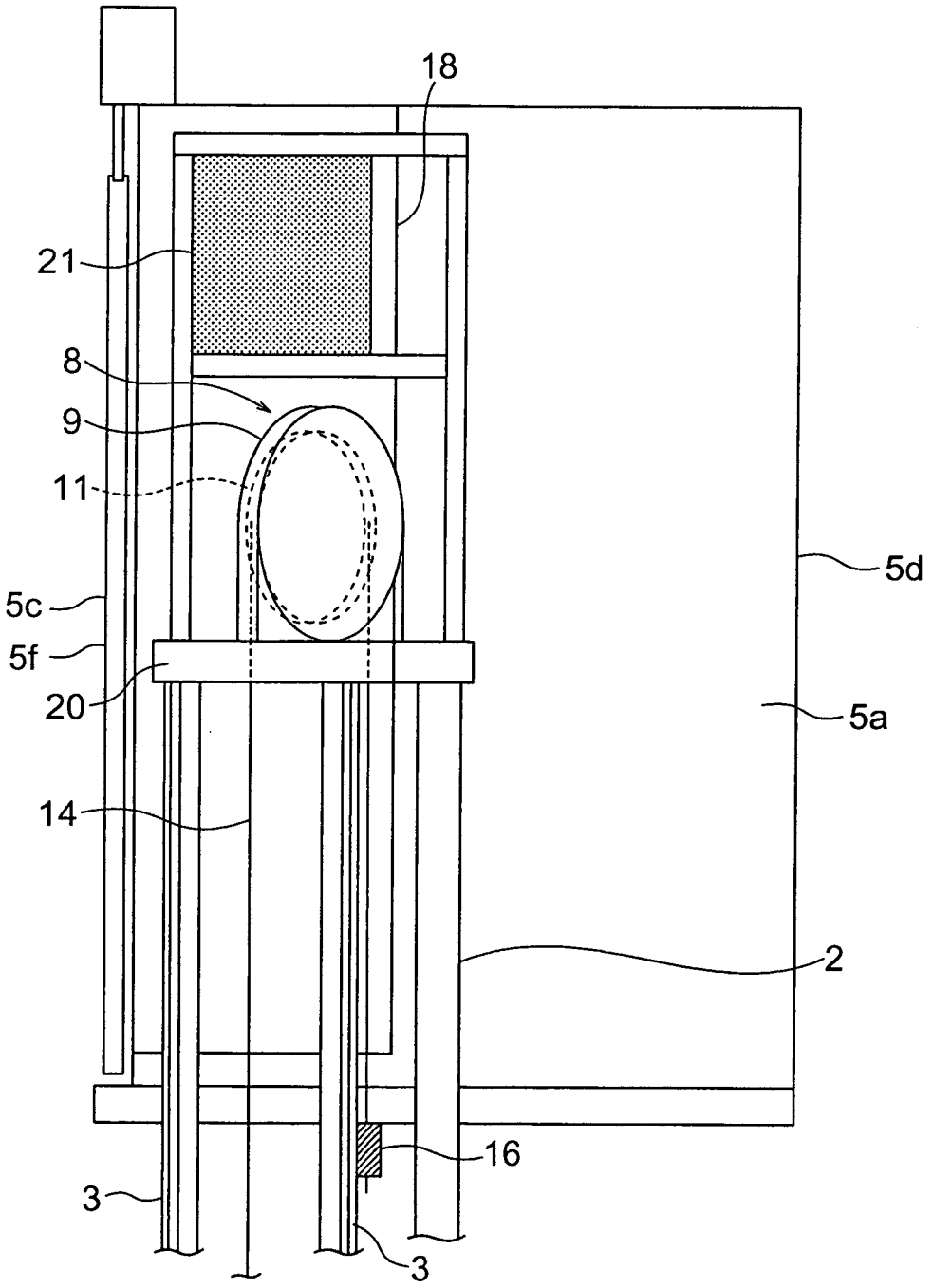


FIG. 4

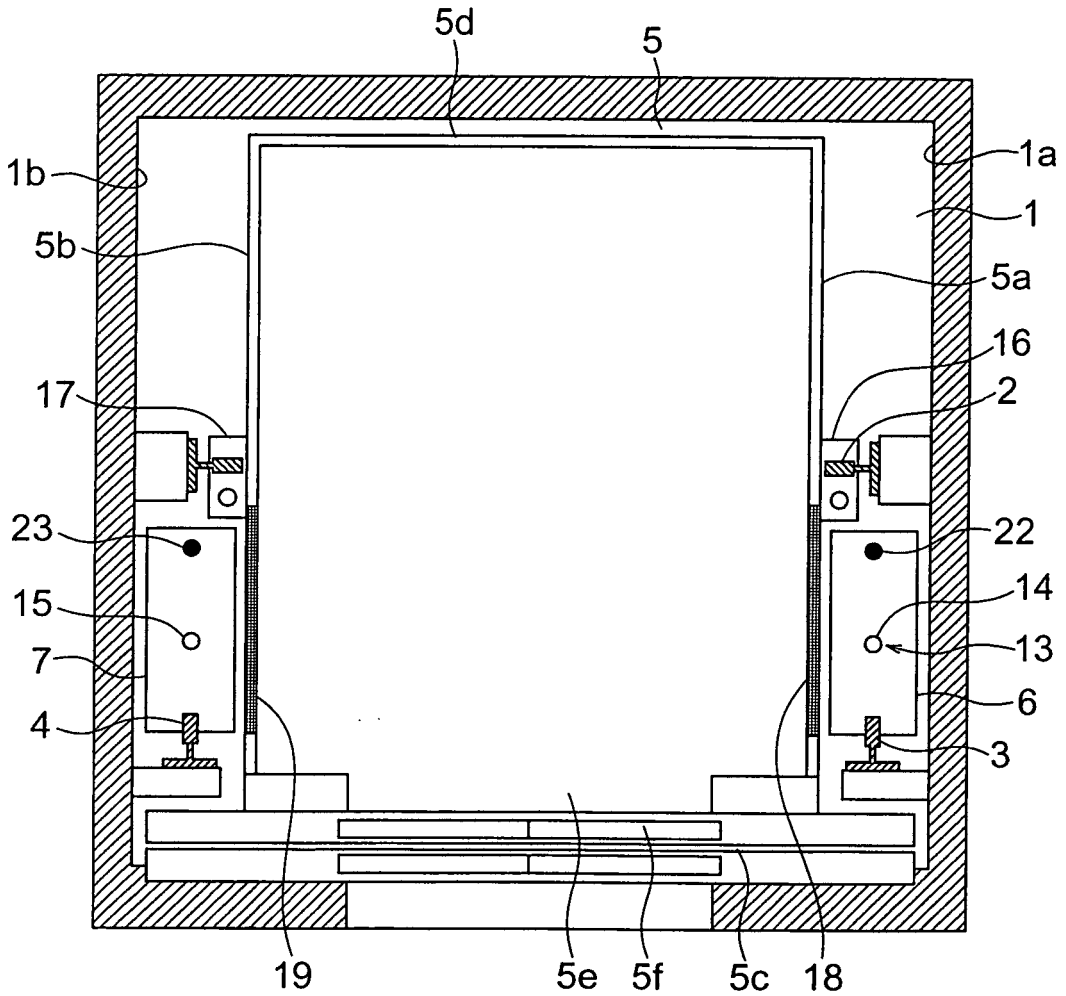


FIG. 5

