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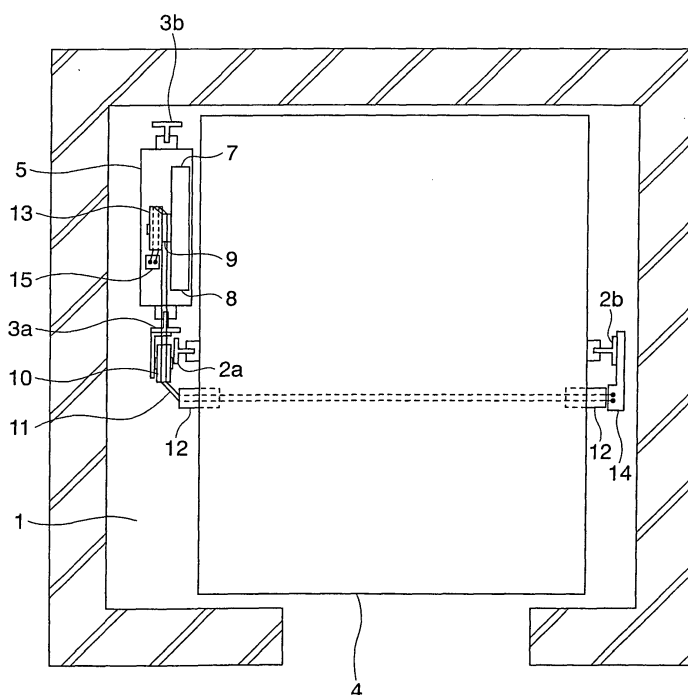
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(54) **ELEVATOR**

(57) In an elevator apparatus, a drive device is arranged in a hoistway. The drive device has a rotatable drive sheave. Further, a deflector sheave, which is spaced from the drive sheave, is arranged in the hoistway. A main rope for suspending a car and a counterweight is wound around the drive sheave and the deflec-

tor sheave. Further, the drive device and the deflector sheave are arranged outside the region of the car as seen in the vertical projection plane of the hoistway. The horizontal sectional area of the hoistway can be reduced by adjusting the respective positions of the drive device and deflector sheave.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to an elevator apparatus in which a drive device (hoisting machine) for raising and lowering a car and a counterweight are arranged in a hoistway (so-called machine room-less elevator apparatus).

Background Art

[0002] Heretofore, in order to reduce the space occupied by an elevator apparatus in a building, there has been proposed a so-called machine room-less elevator apparatus in which a hoisting machine is arranged in a hoistway. In the conventional machine room-less elevator apparatus disclosed in JP 2593288 B, the hoisting machine is arranged at a top portion of the hoistway; as seen in a vertical projection of the hoistway, the hoisting machine is arranged outside the region of the car. The main rope for suspending the car and the counterweight is wound around the drive sheave of the hoisting machine. A pair of car suspension sheaves are provided to a bottom portion of the car. Further, a counterweight suspension sheave is provided to a top portion of the counterweight. Starting from one rope securing portion at a top portion of the hoistway, the main rope is wound around the car suspension sheaves, the drive sheave, and the counterweight suspension sheave in the stated order before reaching the other rope securing portion at a top portion of the hoistway. The car is raised and lowered while being guided by a pair of car guide rails, and the counterweight is raised and lowered while being guided by a pair of counterweight guide rails.

[0003] In the elevator apparatus described above, however, the main rope extending from the drive sheave is directly wound around the car suspension sheaves and the counterweight suspension sheave. Thus, as seen in the vertical projection plane of the hoistway, the drive sheave must be arranged in close proximity to the car suspension sheaves and the counterweight suspension sheave, resulting in restricting the range where the hoisting machine can be installed in the hoistway.

[0004] Further, the car guide rails and the counterweight guide rails are normally arranged between the car suspension sheaves and the counterweight suspension sheave. Accordingly, to secure the installation space for the hoisting machine, it is necessary to enlarge the horizontal cross-sectional area of the hoistway, and the above-described restriction on the range where the hoisting machine can be installed also hinders reductions in the space required by the hoistway.

Disclosure of the Invention

[0005] The present invention has been made to overcome the problems described above, and therefore it is

an object of the present invention to provide an elevator apparatus capable of enlarging a range where the hoisting machine can be installed in the hoistway and achieving a reduction in requisite hoistway space.

[0006] An elevator apparatus according to the present invention includes: a car and a counterweight that are capable of being raised and lowered in a hoistway; a drive device having a drive sheave and arranged outside a region of the car as seen in a vertical projection plane of the hoistway, for raising and lowering the car and the counterweight; a deflector sheave spaced from the drive sheave and arranged outside the region of the car as seen in the vertical projection plane of the hoistway; and a main rope wound around the drive sheave and the deflector sheave, for suspending the car and the counterweight.

Brief Description of the Drawings

[0007]

Fig. 1 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 1 of the present invention;

Fig. 2 is a cross sectional view showing the elevator apparatus of Fig. 1;

Fig. 3 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 2 of the present invention;

Fig. 4 is a cross sectional view showing the elevator apparatus of Fig. 3;

Fig. 5 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 3 of the present invention;

Fig. 6 is a cross sectional view showing the elevator apparatus of Fig. 5.

Best Mode for carrying out the Invention

[0008] Hereinbelow, preferred embodiments of the present invention are described with reference to the drawings.

Embodiment 1

[0009] Fig. 1 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 1 of the present invention, and Fig. 2 is a cross sectional view showing the elevator apparatus of Fig. 1.

