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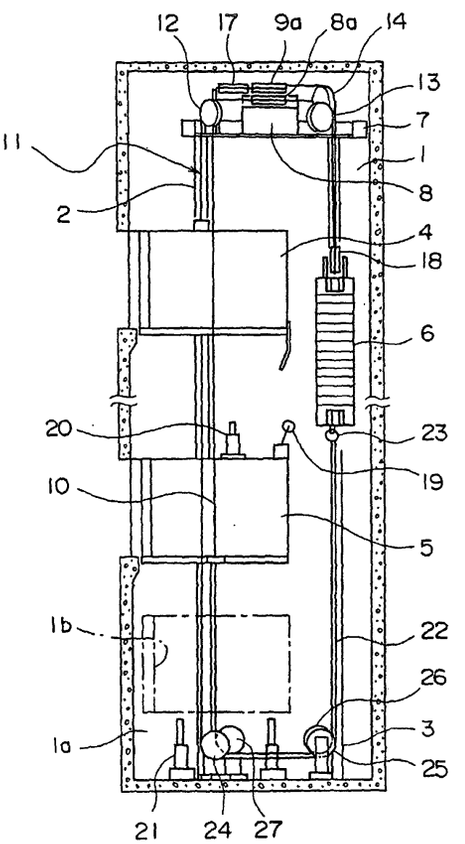
(54) **ELEVATOR DEVICE**

(57) In an elevator apparatus, an upper car and a lower car are raised and lowered in a common hoistway. An upper car driving machine and a lower car driving machine are disposed horizontally in an upper portion inside the hoistway such that rotating shafts of drive sheaves thereof extend vertically. The upper car, the lower car, and a counterweight are suspended inside the hoistway by a main rope body wound around the drive sheaves.

FIG. 1



EP 1 329 412 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator apparatus in which a plurality of cars are raised and lowered inside a common hoistway.

BACKGROUND ART

[0002] Conventionally, an elevator apparatus is disclosed in Japanese Utility Model Laid-Open No. HEI 1-132660, for example, in which two cars are raised and lowered inside different hoistways using a single counterweight for the two cars. However, in this elevator apparatus, a wide hoistway space is required in order to dispose the two cars and the single counterweight horizontally.

[0003] Furthermore, an elevator apparatus is disclosed in Japanese Patent Laid-Open No. SHO 59-153773, for example, in which two cars are disposed vertically inside a common hoistway. However, in this elevator apparatus, since an upper car is suspended by 1:1 roping, a lower car by 2:1 roping, and two counterweights are required, the construction of the apparatus is complex.

[0004] In addition, since a rope passes through the counterweight, installation of the rope is time-consuming, and there is a possibility that the rope will interfere with the counterweight due to swinging. Still furthermore, since the weight of the counterweight is reduced by providing a penetrating aperture for the rope, external dimensions of the counterweight must be increased to compensate.

DISCLOSURE OF THE INVENTION

[0005] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling two cars to be disposed inside a single hoistway efficiently and enabling a compact overall construction.

[0006] According to one aspect of the present invention, there is provided an elevator apparatus including: a hoistway; an upper car raised and lowered inside the hoistway; a lower car disposed below the upper car, the lower car being raised and lowered inside the hoistway independently from the upper car; a counterweight raised and lowered inside the hoistway; an upper car driving machine for raising and lowering the upper car, the upper car driving machine having an upper car drive sheave and being disposed in an upper portion inside the hoistway; a lower car driving machine for raising and lowering the lower car, the lower car driving machine having a lower car drive sheave and being disposed in an upper portion inside the hoistway; and a main rope body for suspending the upper car, the lower car, and the counterweight, the main rope body being wound around the upper car drive sheave and the lower car drive sheave.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a side elevation showing an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a plan showing the elevator apparatus in Figure 1;
Figure 3 is a side elevation showing part of Figure 1 enlarged;
Figure 4 is a plan showing part of Figure 3;
Figure 5 is a side elevation showing an upper portion inside a hoistway from Figure 1 enlarged;
Figure 6 is a perspective showing a construction of a main rope from Figure 1; and
Figure 7 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0008] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0009] Figure 1 is a side elevation showing an elevator apparatus according to Embodiment 1 of the present invention and Figure 2 is a plan showing the elevator apparatus in Figure 1.

