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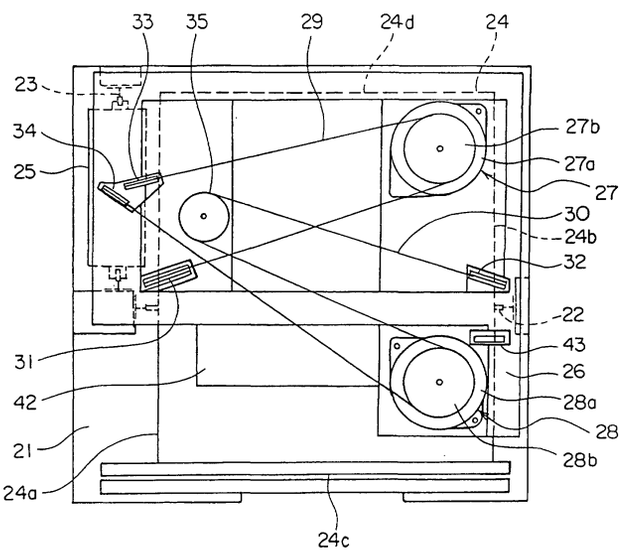
(54) ELEVATOR

(57) In an elevator apparatus, first and second driving machines are disposed horizontally above a car so as to overlap with the car in a vertical plane of projection. A first main rope is wound around a first drive sheave of the first driving machine. A second main rope is wound around a second drive sheave of the second driving machine. A first car return sheave for leading the first main rope to the car and a second car return sheave for leading the second main rope to the car are disposed above the car inside the hoistway. A first counterweight return sheave for leading the first main rope to the counterweight and a second counterweight return sheave for leading the second main rope to the counterweight are disposed above the counterweight inside the hoistway.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a multi-drive elevator apparatus in which a single car is raised and lowered by first and second driving machines.

BACKGROUND ART

[0002] Figure 9 is a perspective showing a conventional elevator apparatus such as that disclosed in Japanese Patent Laid-Open No. HEI 7-117957 (Gazette), for example. In the figure, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are installed inside a hoistway 1. A car 4 is guided by the car guide rails 2 so as to be raised and lowered inside the hoistway 1. A counterweight 5 is guided by the counterweight guide rails 3 so as to be raised and lowered inside the hoistway 1.

[0003] First and second driving machines (hoisting machines) 6 and 7 are disposed above the counterweight 5 inside the hoistway 1. The first driving machine 6 has: a shaft 8 fixed horizontally to an upper portion inside the hoistway 1; a stator (not shown) fixed to the shaft 8; a first drive sheave 9 rotated around the shaft 8; and a rotor (not shown) fixed inside the first drive sheave 9 so as to face the stator.

[0004] The second driving machine 7 has: the shaft 8 shared with the first driving machine 6; a stator (not shown) fixed to the shaft 8; a second drive sheave 10 rotated around the shaft 8; and a rotor (not shown) fixed inside the second drive sheave 10 so as to face the stator.

[0005] Rotatable first and second return sheaves 11 and 12 are disposed above the car 4 inside the hoistway 1. The first and second return sheaves 11 and 12 are rotated around rotating shafts extending horizontally.

[0006] First main ropes 13 are wound around the first drive sheave 9 and the first return sheave 11 using a full winding method. Second main ropes 14 are wound around the second drive sheave 10 and the second return sheave 12 using a full winding method.

[0007] The car 4 is connected to and suspended from first end portions of the first and second main ropes 13 and 14. The counterweight 5 is connected to and suspended from second end portions of the first and second main ropes 13 and 14. In other words, the car 4 and the counterweight 5 are suspended inside the hoistway 1 using a 1:1 roping method.

[0008] In an elevator apparatus of this kind, the first and second main ropes 13 and 14 are moved simultaneously and the car 4 and the counterweight 5 are raised and lowered inside the hoistway 1 by simultaneously driving first and second driving machines 6 and 7. Furthermore, a driving method in which a single car 4 is raised and lowered by two driving machines 6 and 7 is called a "multi-drive method". In addition, an elevator apparatus in which driving machines 6 and 7 are disposed inside a hoistway without providing a machine room is called a "machine-roomless" elevator.

[0009] Here, in the conventional multi-drive machine-roomless elevator shown in Figure 9, the driving machines 6 and 7 are disposed in an upper portion inside the hoistway 1 so as not to interfere with the car 4. In other words, the driving machines 6 and 7 are disposed so as not to overlap with the car 4 in a vertical plane of projection.