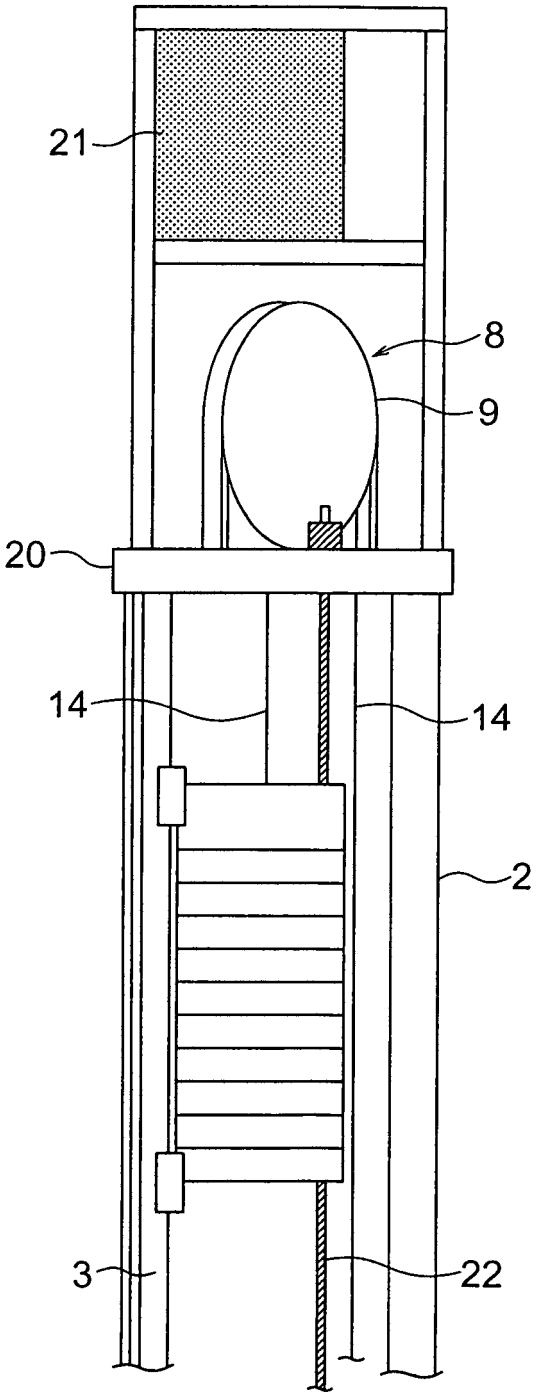


FIG. 6

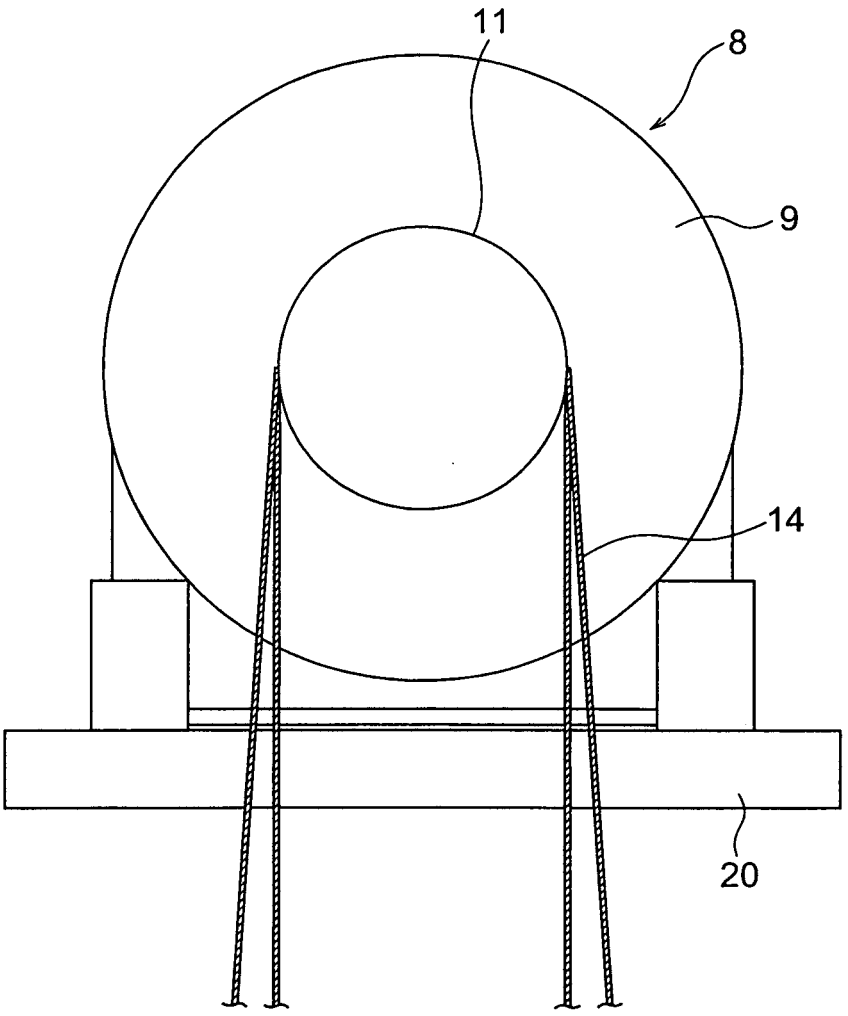