[0010] In the figures, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are installed inside a hoistway 1. An upper car 4 and a lower car 5 are each guided by the car guide rails 2 so as to be independently raised and lowered inside the hoistway 1. A counterweight 6 is guided by the counterweight guide rails 3 so as to be raised and lowered inside the hoistway 1.

[0011] A support platform 7 is disposed in an upper portion inside the hoistway 1. The support platform 7 is supported by the car guide rails 2 and the counterweight guide rails 3. An upper car driving machine 8 for raising and lowering the upper car 4 and a lower car driving machine 9 for raising and lowering the lower car 5 are supported by the support platform 7. The upper car driving machine 8 includes an upper car drive sheave 8a. The lower car driving machine 9 includes a lower car drive sheave 9a.

[0012] Moreover, the counterweight 6 is disposed behind the upper car 4 and the lower car 5, and a center line of the pair of counterweight guide rails 3 is parallel to a straight line connecting centers of rotation of the upper car drive sheave 8a and the lower car drive sheave 9a.

[0013] A main rope body 11 composed of a plurality of main ropes 10 each made of a synthetic fiber rope is wound around the upper car drive sheave 8a and the lower car drive sheave 9a. The upper car 4, the lower car 5, and the counterweight 6 are suspended inside the hoistway 1 by the main rope body 11. The upper car drive sheave 8a and the lower car drive sheave 9a are disposed such that their respective positions in a height direction are offset from each other in order to prevent interference among portions of the main rope body 11.

[0014] An upper car deflection sheave 12, first and second counterweight deflection sheaves 13 and 14, first and second lower car deflection sheaves 15 and 16, and a horizontal deflection sheave 17 are supported by the support platform 7.

[0015] The upper car deflection sheave 12 directs the main rope body 11 from the upper car drive sheave 8a to the upper car 4. The first counterweight deflection sheave 13 directs the main rope body 11 from the upper car drive sheave 8a to the counterweight 6. The second counterweight deflection sheave 14 directs the main rope body 11 from the lower car drive sheave 9a to the counterweight 6.

[0016] At an intermediate point between the lower car drive sheave 9a and the lower car 5, the main ropes 10 in the main rope body 11 are distributed in first and second directions so as to pass along first and second sides of the upper car 4. A first distributed portion of the main rope body 11 is directed toward the lower car 5 by the first lower car deflection sheave 15. A second distributed portion of the main rope body 11 is directed toward the lower car 5 by the second lower car deflection sheave 16 and the horizontal deflection sheave 17.

[0017] A counterweight suspension sheave 18 around which the main rope body 11 is wound is disposed on an upper portion of the counterweight 6.

[0018] A first end portion of the main rope body 11 is connected to a central portion of an upper portion of the upper car 4. The main rope body 11 is wound in sequence from the first end portion around the upper car deflection sheave 12, the upper car drive sheave 8a, the first counterweight deflection sheave 13, the counterweight suspension sheave 18, the second counterweight deflection sheave 14, and the lower car drive sheave 9a and is then distributed in the first and second directions. Second end portions of the first and second distributed portions of main rope body 11 are connected to lower portions of first and second sides of the lower car 5, respectively.

[0019] Hence, the upper car 4 and the lower car 5 are each suspended by a 1:1 roping method and the counterweight 6 is suspended by a 2:1 roping method relative to the upper car drive sheave 8a and the lower car drive sheave 9a.

[0020] An interference detection switch 19 for detecting interference with the upper car 4 and an inter-car buffer 20 for buffering impact if the upper car 4 collides are both mounted on upper portions of the lower car 5. A plurality of buffers 21 are installed in a pit (a bottom portion) 1a in the hoistway 1 to buffer impact if the lower car 5 collides into the pit 1a.

[0021] Furthermore, a standby space 1b for the lower car 5 to stand by in is reserved in the pit 1a. A pair of left and right compensating ropes 22 are suspended from lower portions of the upper car 4, the lower car 5, and the counterweight 6.