[0010] Normally, the diameter of the drive sheaves 6 and 7 cannot be reduced further than a size defined by a ratio to the diameter of the main ropes 13 and 14, etc. Because of this, the diameter of the drive sheaves 6 and 7 is larger than a thickness dimension of the counterweight 5. In this regard, since the rotating shaft of the drive sheaves 6 and 7 is disposed so as to extend horizontally, in order to avoid interference between the car 4 and the drive sheaves 6 and 7, it is necessary to dispose the counterweight 5 away from the car 4 to account for the diameter of the drive sheaves 6 and 7, increasing the horizontal surface area of the hoistway 1.

[0011] In addition, since the rotating shafts of the drive sheaves 6 and 7 and the return sheaves 11 and 12 are disposed so as to extend horizontally, and sufficient traction capacity cannot be ensured if the main ropes 13 and 14 are wound using a half winding method, the main rope 13 and 14 are wound using a full winding method. Because of this, the axle load acting on the rotating shafts of the drive sheaves 6 and 7 and the return sheaves 11 and 12 is large, increasing the size and expense of the rotating shafts and their supporting members.

DISCLOSURE OF THE INVENTION

[0012] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling space to be saved inside a hoistway and enabling simplification of a supporting construction of a driving machine and a return sheave.

[0013] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus including: a hoistway; a first driving machine having a first drive sheave, the first driving machine being disposed in an upper portion inside the hoistway; a second driving machine having a second drive sheave, the second driving machine being disposed in an upper portion inside the hoistway; a first main rope having first and second end portions, the first main rope being wound around the first drive sheave; a second main rope having third and fourth end portions, the second main rope being wound around the second drive sheave; a car suspended by the first end portion of the first main rope and the third end portion of the second main rope, the car being raised and lowered inside the hoistway by the first and second driving ma-

chines; and a counterweight suspended by the second end portion of the first main rope and the fourth end portion of the second main rope, the counterweight being raised and lowered inside the hoistway by the first and second driving machines, wherein: the first and second driving machines are disposed horizontally so as to overlap with the car in a vertical plane of projection and such that rotating shafts of the first and second drive sheaves extend vertically, a first car return sheave for leading the first main rope to the car and a second car return sheave for leading the second main rope to the car are disposed above the car inside the hoistway, and a first counterweight return sheave for leading the first main rope to the counterweight and a second counterweight return sheave for leading the second main rope to the counterweight are disposed above the counterweight inside the hoistway.

[0014] According to another aspect of the present invention, there is provided an elevator apparatus including: a hoistway; a first driving machine having a first drive sheave, the first driving machine being disposed in an upper portion inside the hoistway; a second driving machine having a second drive sheave, the second driving machine being disposed in an upper portion inside the hoistway; and a car and a counterweight raised and lowered inside the hoistway by the first and second driving machines, wherein: the first and second driving machines are disposed horizontally so as to overlap with the car in a vertical plane of projection and such that rotating shafts of the first and second drive sheaves extend vertically, a main rope having first and second end portions is wound around the first and second drive sheaves, the first and second end portions are connected to the counterweight, first and second car suspension sheaves around which the main rope is wound are mounted to a lower portion of the car, a first car return sheave for leading the main rope from the first drive sheave to the first car suspension sheave and a second car return sheave for leading the main rope from the second drive sheave to the second car suspension sheave are disposed above the car inside the hoistway, and a first counterweight return sheave for leading the main rope from the first drive sheave to the counterweight and a second counterweight return sheave for leading the main rope from the second drive sheave to the counterweight are disposed above the counterweight inside the hoistway.