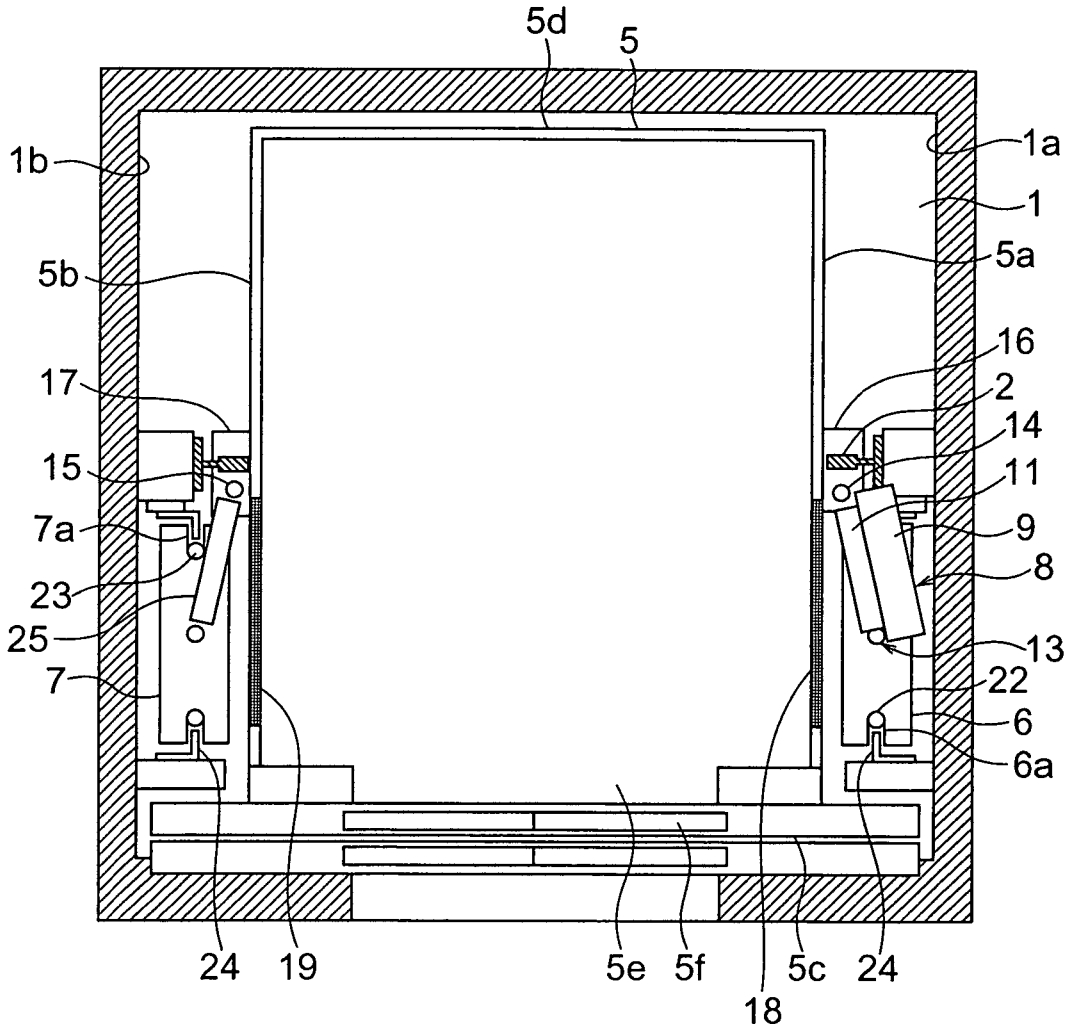


FIG. 7


5d
5
1b
1a
1
5b
5a
16
17
2
14
15
11
7a
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6
6a
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19
5e
5f
18
5c
24