[0010] Referring to the figures, a pair of car guide rails 2a, 2b and a pair of counterweight guide rails 3a, 3b are provided in a hoistway 1. A car 4 is arranged between the car guide rails 2a, 2b, and a counterweight 5 is arranged between the counterweight guide rails 3a, 3b. The car 4 is guided by the car guide rails 2a, 2b as it is raised and lowered in the hoistway 1. The counterweight 5 is guided by the counterweight guide rails 3a, 3b as it is raised and lowered in the hoistway 1.

[0011] It should be noted that the elevator apparatus shown in Figs. 1 and 2 is a counterweight side drop type elevator apparatus in which the car 4 and the counterweight 5 are adjacent to each other with respect to the width direction of the car 4 as seen in the vertical projection plane of the hoistway 1. Further, as seen in the vertical projection plane of the hoistway 1, the line connecting the car guide rails 2a, 2b to each other is perpendicular to the line connecting the counterweight guide rails 3a, 3b to each other (Fig. 2).

[0012] A horizontally extending support member 6 is fixed to top portions of the counterweight guide rails 3a, 3b. A drive device (hoisting machine) 7 for raising and lowering the car 4 and the counterweight 5 is supported on the support member 6. The drive device 7 has a drive device main body 8 including a motor, and a drive sheave 9 that is rotated by the drive device main body 8. Further, the drive device 7 is a hoisting machine whose dimension in the axial direction of the drive sheave 9 is smaller than its dimension in the direction perpendicular to the axis of the drive sheave 9, that is, the drive device 7 is a thin hoisting machine. Further, the drive device 7 is arranged above the counterweight 5. Furthermore, as seen in the vertical projection plane of the hoistway 1, the drive device 7 is arranged outside the region of the car 4 and inside the region of the counterweight 5 (Fig. 2). In this example, the drive device 7 is arranged such that, as seen in the vertical projection plane of the hoistway 1, the axis of the drive sheave 9 passes through the center of the line connecting the counterweight guide rails 3a, 3b to each other (Fig. 2).

[0013] Provided at a top portion of the counterweight guide rail 3a is a deflector sheave 10 that is arranged spaced from the drive sheave 9. As seen in the vertical projection plane of the hoistway 1, the deflector sheave 10 is arranged outside the respective regions of the car 4 and counterweight 5 (Fig. 2). Further, as seen in the vertical projection plane of the hoistway 1, the deflector sheave 10 is arranged within the range of the thickness of the counterweight 5 (the length of the counterweight 5 with respect to the direction perpendicular to the line connecting the counterweight guide rails 3a, 3b to each other) and at a position that is farther away from the car 4 than the car guide rail 2a and farther away from the counterweight 5 than the counterweight guide rail 3a (Fig. 2).

[0014] A plurality of main ropes 11 are wound around the drive sheave 9. Provided at a lower end portion of the car 4 are a pair of car suspension sheaves 12 around which the main ropes 11 are wound. Provided at an upper end portion of the counterweight 5 is a counterweight suspension sheave 13 around which the main ropes 11 are wound. In this example, the line connecting the car suspension sheaves 12 to each other extends parallel to the line connecting the car guide rails 2a, 2b to each other.

[0015] A first rope securing portion 14 is fixed to a top portion of the car guide rail 2b. A second rope securing portion 15 is fixed to the support member 6. Each main

rope 11 has a first end portion 11a connected to the first rope securing portion 14, and a second end portion 11b connected to the second rope securing portion 15. Further, starting from the first end portion 11a, the main ropes 11 are wound around the pair of car suspension sheaves 12, the deflector sheave 10, the drive sheave 9, and the counterweight suspension sheave 13 in the stated order before reaching the second end portion 11b. That is, the main ropes 11 are wound around the drive sheave 9 and the deflector sheave 10, thus suspending the car 4 on one end side and the counterweight 5 on the other end side. Further, each main rope 11 has an outer layer portion (covering material) (not shown) formed of a high-friction material (resin) having a high friction coefficient in order to prevent slippage of the main rope 11 with respect to the pair of car suspension sheaves 12, the deflector sheave 10, the drive sheave 9, and the counterweight suspension sheave 13.

[0016] In the elevator apparatus as described above, as seen in the vertical projection plane of the hoistway 1, the drive device 7 and the deflector sheave 13 are arranged outside the region of the car 4, whereby the car 4 can be raised to a position where the ceiling level of the car 4 exceeds the installation heights of the drive device 7 and deflector sheave 13. Furthermore, as seen in the vertical projection plane of the hoistway 1, the drive sheave 9 can be arranged at a spacing from the car suspension sheaves 12, which makes it unnecessary to arrange the drive sheave 9 in close proximity to both the car suspension sheaves 12 and the counterweight suspension sheave 13, whereby the range where the drive device 7 can be installed in the hoistway 1 can be enlarged. As a result, the drive device 7 can be arranged at a position closer to the car 4 while avoiding interference with the car guide rail 2a, the counterweight guide rail 3a, and the like, thereby achieving a reduction in the space required by the hoistway 1.

[0017] Further, by changing the respective positions of the deflector sheave 10, the car suspension sheaves 12, and the car guide rails 2a, it is possible to widen the spacing between the counterweight guide rails 3a, 3b, and to enlarge the dimension in the thickness direction of the counterweight 5, whereby the dimension in the thickness direction of the counterweight 5 can be reduced. Accordingly, a reduction in the requisite space of the hoistway 1 can be achieved.