[0015] According to yet another aspect of the present invention, there is provided an elevator apparatus including: a hoistway; a first driving machine having a first drive sheave, the first driving machine being disposed in an upper portion inside the hoistway; a second driving machine having a second drive sheave, the second driving machine being disposed in an upper portion inside the hoistway; and a car and a counterweight raised and lowered inside the hoistway by the first and second driving machines, wherein: the first and second driving machines are disposed horizontally so as to overlap with the car in a vertical plane of projection and such that rotating shafts of the first and second drive sheaves extend vertically, a main rope having first and second end portions is wound around the first and second drive sheaves, the first end portion is connected to a first side of the car, and the second end portion is connected on a second side of the car, a counterweight suspension sheave around which the main rope is wound is mounted to a lower portion of the counterweight, a first car return sheave for leading the main rope from the first drive sheave to the first side of the car and a second car return sheave for leading the main rope from the second drive sheave to the second side of the car are disposed above the car inside the hoistway, and a first counterweight return sheave for leading the main rope from the first drive sheave to the counterweight suspension sheave and a second counterweight return sheave for leading the main rope from the second drive sheave to the counterweight suspension sheave are disposed above the counterweight inside the hoistway.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a plan showing an elevator apparatus according to Embodiment 1 of the present invention;
Figure 2 is a general front elevation showing the elevator apparatus in Figure 1;
Figure 3 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention;
Figure 4 is a general front elevation showing the elevator apparatus in Figure 3;
Figure 5 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention;
Figure 6 is a general front elevation showing the elevator apparatus in Figure 5;
Figure 7 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention;
Figure 8 is a general front elevation showing the elevator apparatus in Figure 7; and
Figure 9 is a perspective showing an example of a conventional elevator apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0018] Figure 1 is a plan showing an elevator apparatus according to Embodiment 1 of the present invention,

and Figure 2 is a general front elevation showing the elevator apparatus in Figure 1.

[0019] In the figures, a pair of car guide rails 22 and a pair of counterweight guide rails 23 are installed inside a hoistway 21. A car 24 is guided by the car guide rails 22 so as to be raised and lowered inside the hoistway 21. A counterweight 25 is guided by the counterweight guide rails 23 so as to be raised and lowered inside the hoistway 21.

[0020] The car 24 has: mutually opposite first and second side surfaces 24a and 24b; and a mutually opposite front surface 24c and rear surface 24d. A car entrance is disposed on the front surface 24c.

[0021] The counterweight 25 is disposed beside the car 24 so as to face the first side surface 24a. The counterweight guide rails 23 are installed such that a straight line connecting the pair of counterweight guide rails 23 extends at a right angle to a straight line connecting the pair of car guide rails 22 in a vertical plane of projection.

[0022] A machine base 26 is fixed to and supported by upper end portions of the car guide rails 22 and the counterweight guide rails 23. First and second driving machines (hoisting machines) 27 and 28 for raising and lowering the car 24 and the counterweight 25 are mounted to the machine base 26. The first driving machine 27 has: a first driving machine main body 27a including a motor; and a first drive sheave 27b rotated by the first driving machine main body 27a.

[0023] The second driving machine 28 has a size and construction like those of the first driving machine 27, having a second driving machine main body 28a and a second drive sheave 28b.

[0024] Thin hoisting machines in which a diameter of the drive sheaves 27b and 28b is larger than an axial dimension of the driving machine main bodies 27a and 28a are used for the driving machines 27 and 28. The driving machines 27 and 28 are installed horizontally such that rotating shafts of the drive sheaves 27b and 28b extend vertically. In addition, the first and second driving machines 27 and 28 are disposed above the car 24 toward the second side surface 24b from center in a direction of frontage of the car 24. Specifically, the first and second driving machines 27 and 28 are disposed inside a region of the car 24 in a vertical plane of projection.

[0025] The first and second driving machines 27 and 28 are disposed such that the first and second drive sheaves 27b and 28b are at a generally equal height.

[0026] A first main rope 29 for suspending the car 24 and the counterweight 25 is wound around the first drive sheave 27b. Only one first main rope 29 is shown in the figures, but a plurality of ropes may also be included.

[0027] A second main rope 30 for suspending the car 24 and the counterweight 25 is wound around the second drive sheave 28b. Only one second main rope 30 is shown in the figures, but a plurality of ropes may also be included.

[0028] The contact angle of the first and second main ropes 29 and 30 on the drive sheaves 27b and 28b is set to greater than 90 degrees (90°). More specifically, the contact angle in question is set to greater than 130 degrees (130°). The first and second main ropes 29 and 30 are wound around the drive sheaves 27b and 28b using a half winding method.

[0029] A first car return sheave 31 for leading the first main rope 29 to the car 24 is disposed above the first side surface 24a of the car 24. A second car return sheave 32 for leading the second main rope 30 to the car 24 is disposed above the second side surface 24b of the car 24.

[0030] A first counterweight return sheave 33 for leading the first main rope 29 to the counterweight 25 and a second counterweight return sheave 34 for leading the second main rope 30 to the counterweight 25 are disposed above the counterweight 25 inside the hoistway 21.