FIG. 8

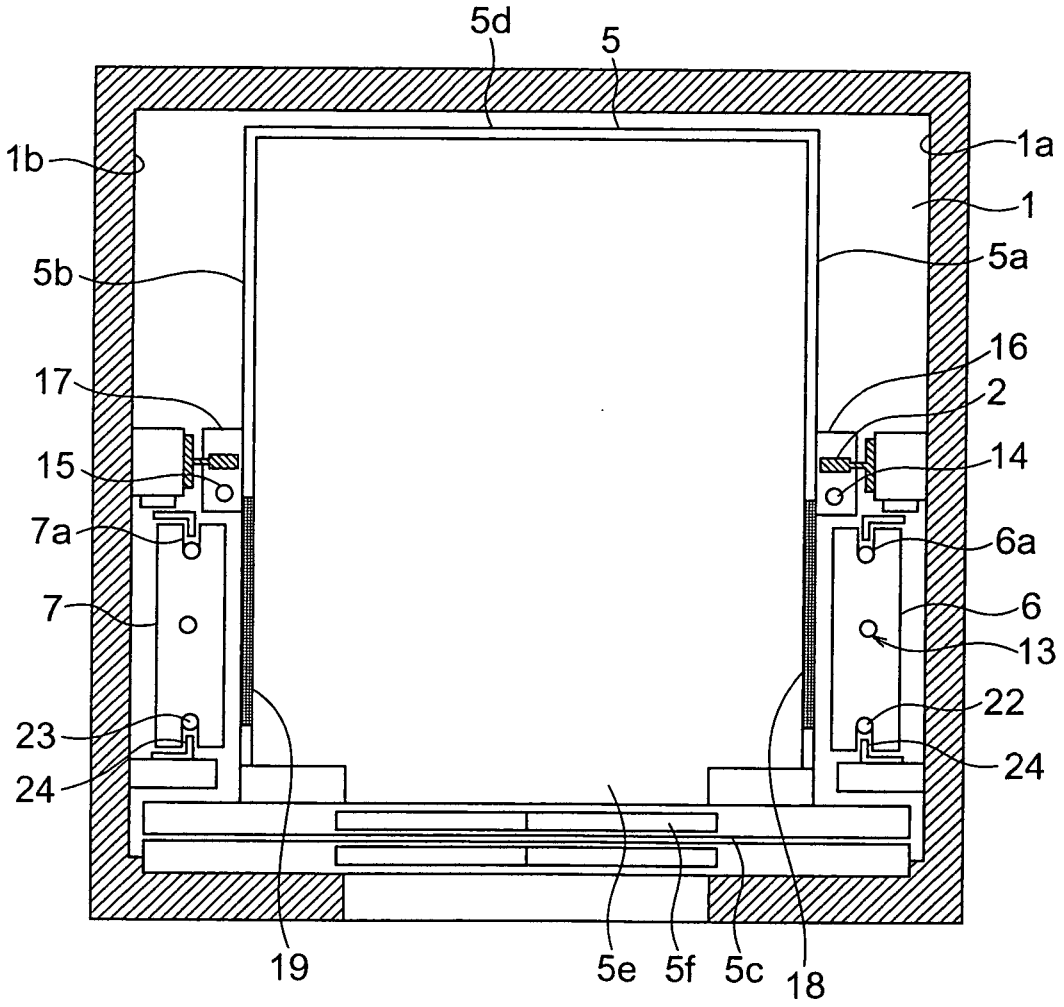


FIG. 9

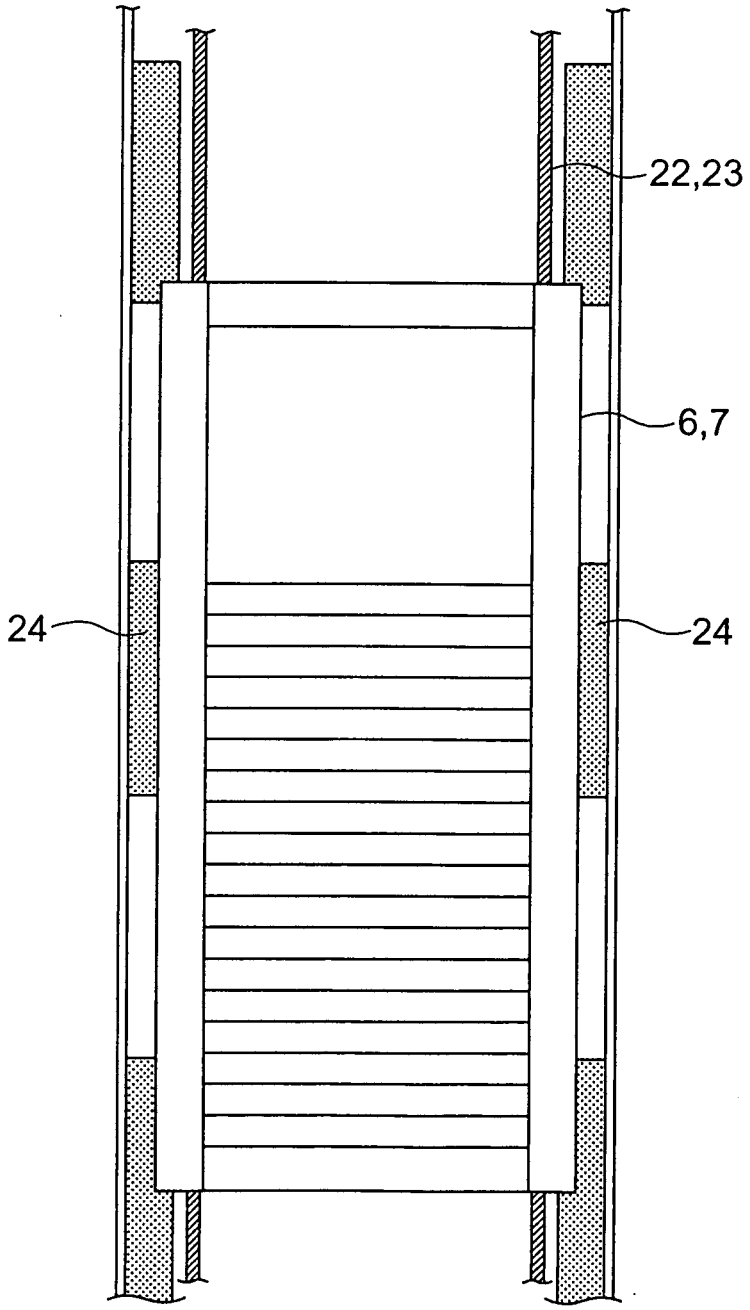
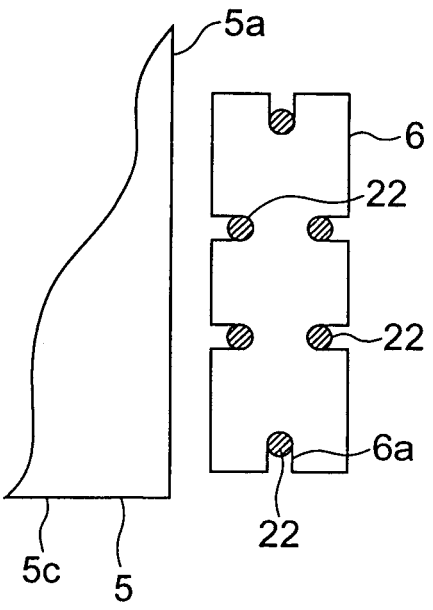


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/15886

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	1996-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Toroku Jitsuyo Shinan Koho	1994-2004

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 A	JP 2002-504471 A (Otis Elevator Co.), 12 February, 2002 (12.02.02), Par. Nos. [0010], [0015]; Figs. 1 to 3 & WO 99/43593 A1 & BR 9908230 A	1-2,4 3,5-10
Y A	JP 11-310372 A (Toshiba Elevator and Building Systems Corp.), 09 November, 1999 (09.11.99), Par. Nos. [0064] to [0068]; Figs. 1, 9 to 10 & EP 0953538 A2 & CN 1233583 A & US 6247557 B1	1-4,6-8,10 5,9
Y	JP 4-89787 A (Mitsubishi Electric Corp.), 23 March, 1992 (23.03.92), Page 2, upper right column, line 3 to lower left column, line 18; Figs. 1 to 3 (Family: none)	1-4,6-8,10

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 2000-44146 A (Hitachi, Ltd.), 15 February, 2000 (15.02.00), Par. Nos. [0018] to [0019], [0021] to [0022]; Figs. 1 to 2 (Family: none)	6
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Y	JP 62-70187 A (Mitsubishi Electric Corp.), 31 March, 1987 (31.03.87), Page 2, upper right column, line 1 to lower left column, line 10; Figs. 1 to 2 (Family: none)	7
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