[0018] Further, as seen in the vertical projection plane of the hoistway 1, the drive device 7 is arranged within the region of the counterweight 5, thus enabling efficient utilization of space with respect to the vertical direction of the hoistway 1. Further, the drive device 7 can be arranged within the range of the thickness of the counterweight 5, thus allowing a further reduction in the requisite space of the hoistway 1.

[0019] Further, each main rope 11 has the outer layer portion formed of a high-friction material, thereby making it possible to prevent slippage of the main rope 11 with respect to the drive sheave 9, the deflector sheave 10,

the pair of car suspension sheaves 12, and the counterweight suspension sheave 13.

[0020] While in the above-described example the entirety of the drive device 7 is arranged within the region of the counterweight 5 as seen in the vertical projection plane of the hoistway 1, as long as a reduction in the horizontal sectional area of the hoistway 1 can be achieved, it is also possible to arrange a part of the drive device 7 within the region of the counterweight 5 or to arrange the drive device 7 outside the region of the counterweight 5.

[0021] Further, while in the above-described example the line connecting the car suspension sheaves 12 to each other is parallel to the line connecting the car guide rails 2a, 2b to each other, as seen in the vertical projection plane of the hoistway 1, the line connecting the car suspension sheaves 12 to each other may be inclined with respect to the line connecting the car guide rails 2a, 2b to each other, with the car suspension sheaves 12 being arranged at symmetrical positions about the center of gravity of the car 4.

Embodiment 2

[0022] Fig. 3 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 2 of the present invention, and Fig. 4 is a cross sectional view showing the elevator apparatus of Fig. 3. The elevator apparatus shown in Figs. 3 and 4 is a counterweight rear drop type elevator apparatus in which, as seen in the vertical projection plane of a hoistway 1, a car 4 and a counterweight 5 are adjacent to each other with respect to the depth direction of the car 4. Further, as seen in the vertical projection plane of the hoistway 1, the line connecting counterweight guide rails 3a, 3b to each other extends parallel to the line connecting car guide rails 2a, 2b to each other (Fig. 4).

[0023] A support member 6 is fixed to top portions of the counterweight guide rails 3a, 3b. A drive device 7 is supported on the support member 6. The drive device 7 has a drive device main body 8 and a drive sheave 9 that is rotated by the drive device main body 8. Further, as seen in the vertical projection plane of the hoistway 1, the drive device 7 is arranged outside the region of the car 4 and inside the region of the counterweight 5 (Fig. 4).

[0024] Provided at a top portion of the counterweight guide rail 3b is a deflector sheave 21 spaced from the drive sheave 9. As seen in the vertical projection plane of the hoistway 1, the deflector sheave 21 is arranged outside the respective regions of the car 4 and counterweight 5 and within the range of the thickness of the counterweight 5 (the thickness of the counterweight 5 with respect to the direction perpendicular to the line connecting the counterweight guide rails 3a, 3b to each other).

[0025] A pair of car suspension sheaves 12 are provided at a lower end portion of the car 4. One of the car suspension sheaves 12 is arranged in close proximity to the deflector sheave 21 as seen in the vertical projection

plane of the hoistway 1. As seen in the vertical projection plane of the hoistway 1, the line connecting the car suspension sheaves 12 to each other is inclined with respect to the width direction of the car 4 and passes through a position near the center of gravity of the car 4 (Fig. 4).

[0026] A counterweight suspension sheave 13 is provided at a lower end portion of the counterweight 5. The respective axes of the drive sheave 9, counterweight suspension sheave 13, and deflector sheave 21 are parallel to each other.

[0027] A first rope securing portion 14 is fixed at a top portion of the hoistway 1. A second rope securing portion 15 is fixed to the support member 6. A first end portion 11a of a main rope 11 is connected to the first rope securing portion 14 and the second end portion 11b of the main rope 11 is connected to the second rope securing portion 15. Starting from the first end portion 11a, the main rope 11 is wound around the pair of car suspension sheaves 12, the deflector sheave 21, the drive sheave 9, and the counterweight suspension sheave 13 in the stated order before reaching the second end portion 11b. Otherwise, Embodiment 2 is of the same construction as Embodiment 1.

[0028] In the elevator apparatus as described above, the drive device 7 and the deflector sheave 21 are arranged outside the region of the car 4 as seen in the vertical projection plane of the hoistway 1, whereby, as in Embodiment 1, the range where the drive device 7 can be installed in the hoistway 1 can be enlarged, thus allowing a reduction in the requisite space of the hoistway 1.

Embodiment 3

[0029] Fig. 5 is a longitudinal sectional view showing an elevator apparatus according to Embodiment 3 of the present invention, and Fig. 6 is a cross sectional view showing the elevator apparatus of Fig. 5. In this example, a pair of return pulleys, a first return pulley 31 and a second return pulley 32, is provided at a top portion of a hoistway 1. As seen in the vertical projection plane of the hoistway 1, the first return pulley 31 and the second return pulley 32 are arranged outside the respective regions of a car 4 and a counterweight 5 (Fig. 6). The respective axes of the first return pulley 31 and second return pulley 32 are perpendicular to the axis of a deflector sheave 21. Further, as seen in the vertical projection plane of the hoistway 1, the line connecting the respective centers of the first return pulley 31 and second return pulley 32 is perpendicular to the line connecting the respective centers of a drive sheave 9 and the deflector sheave 21 (Fig. 6). Furthermore, the first return pulley 31 is positioned lower than the second return pulley 32 and, as seen in the vertical projection plane of the hoistway 1, arranged on the deflector sheave 21 side with respect to second return pulley 32.