[0031] An auxiliary pulley 35 around which the second main rope is wound to increase the contact angle of the second main rope 30 on the second drive sheave 28b is disposed in an upper portion inside the hoistway 21.

[0032] Rotating shafts of the return sheaves 31 to 34 are disposed so as to extend horizontally. A rotating shaft of the auxiliary pulley 35 is disposed so as to extend generally vertically.

[0033] First and second car suspension portions 36 and 37 are disposed on lower edge portions of the first and second side surfaces 24a and 24b of the car 24. The first and second car suspension portions 36 and 37 are disposed such that a straight line joining them to each other passes through the center of gravity of the car 24 in a vertical plane of projection.

[0034] The first main rope 29 has: a first end portion 29a connected to the first car suspension portion 36; and a second end portion 29b connected to an upper frame 25a of the counterweight 25. The second main rope 30 has: a third end portion 30a connected to the second car suspension portion 37; and a fourth end portion 30b connected to the upper frame 25a of the counterweight 25.

[0035] A rope shackle 38 is connected to each of the first to fourth end portions 29a, 29b, 30a, and 30b. A shackle spring 39 is interposed between each of the rope shackles 38 and the lower surfaces of the car suspension portions 36 and 37 and between each of the rope shackles 38 and the lower surface of the upper frame 25a.

[0036] A first detecting apparatus 40 for detecting the amount of displacement of the rope shackle 38 in the first car suspension portion 36 and a second detecting apparatus 41 for detecting the amount of displacement of the rope shackle 38 in the second car suspension portion 37 are disposed on lower portions of the car 24. Reflecting optical sensors, for example, may be used for the first and second detecting apparatuses 40 and 41. Furthermore, not only reflecting optical sensors, but various kinds of contact or non-contact sensors can also

be used.

[0037] A control panel 42 for controlling the first and second driving machines 27 and 28 and a speed governor 43 for detecting acceleration of the car 24 are mounted to the machine base 26. in other words, the control panel 42, the speed governor 43, the first and second driving machines 27 and 28, the first and second car return sheaves 31 and 32, the first and second counterweight return sheaves 33 and 34, and the auxiliary pulley 35 are mounted to the machine base 26.

[0038] The machine base 26, as shown in Figure 2, is installed within a vertical installation range of the first and second driving machines 27 and 28, the first and second car return sheaves 31 and 32, and the first and second counterweight return sheaves 33 and 34. In addition, the machine base 26 is supported on upper portions of the car guide rails 22 and the counterweight guide rails 23 by means of a plurality of supporting platforms 44 and a plurality of buffering members 45.

[0039] In an elevator apparatus of this kind, the car 24 and the counterweight 25 are raised and lowered inside the hoistway 21 by simultaneously driving first and second driving machines 27 and 28. Here, because the first and second driving machines 27 and 28 are disposed horizontally, and car return sheaves 31 and 32 and counterweight return sheaves 33 and 34 are used, sufficient contact angle can be ensured even if the main ropes 29 and 30 are wound around the drive sheaves 27b and 28b using a half winding method. Thus, the axle load on the drive sheaves 27b and 28b is reduced, enabling simplification of the supporting construction of the driving machines 27 and 28 and the return sheaves 31 to 34.

[0040] Because the first and second driving machines 27 and 28 are disposed so as to overlap with the car 24 in a vertical plane of projection, the planar dimensions of the hoistway 21 can be kept small. Moreover, because thin hoisting machines are used for the driving machines 27 and 28, increases in vertical dimensions of the hoistway 21 can be suppressed while avoiding interference between the car 24 and the driving machines 27 and 28 irrespective of the diameter of the drive sheaves 27b and 28b. Thus, space can be saved inside the hoistway 21.

[0041] In addition, because the first and second detecting apparatuses 40 and 41 are disposed on lower portions of the car 24, a difference in tensile force between the first and second main ropes 29 and 30 can be monitored. The difference in tensile force is monitored by the control panel 42, and if the difference in tensile force reaches a preset value, a command signal for resolving the difference in tensile force is output from the control panel 42 to the driving machines 27 and 28.

[0042] Furthermore, because an auxiliary pulley 35 is used, the contact angle of the second main rope 30 on the second drive sheave 28b is increased, enabling sufficient traction capacity to be ensured.

[0043] Because the control panel 42, the speed governor 43, the first and second driving machines 27 and 28, the first and second car return sheaves 31 and 32, the first and second counterweight return sheaves 33 and 34, and the auxiliary pulley 35 are mounted to a common machine base 26, the construction can be simplified. In addition, installation inside the hoistway 21 can be facilitated by modularizing the machine base 26 and the equipment mounted to the machine base 26.