[0022] Figure 3 is a side elevation showing part of Figure 1 enlarged, and Figure 4 is a plan showing part of Figure 3. A pair of return sheaves 23 around which the compensating ropes 22 are wound are disposed on a lower portion of the counterweight 6. A pair of first upper car tension sheaves 24, a pair of second upper car tension sheaves 25, a pair of first lower car tension sheaves 26, and a pair of second lower car tension sheaves 27 are disposed in the pit 1a.

[0023] First end portions of the compensating ropes 22 are connected to lower portions of the upper car 4, and second end portions of the compensating ropes 22 are connected to lower portions of the lower car 5. Furthermore, intermediate portions of the compensating ropes 22 are wound in sequence around the first upper car tension sheaves 24, the second upper car tension sheaves 25, the return sheaves 23, the first lower car tension sheaves 26, and the second lower car tension sheaves 27.

[0024] A fixed cable hanger 28 is fixed inside the hoistway 1. The fixed cable hanger 28 is fixed to the car guide rails 2. Upper car and lower car cable hangers 29 and 30 are disposed on the upper car 4 and the lower car 5, respectively. A flexible upper car control cable 31 is connected between the fixed cable hanger 28 and the upper car cable hanger 29. A flexible lower car control cable 32 is similarly connected between the fixed cable hanger 28 and the lower car cable hanger 30.

[0025] Figure 5 is a side elevation showing an upper portion inside the hoistway in Figure 1 enlarged. The upper car driving machine 8 is fixed to the support platform 7 by means of support brackets 33. A plurality of elastic bodies 34 are interposed between the support brackets 33 and the upper car driving machine 8. The support construction of the lower car driving machine 9 is similar to that of the upper car driving machine 8.

[0026] Figure 6 is a perspective showing a construction of a main rope 10 from Figure 1. In the figure, an inner strand layer 44 having a plurality of inner strands 42 and filler strands 43 disposed in gaps between these inner strands 42 is disposed around a core wire 41. Each of the inner strands 42 is composed of a plurality of aramid fibers and an impregnating material such as a polyurethane or the like. The filler strands 43 are composed of a polyamide, for example.

[0027] An outer strand layer 46 having a plurality of outer strands 45 is disposed around an outer circumference of the inner strand layer 44. Each of the outer strands 45 is composed of a plurality of aramid fibers and an impregnating material such as a polyurethane

or the like in a similar manner to the inner strands 42.

[0028] A friction-reducing coating layer 47 for preventing abrasion of the strands 42 and 45 due to friction among the strands 42 and 45 during winding onto the drive sheaves 8a and 9a is disposed between the inner strand layer 44 and the outer strand layer 46. A protective coating layer 48 is also disposed on an outer circumferential portion of the outer strand layer 46. A synthetic fiber rope of this kind has a high coefficient of friction compared to a steel rope and is superior in flexibility.

[0029] In an elevator apparatus of this kind, since the upper car 4 and the lower car 5 are raised and lowered inside the common hoistway 1 independently, transport capacity can be raised and the two cars 4 and 5 can be disposed efficiently without expanding the area of the hoistway 1. Furthermore, since the upper car driving machine 8 and the lower car driving machine 9 are disposed in the upper portion inside the hoistway 1, a compact overall construction is made possible.

[0030] In addition, because the upper car 4 and the lower car 5 are each suspended by a 1:1 roping method and the counterweight 6 is suspended by a 2:1 roping method relative to the upper car drive sheave 8a and the lower car drive sheave 9a, only one counterweight 6 is required, enabling the construction to be simplified.

[0031] Still furthermore, because the upper car driving machine 8 and the lower car driving machine 9 are disposed horizontally, and a plurality of deflection sheaves 12 to 17 for directing the main rope body 11 from the upper car drive sheave 8a and the lower car drive sheave 9a to the upper car 4, the lower car 5, and the counterweight 6 are disposed in the upper portion inside the hoistway 1, a compact overall construction is made possible.

[0032] Furthermore, because the upper car driving machine 8, the lower car driving machine 9, and all of the deflection sheaves 12 to 17 are supported on the common support platform 7, the number of parts is reduced, also making a compact overall construction possible.