[0030] Starting from its first end portion 11a, a main rope 11 is wound around a pair of car suspension

sheaves 12, the second return pulley 32, the first return pulley 31, the deflector sheave 21, the drive sheave 9, and a counterweight suspension sheave 13 in the stated order before reaching a second end portion 11b. Otherwise, Embodiment 3 is of the same construction as Embodiment 1.

[0031] In the elevator apparatus as described above, as seen in the vertical projection plane of the hoistway 1, the first return pulley 31 and the second return pulley 32, around each of which the main rope 11 is wound, are arranged outside the region of the car 4, whereby the car 4 can be raised to a position where the ceiling level of the car 4 exceeds the installation heights of the first and second return pulleys 31, 32. Moreover, each car suspension sheave 12 can be arranged at a spacing from the deflector sheave 21 as seen in the vertical projection plane of the hoistway 1, thereby enhancing the degree of freedom in the arrangement of the car suspension sheaves 12 in the car 4.

[0032] While in the above-described example the pair of the first and second return pulleys 31, 32 is provided in the hoistway 1, two or more pairs of the first and second return pulleys 31, 32 may also be provided in the hoistway 1.

rope has an outer layer portion formed of a high-friction material.

Claims

1. An elevator apparatus **characterized by** comprising:

a car and a counterweight that are capable of being raised and lowered in a hoistway;
 a drive device having a drive sheave and arranged outside a region of the car as seen in a vertical projection plane of the hoistway, for raising and lowering the car and the counterweight;
 a deflector sheave spaced from the drive sheave and arranged outside the region of the car as seen in the vertical projection plane of the hoistway; and
 a main rope wound around the drive sheave and the deflector sheave, for suspending the car and the counterweight.

2. An elevator apparatus according to Claim 1, **characterized in that** at least a part of the drive device is arranged inside a region of the counterweight as seen in the vertical projection plane of the hoistway.

3. An elevator apparatus according to Claim 1 or 2, **characterized by** further comprising a pair of return pulleys around which the main rope is wound and which are arranged outside the region of the car as seen in the vertical projection plane of the hoistway.