[0044] Because the machine base 26 is installed within a vertical installation range of the first and second driving machines 27 and 28, the first and second car return sheaves 31 and 32, and the first and second counterweight return sheaves 33 and 34, space can be saved in the upper portion inside the hoistway 21.

[0045] Because the machine base 26 is supported on upper portions of the car guide rails 22 and the counterweight guide rails 23 by means of a plurality of supporting platforms 44 and a plurality of buffering members 45, vibration from the driving machines 27 and 28 and the return sheaves 31 to 34, etc., can be prevented from propagating to the guide rails 22 and 23.

[0046] In addition, since the car suspension portions 36 and 37 are disposed in a position lower than the upper surface of the car 24, and shackle springs 39 are disposed on lower portions of the car suspension portions 36 and 37, the rope shackles 38 and the shackle springs 39 are disposed so as not to project above the car 24, enabling height dimensions of the hoistway 21 to be kept small. Similarly, since the shackle springs 39 are also disposed on a lower portion of the upper frame 25a in the counterweight 25, height dimensions of the hoistway 21 can be kept small.

[0047] Furthermore, because the first and second car suspension portions 36 and 37 are disposed such that a straight line joining them to each other passes through the center of gravity of the car 24 in a vertical plane of projection, the car 24 can be suspended stably.

[0048] Moreover, in Embodiment 1, the first and second driving machines 27 and 28 are disposed toward the second side surface 24b from center in a direction of frontage of the car 24, but the second driving machine 28 may also be disposed toward the first side surface 24a, for example. In that case, the auxiliary pulley 35 is disposed in the vicinity of the first driving machine 27, and a portion of the second main rope 30 leading from the second drive sheave 28b to the second counterweight return sheave 34 is wound around the auxiliary pulley 35, thus enabling the contact angle of the second main rope 30 on the second drive sheave 28b to be increased.

Embodiment 2

[0049] Next, Figure 3 is a plan showing an elevator apparatus according to Embodiment 2 of the present invention, and Figure 4 is a general front elevation showing the elevator apparatus in Figure 3. In the figures, a counterweight 25 is disposed behind a car 24 so as to

face a rear surface 24d of the car 24. A pair of counterweight guide rails 23 are installed such that a straight line connecting the counterweight guide rails 23 extends parallel to a straight line connecting a pair of car guide rails 22 in a vertical plane of projection.

[0050] The first and second driving machines 27 and 28 are disposed above the car 24 toward a front surface 24c from center in a depth direction of the car 24 (top-to-bottom in Figure 3). A portion of a first main rope 29 extending from a first drive sheave 27b to a first car return sheave 31 and a portion of a second main rope 30 extending from a second drive sheave 28b to a second car return sheave 32 cross each other. The rest of the construction is similar to that of Embodiment 1.

[0051] In an elevator apparatus of this kind, because the first and second driving machines 27 and 28 are disposed horizontally so as to overlap with the car 24 in a vertical plane of projection, and the main ropes 29 and 30 are directed to the car 24 and the counterweight 25 by the car return sheaves 31 and 32 and the counterweight return sheaves 33 and 34, similar effects to those in Embodiment 1 can be achieved.

Embodiment 3

[0052] Next, Figure 5 is a plan showing an elevator apparatus according to Embodiment 3 of the present invention, and Figure 6 is a general front elevation showing the elevator apparatus in Figure 5. In the figures, rotatable first and second car return sheaves 51 and 52 are mounted to a lower portion of a car 24. Rotating shafts of the car return sheaves 51 and 52 are disposed so as to extend horizontally parallel to the depth direction of the car 24. Furthermore, the car return sheaves 51 and 52 are disposed so as to intersect with first and second side surfaces 24a and 24b in a vertical plane of projection.

[0053] A main rope 53 is wound around first and second drive sheaves 27b and 28b, first and second car return sheaves 31 and 32, first and second counterweight return sheaves 33 and 34, and the first and second car suspension sheaves 51 and 52. Only one main rope 53 is shown in the figures, but one rope or a plurality of ropes may be included.

[0054] The car return sheaves 51 and 52 are disposed such that the main rope 53 passing between them passes through the center of gravity of the car 24.

[0055] The main rope 53 has first and second end portions 53a and 53b. The first and second end portions 53a and 53b are connected to an upper frame 25a of a counterweight 25 by means of rope shackles 38 and shackle springs 39.