[0033] In addition, since the support platform 7 is supported by the guide rails 2 and 3, a load acting on the support platform 7 can be borne by the pit 1a via the guide rails 2 and 3. However, the support platform 7 may also be supported directly by a building, and in that case, the load acting on the guide rails 2 and 3 is alleviated, enabling a cross-sectional area of the guide rails 2 and 3 to be reduced.

[0034] Still furthermore, because the plurality of elastic bodies 34 are interposed between the upper car driving machine 8 and the support platform 7 and between the lower car driving machine 9 and the support platform 7, vibration from the driving machines 8 and 9 is prevented from propagating to the building.

[0035] Furthermore, because the plurality of main ropes 10 are distributed so as to pass along the first and second sides of the upper car 4 at an intermediate point between the lower car 5 and the lower car driving machine 9, the lower car 5 can be stably suspended.

[0036] In addition, since a standby space 1b for the lower car 5 to stand by in is reserved in the pit 1a of the hoistway 1, the upper car 4 can be stopped at a lowermost landing, and when the work load on the elevator apparatus is small, the lower car 5 may also be made to stand by in the standby space 1b while only the upper car 4 operates, enabling operating efficiency to be improved.

[0037] Still furthermore, since the control cables 31 and 32 are disposed outside a region of movement of the upper car 4, the lower car 5, and the counterweight 6, the control cables 31 and 32 will not interfere with the upper car 4, the lower car 5, or the counterweight 6.

[0038] Furthermore, because main ropes 10 made of a synthetic fiber rope having a high coefficient of friction and superior flexibility are used, diameters of the drive sheaves 8a and 9a and the deflection sheaves 12 to 17 can be reduced, making an even more compact overall construction possible.

[0039] Moreover, in Embodiment 1, the upper car 4 is suspended by a central portion of an upper portion thereof, but may be suspended by first and second side portions by distributing the plurality of main ropes 10 in a similar manner to the lower car 5.

[0040] Furthermore, in Embodiment 1, the single counterweight 6 is used for the two cars 4 and 5, but two counterweights may also be used.

Embodiment 2

[0041] In addition, in Embodiment 1, the counterweight 6 is disposed behind the cars 4 and 5, but the present invention can also be applied to an elevator apparatus in which the counterweight 6 is disposed beside the cars 4 and 5, as shown in Figure 7, for example. In this case, the center line of the pair of counterweight guide rails 3 is perpendicular to the straight line connecting the centers of rotation of the upper car drive sheave 8a and the lower car drive sheave 9a.

Claims

1. An elevator apparatus comprising:

a hoistway;
an upper car raised and lowered inside said hoistway;
a lower car disposed below said upper car, said lower car being raised and lowered inside said hoistway independently from said upper car;
a counterweight raised and lowered inside said hoistway;
an upper car driving machine for raising and lowering said upper car, said upper car driving machine having an upper car drive sheave and being disposed in an upper portion inside said

hoistway;
a lower car driving machine for raising and lowering said lower car, said lower car driving machine having a lower car drive sheave and being disposed in an upper portion inside said hoistway; and
a main rope body for suspending said upper car, said lower car, and said counterweight, said main rope body being wound around said upper car drive sheave and said lower car drive sheave.

2. The elevator apparatus according to claim 1, wherein said upper car and said lower car are each suspended by a 1:1 roping method and said counterweight is suspended by a 2:1 roping method relative to said upper car drive sheave and said lower car drive sheave.

3. The elevator apparatus according to claim 1, wherein said upper car driving machine and said lower car driving machine are disposed horizontally such that a rotating shaft of each of said drive sheaves extends in a vertical direction, a plurality of deflection sheaves for directing said main rope body from said upper car drive sheave and said lower car drive sheave to said upper car, said lower car, and said counterweight being disposed in an upper portion inside said hoistway.

4. The elevator apparatus according to claim 3, wherein said upper car driving machine, said lower car driving machine, and all of said deflection sheaves are supported by a common support platform disposed in an upper portion inside said hoistway.

5. The elevator apparatus according to claim 4, wherein a plurality of guide rails for guiding raising and lowering of said upper car, said lower car, and said counterweight are installed inside said hoistway, said support platform being supported by said guide rails.