4. An elevator apparatus according to any one of Claims 1 through 3, **characterized in that** the main

FIG. 1

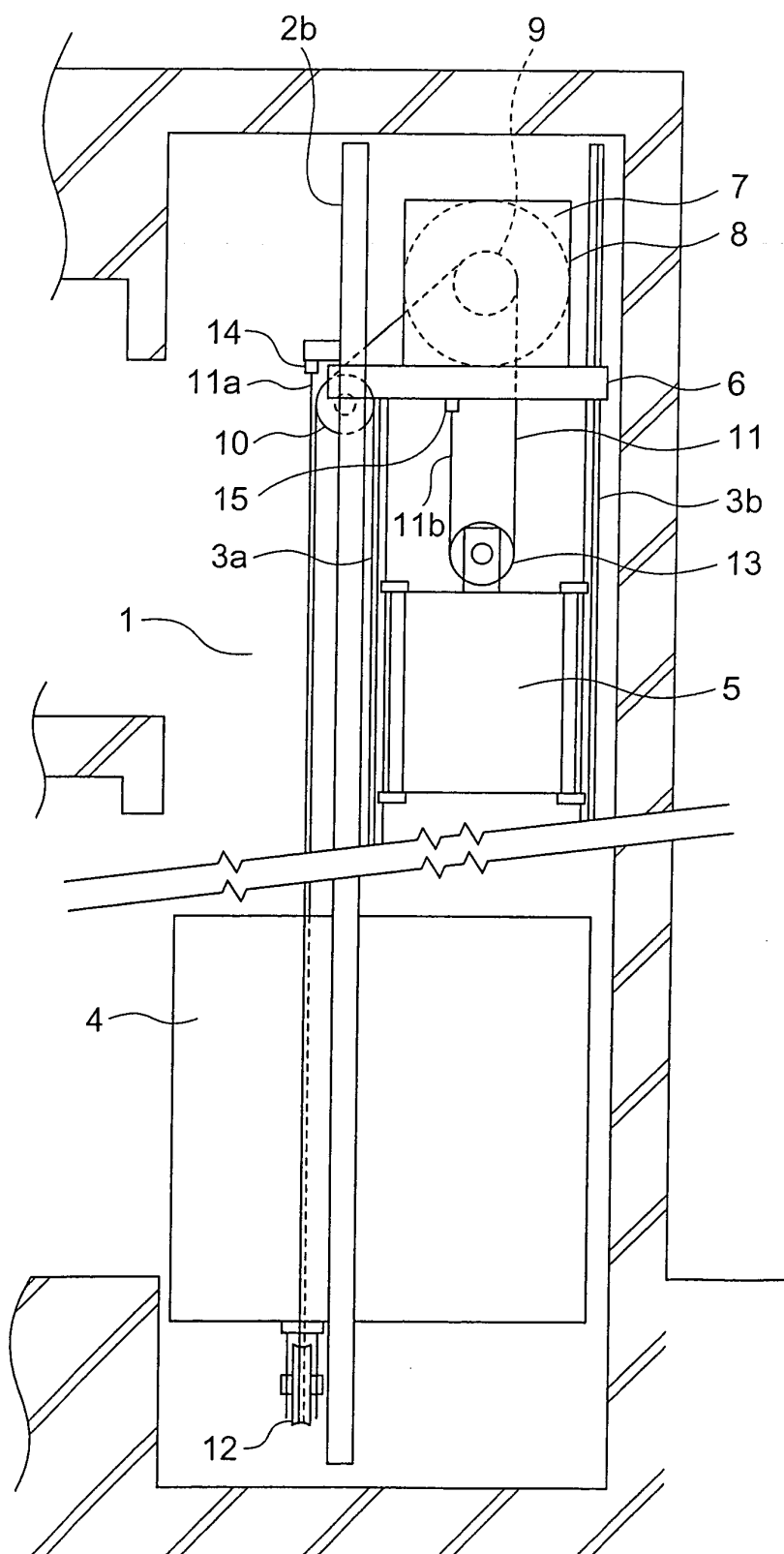