[0056] The main rope 53 is wound in sequence from the first end portion 53a, around the first counterweight return sheave 33, the first drive sheave 27b, the first car return sheave 31, the first car suspension sheave 51, the second car suspension sheave 52, the second car return sheave 32, the second drive sheave 28b, and the second counterweight return sheave 34 to the second end portion 53b.

[0057] First and second detecting apparatuses 40 and 41 are mounted to the upper frame 25a of the counterweight 25. The rest of the construction is similar to that of Embodiment 2.

[0058] In an elevator apparatus of this kind, because the first and second driving machines 27 and 28 are disposed horizontally so as to overlap with the car 24 in a vertical plane of projection, and the main rope 53 is directed to the car 24 and the counterweight 25 by the car return sheaves 31 and 32 and the counterweight return sheaves 33 and 34, similar effects to those in Embodiments 1 and 2 can be achieved.

[0059] Furthermore, because the car 24 is suspended by the rotatable car suspension sheaves 51 and 52, the car 24 can be suspended stably. In addition, the number of main ropes 53 can be reduced, thereby enabling the number of terminal connection portions for the main ropes 53 also to be reduced, enabling costs to be reduced.

Embodiment 4

[0060] Next, Figure 7 is a plan showing an elevator apparatus according to Embodiment 4 of the present invention, and Figure 8 is a general front elevation showing the elevator apparatus in Figure 7. In the figures, a rotatable counterweight suspension sheave 54 is mounted to a lower portion of a counterweight 25. A rotating shaft of the counterweight suspension sheave 54 is disposed so as to extend horizontally parallel to a width direction of the counterweight 25 (left-to-right in Figures 7 and 8). Furthermore, the counterweight suspension sheave 54 is disposed on a central portion in the width direction of the counterweight 25, that is, at a position of the center of gravity of the counterweight 25.

[0061] A first end portion 53a of a main rope 53 is connected to a first car suspension portion 36 by means of a rope shackle 38 and a shackle spring 39. A second end portion 53b of the main rope 53 is connected to a second car suspension portion 37 by means of a rope shackle 38 and a shackle spring 39.

[0062] The main rope 53 is wound in sequence from the first end portion 53a, around a first car return sheave 31, a first drive sheave 27b, a first counterweight return sheave 33, the counterweight suspension sheave 54, a second counterweight return sheave 34, a second drive sheave 28b, and a second car return sheave 32 to the second end portion 53b. The rest of the construction is similar to that of Embodiment 2.

[0063] In an elevator apparatus of this kind, because the first and second driving machines 27 and 28 are disposed horizontally so as to overlap with the car 24 in a vertical plane of projection, and the main rope 53 is directed to the car 24 and the counterweight 25 by the car return sheaves 31 and 32 and the counterweight return sheaves 33 and 34, similar effects to those in Embodi-

ments 1 and 2 can be achieved.

[0064] Furthermore, because the counterweight 25 is suspended by the rotatable counterweight suspension sheave 54, the counterweight 25 can be suspended stably. In addition, the number of main ropes 53 can be reduced, thereby enabling the number of terminal connection portions for the main ropes 53 also to be reduced, enabling costs to be reduced.

[0065] Moreover, in Embodiment 4, the counterweight suspension sheave 54 is mounted to a lower portion of the counterweight 25, but the counterweight suspension sheave 54 may also be mounted to an upper portion of the counterweight 25.

[0066] In Embodiments 1 to 4, the machine base 26 may also be secured to a hoistway wall instead of to the guide rails 22 and 23.

[0067] A steel rope may also be used for the main rope, but a resin-coated rope in which an outer layer coating body composed of a high-friction resin material is disposed on an outer peripheral portion can also be used, enabling the diameter of the drive sheaves, return sheaves, etc., to be reduced thereby enabling space to be saved inside the hoistway.