6. The elevator apparatus according to claim 4, wherein said support platform is supported by a building.

7. The elevator apparatus according to claim 4, wherein a plurality of elastic bodies are interposed between said upper car driving machine and said support platform and between said lower car driving machine and said support platform.

8. The elevator apparatus according to claim 1, wherein said main rope body includes a plurality of main ropes, said plurality of main ropes being distributed at an intermediate point between said lower car driving machine and said lower car so as to pass along first and second sides of said upper car.

9. The elevator apparatus according to claim 1, wherein a pair of counterweight guide rails for guiding raising and lowering of said counterweight are installed inside said hoistway, a center line of said pair of counterweight guide rails being parallel to a straight line connecting centers of rotation of said upper car drive sheave and said lower car drive sheave.

10. The elevator apparatus according to claim 1, wherein a pair of counterweight guide rails for guiding raising and lowering of said counterweight are installed inside said hoistway, a center line of said pair of counterweight guide rails being perpendicular to a straight line connecting centers of rotation of said upper car drive sheave and said lower car drive sheave.

11. The elevator apparatus according to claim 1, wherein a standby space for said lower car to stand by in is reserved in a pit of said hoistway.

12. The elevator apparatus according to claim 1, wherein said main rope body includes a main rope made of a synthetic fiber rope.