FIG. 2

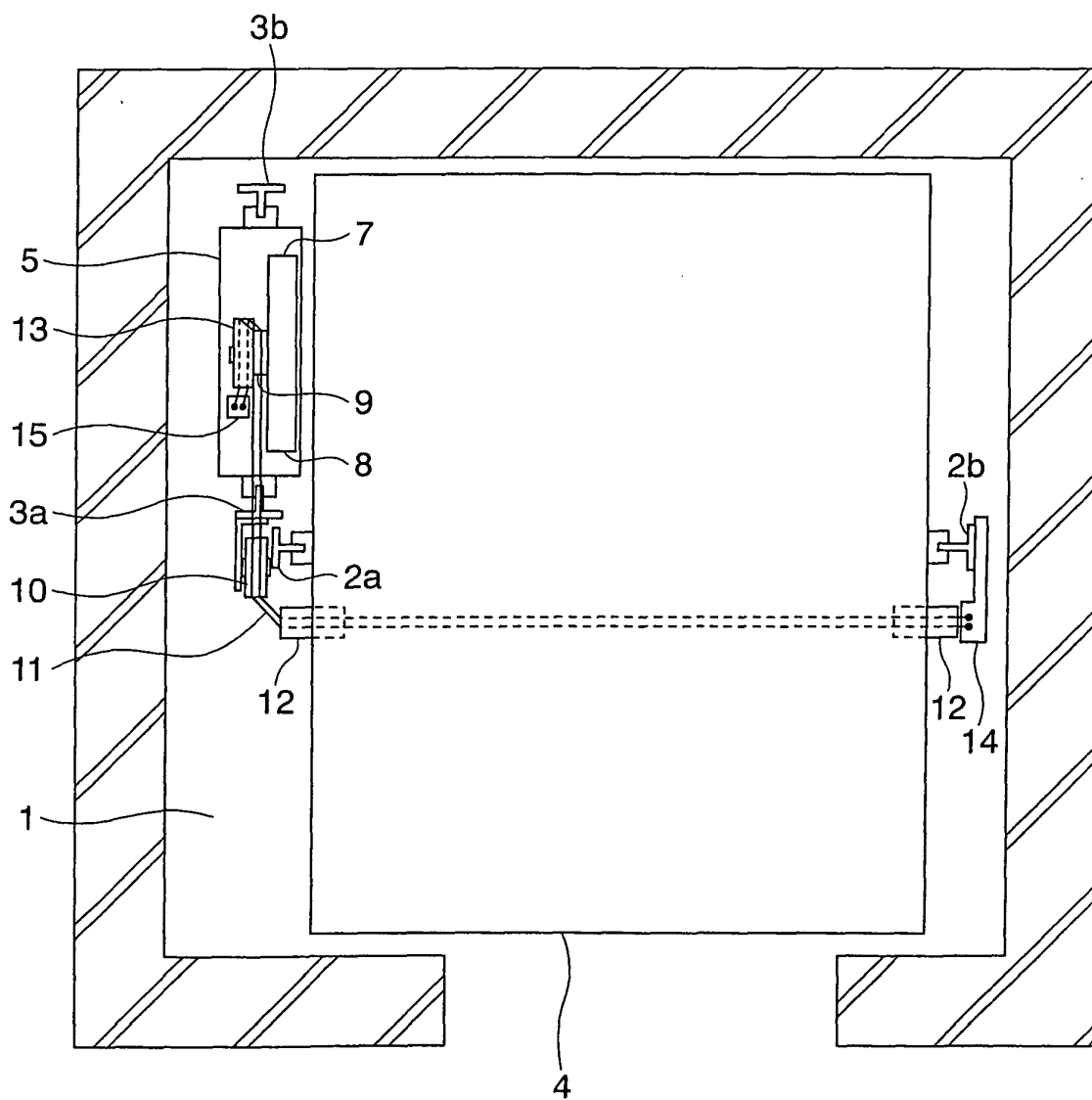


FIG. 3

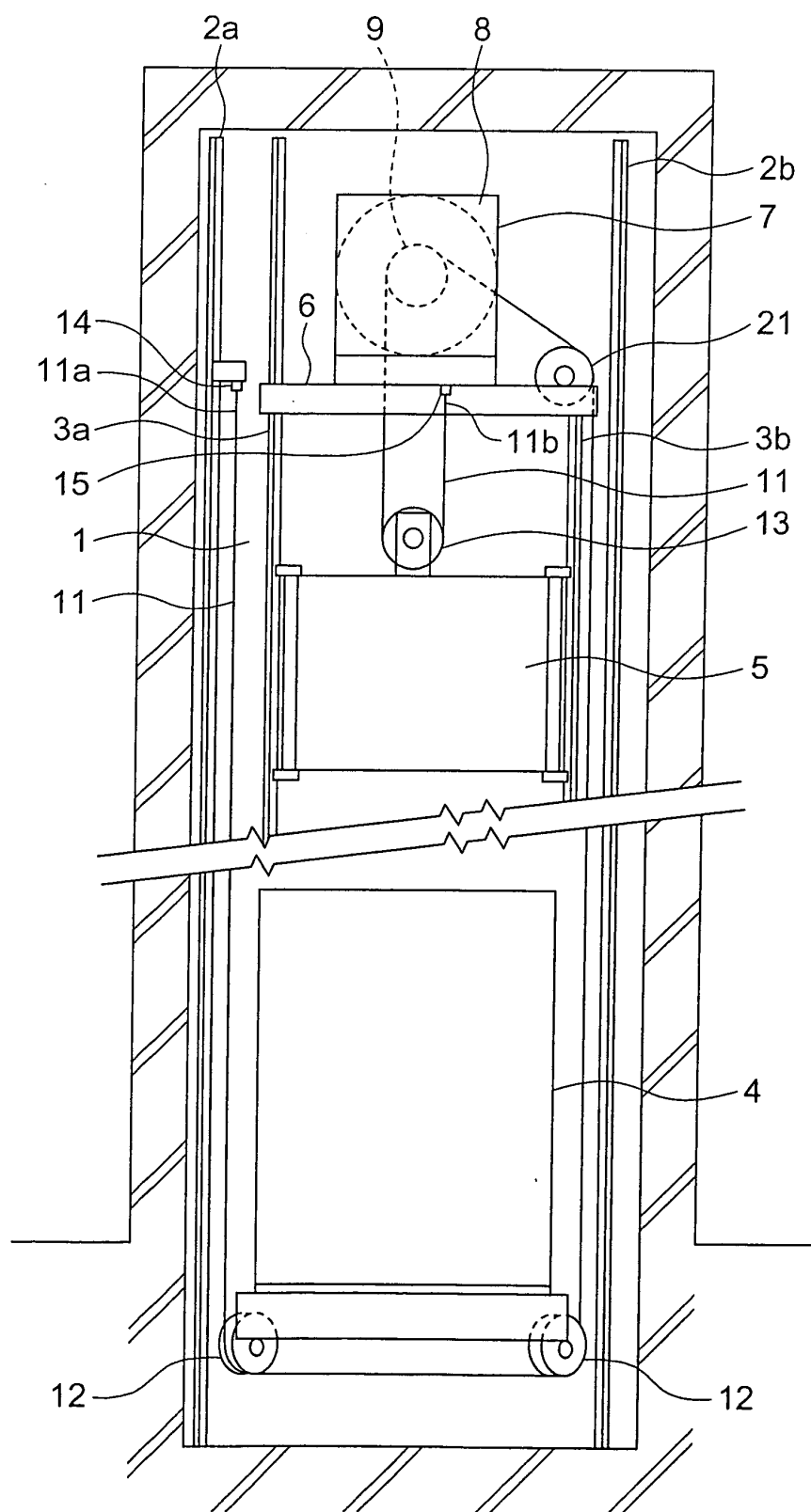


FIG. 4