Claims

1. An elevator apparatus comprising:

a hoistway;
a first driving machine having a first drive sheave, said first driving machine being disposed in an upper portion inside said hoistway;
a second driving machine having a second drive sheave, said second driving machine being disposed in an upper portion inside said hoistway;
a first main rope having first and second end portions, said first main rope being wound around said first drive sheave;
a second main rope having third and fourth end portions, said second main rope being wound around said second drive sheave;
a car suspended by said first end portion of said first main rope and said third end portion of said second main rope, said car being raised and lowered inside said hoistway by said first and second driving machines; and
a counterweight suspended by said second end portion of said first main rope and said fourth end portion of said second main rope, said counterweight being raised and lowered inside said hoistway by said first and second driving machines,

wherein:

said first and second driving machines are disposed horizontally so as to overlap with said car in a vertical plane of projection and such that rotating shafts of said first and second drive sheaves extend vertically,
a first car return sheave for leading said first main rope to said car and a second car return sheave for leading said second main rope to said car are disposed above said car inside said hoistway, and
a first counterweight return sheave for leading said first main rope to said counterweight and a second counterweight return sheave for leading said second main rope to said counterweight are disposed above said counterweight inside said hoistway.

2. The elevator apparatus according to Claim 1, wherein:

said car has mutually opposite first and second side surfaces and a mutually opposite front surface and rear surface,
said counterweight is disposed so as to face said first side surface,
said first and second driving machines are disposed toward said second side surface from center in a direction of frontage of said car in a vertical plane of projection,
said first car return sheave is disposed above said first side surface,
said second car return sheave is disposed above said second side surface, and
an auxiliary pulley around which said second main rope is wound to increase a contact angle of said second main rope on said second drive sheave is disposed in an upper portion inside said hoistway.

3. The elevator apparatus according to Claim 1, wherein:

said car has mutually opposite first and second side surfaces and a mutually opposite front surface and rear surface,
said counterweight is disposed so as to face said rear surface,
said first and second driving machines are disposed toward said front surface from center in a depth direction of said car in a vertical plane of projection,
said first car return sheave is disposed above said first side surface,
said second car return sheave is disposed above said second side surface, and
a portion of said first main rope extending from said first drive sheave to said first car return sheave and a portion of said second main rope extending from said second drive sheave to

said second car return sheave cross each other.

4. The elevator apparatus according to Claim 1, wherein:

a first detecting apparatus for detecting displacement of said first end portion of said first main rope and a second detecting apparatus for detecting displacement of said third end portion of said second main rope are mounted to said car.

5. An elevator apparatus comprising:

a hoistway;
a first driving machine having a first drive sheave, said first driving machine being disposed in an upper portion inside said hoistway;
a second driving machine having a second drive sheave, said second driving machine being disposed in an upper portion inside said hoistway;
and
a car and a counterweight raised and lowered inside said hoistway by said first and second driving machines,

wherein:

said first and second driving machines are disposed horizontally so as to overlap with said car in a vertical plane of projection and such that rotating shafts of said first and second drive sheaves extend vertically,
a main rope having first and second end portions is wound around said first and second drive sheaves,
said first and second end portions are connected to said counterweight,
first and second car suspension sheaves around which said main rope is wound are mounted to a lower portion of said car,
a first car return sheave for leading said main rope from said first drive sheave to said first car suspension sheave and a second car return sheave for leading said main rope from said second drive sheave to said second car suspension sheave are disposed above said car inside said hoistway, and
a first counterweight return sheave for leading said main rope from said first drive sheave to said counterweight and a second counterweight return sheave for leading said main rope from said second drive sheave to said counterweight are disposed above said counterweight inside said hoistway.

6. An elevator apparatus comprising:

a hoistway;
a first driving machine having a first drive sheave, said first driving machine being disposed in an upper portion inside said hoistway;
a second driving machine having a second drive sheave, said second driving machine being disposed in an upper portion inside said hoistway;
and
a car and a counterweight raised and lowered inside said hoistway by said first and second driving machines,

wherein:

said first and second driving machines are disposed horizontally so as to overlap with said car in a vertical plane of projection and such that rotating shafts of said first and second drive sheaves extend vertically,
a main rope having first and second end portions is wound around said first and second drive sheaves,
said first end portion is connected to a first side of said car, and said second end portion is connected on a second side of said car,
a counterweight suspension sheave around which said main rope is wound is mounted to a lower portion of said counterweight,
a first car return sheave for leading said main rope from said first drive sheave to said first side of said car and a second car return sheave for leading said main rope from said second drive sheave to said second side of said car are disposed above said car inside said hoistway, and
a first counterweight return sheave for leading said main rope from said first drive sheave to said counterweight suspension sheave and a second counterweight return sheave for leading said main rope from said second drive sheave to said counterweight suspension sheave are disposed above said counterweight inside said hoistway.