FIG. 1

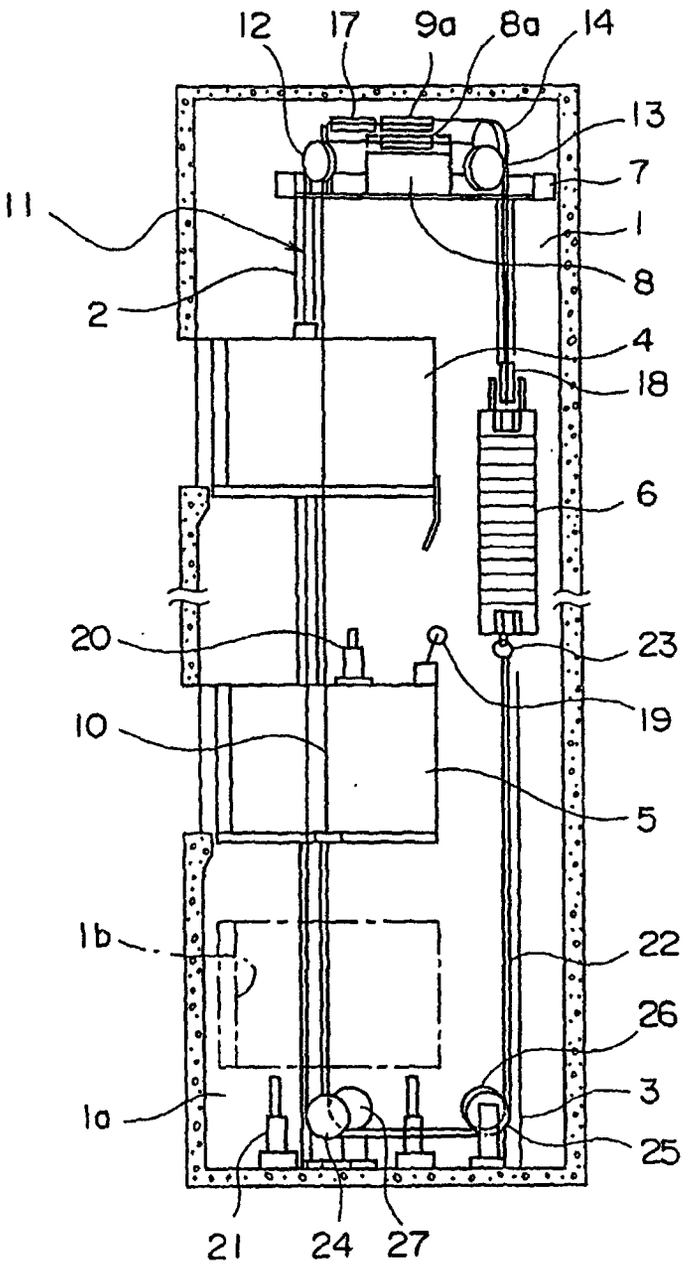


FIG. 2

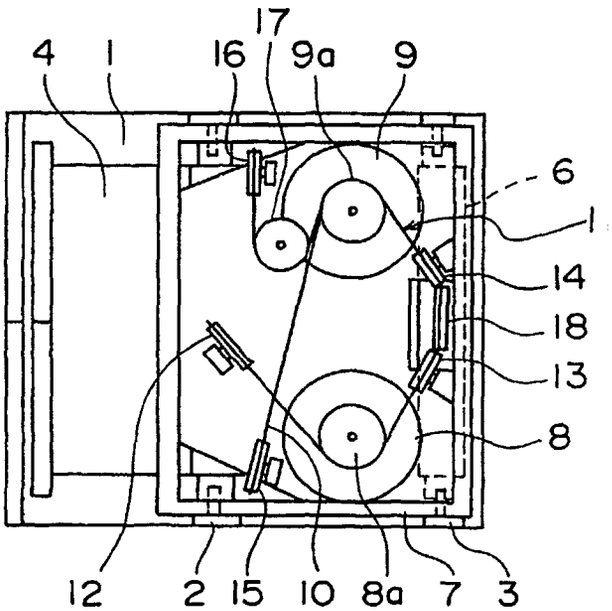


FIG. 3

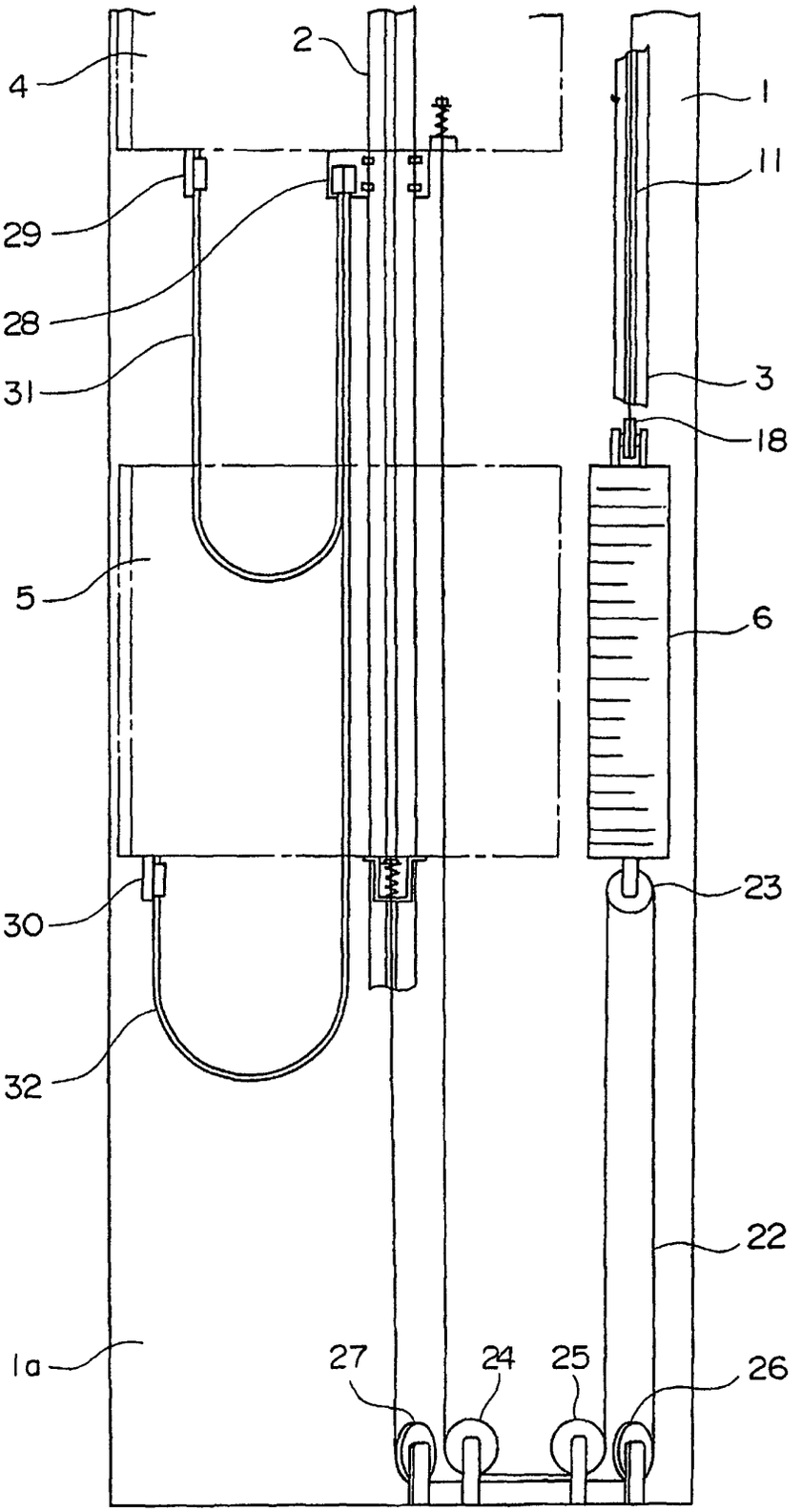


FIG. 4

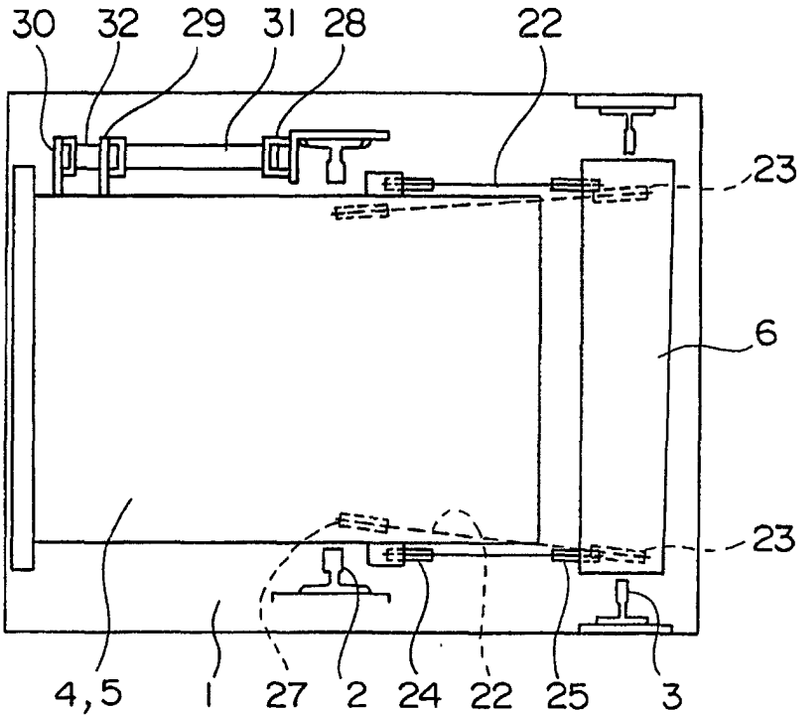


FIG. 5

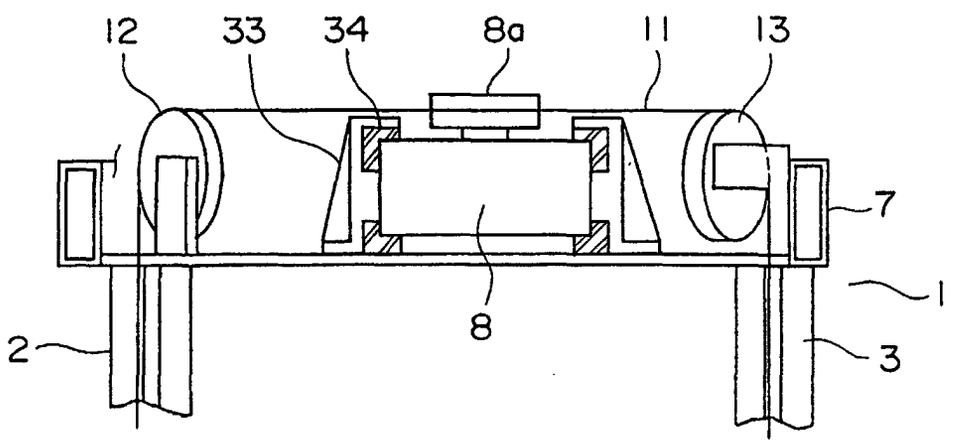


FIG. 6

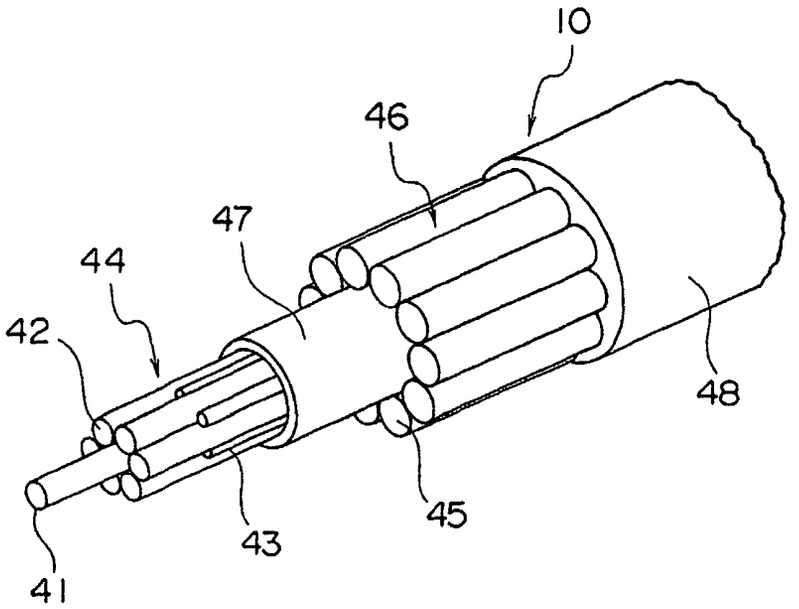
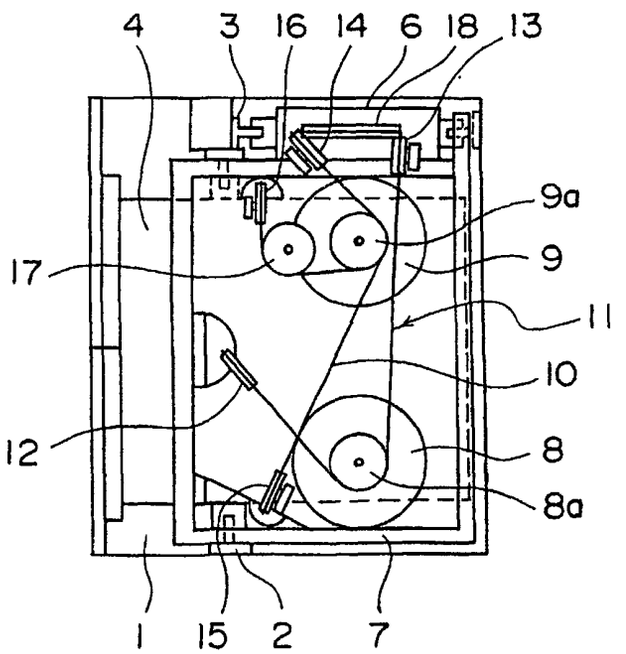


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/07026

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B 7/00, B66B 7/06, B66B11/04

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] B66B 1/00-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 1996-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Toroku Jitsuyo Shinan Koho 1994-2001

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.
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Y A	US, 6006865, A (Inventio AG), 28 December, 1999 (28.12.99), & CA, 2220582, A & EP, 0841283, A1 & JP, 10-139321, A	1-3,8,11-12 4-7,9-10
Y	US, 5419414, A (Masami SAKITA), 30 May, 1995 (30.05.95), & JP, 7-187525, A	8
Y	JP, 59-153773, A (Toshiba K.K.), 01 September, 1984 (01.09.84), (Family: none)	11

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

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Date of the actual completion of the international search	Date of mailing of the international search report
19 June, 2001 (19.06.01)	03 July 2001 (03.07.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/07026

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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