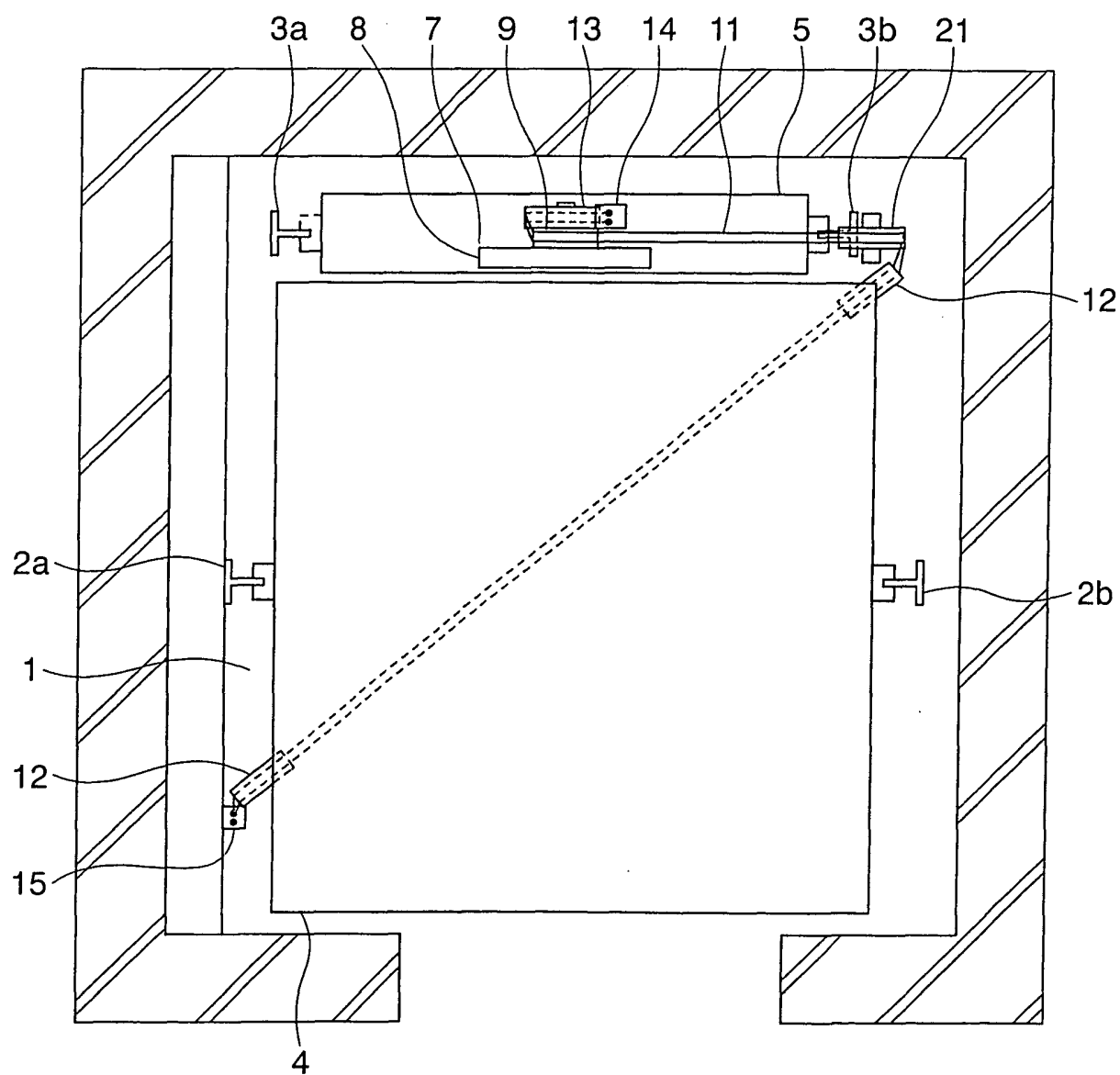


FIG. 5

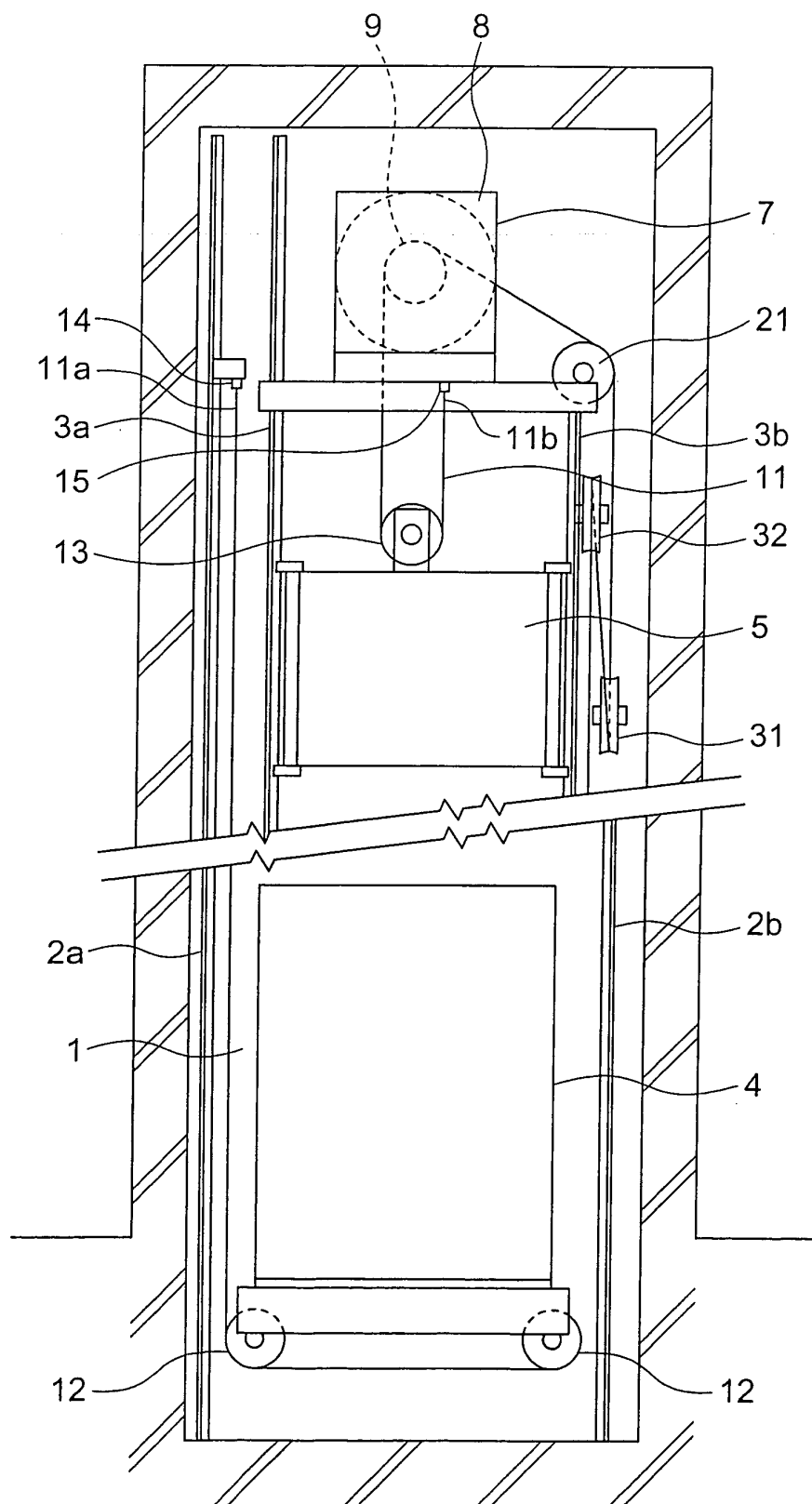
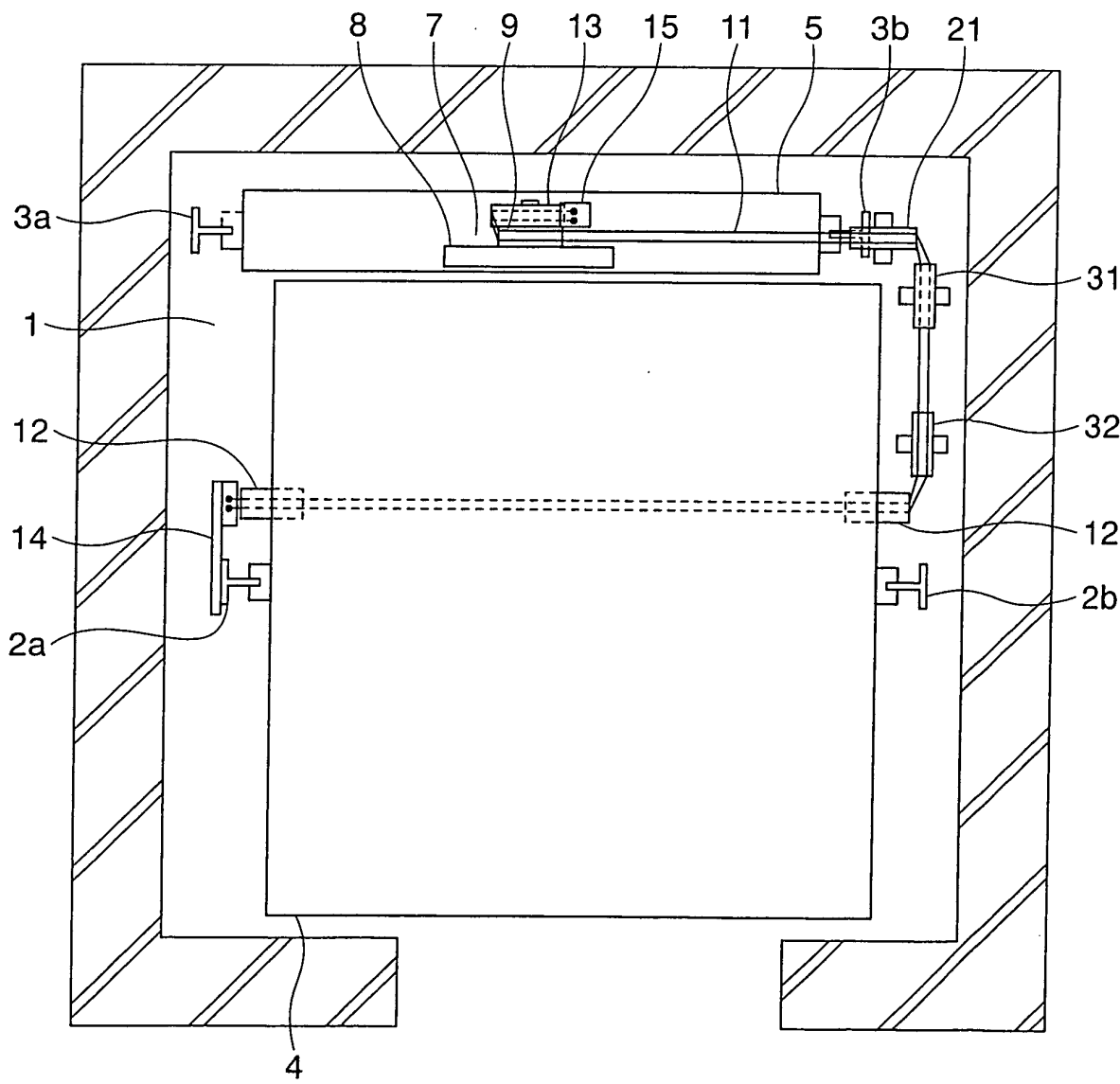


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/001393

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ B66B11/08, B66B7/00		
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 Y	JP 2002-87741 A (Toshiba Corp.), 27 March, 2002 (27.03.02), Pay attention to Par. Nos. [0014] to [0019]; Fig. 1 (Family: none)	1-2 4
X Y	JP 2002-145555 A (Toshiba Elevator and Building Systems Corp., Toshiba Corp.), 22 May, 2002 (22.05.02), Pay attention to Par. Nos. [0011] to [0014]; Figs. 2 to 3 (Family: none)	1, 3 4
☒ 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 "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 05 November, 2004 (05.11.04)		Date of mailing of the international search report 22 November, 2004 (22.11.04)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/001393

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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X Y A	JP 11-310372 A (Toshiba Elevator and Building Systems Corp., Toshiba Corp.), 09 November, 1999 (09.11.99), Pay attention to Par. Nos. [0055] to [0063]; Figs. 7 to 8 Pay attention to Par. Nos. [0064] to [0068]; Figs. 9 to 10	1 4 2
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Y	JP 2001-262482 A (Hitachi, Ltd.), 26 September, 2001 (26.09.01), Pay attention to Par. Nos. [0011] to [0015], [0063]; Fig. 13 & WO 01/68973 A1 & EP 1273695 A1 & US 2003/0089551 A1	4
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Y	JP 2002-504471 A (Otis Elevator Co.), 12 February, 2002 (12.02.02), Pay attention to Par. Nos. [0027] to [0033]; Figs. 9 to 11 & WO 99/43593 A1 & BR 9908230 A	4

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REFERENCES CITED IN THE DESCRIPTION

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