7. The elevator apparatus according to any of Claims 1 to 6, wherein:

said first and second driving machines are thin hoisting machines each having a driving machine main body including a motor, and a drive sheave rotated by said driving machine main body, a diameter of said drive sheave being larger than an axial dimension of said driving machine main body.

8. The elevator apparatus according to any of Claims 1 to 6, wherein:

a machine base is installed in an upper portion inside said hoistway, and
mounted to said machine base are: a control panel for controlling said first and second driving machines; a speed governor for detecting acceleration of said car; said first and second driving machines; said first and second car return sheaves; and said first and second counterweight return sheaves.

9. The elevator apparatus according to Claim 8, wherein:

said machine base is installed within a vertical installation range of said first and second driving machines, said first and second car return sheaves, and said first and second counterweight return sheaves.

10. The elevator apparatus according to Claim 8, wherein:

a car guide rail for guiding ascent and descent of said car, and a counterweight guide rail for guiding ascent and descent of said counterweight are installed inside said hoistway, and
said machine base is supported by means of a buffering member on an upper portion of at least one of said car guide rail and said counterweight guide rail.

FIG. 1

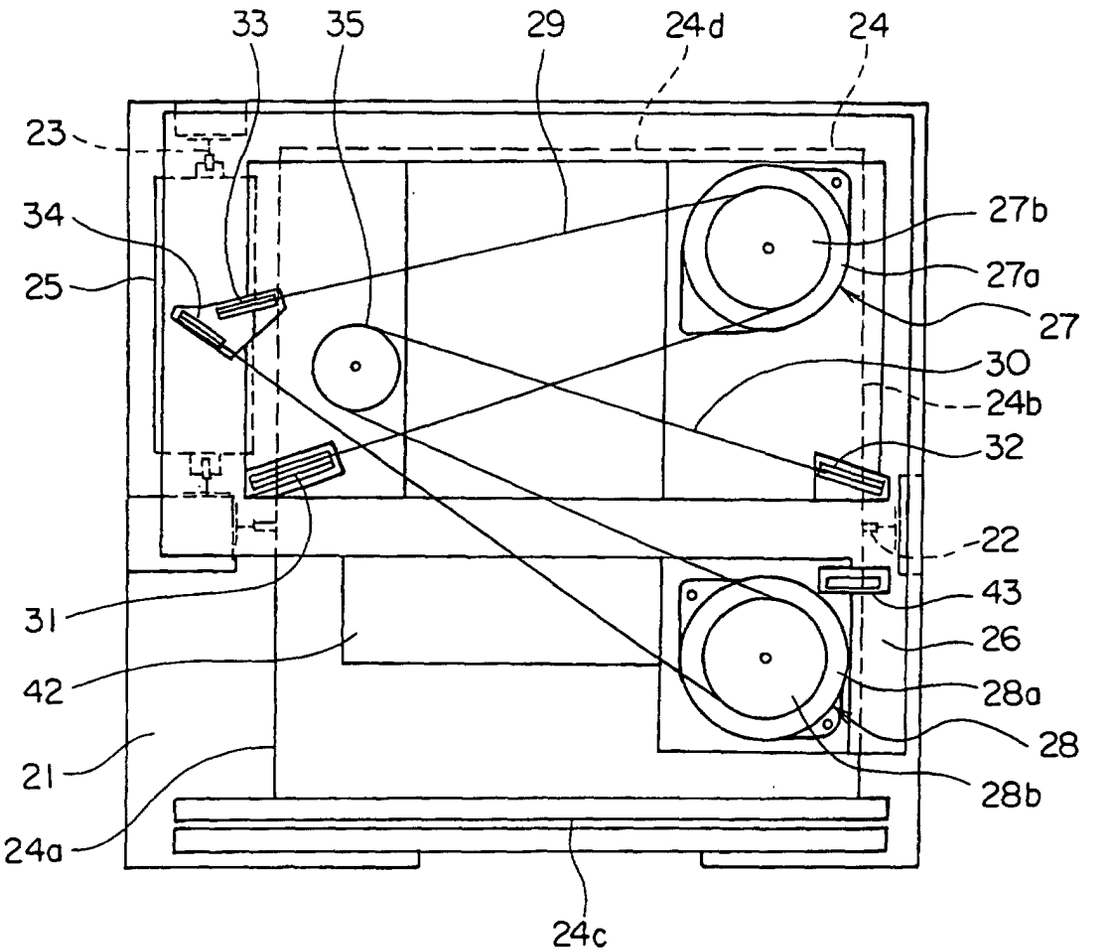
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FIG. 2

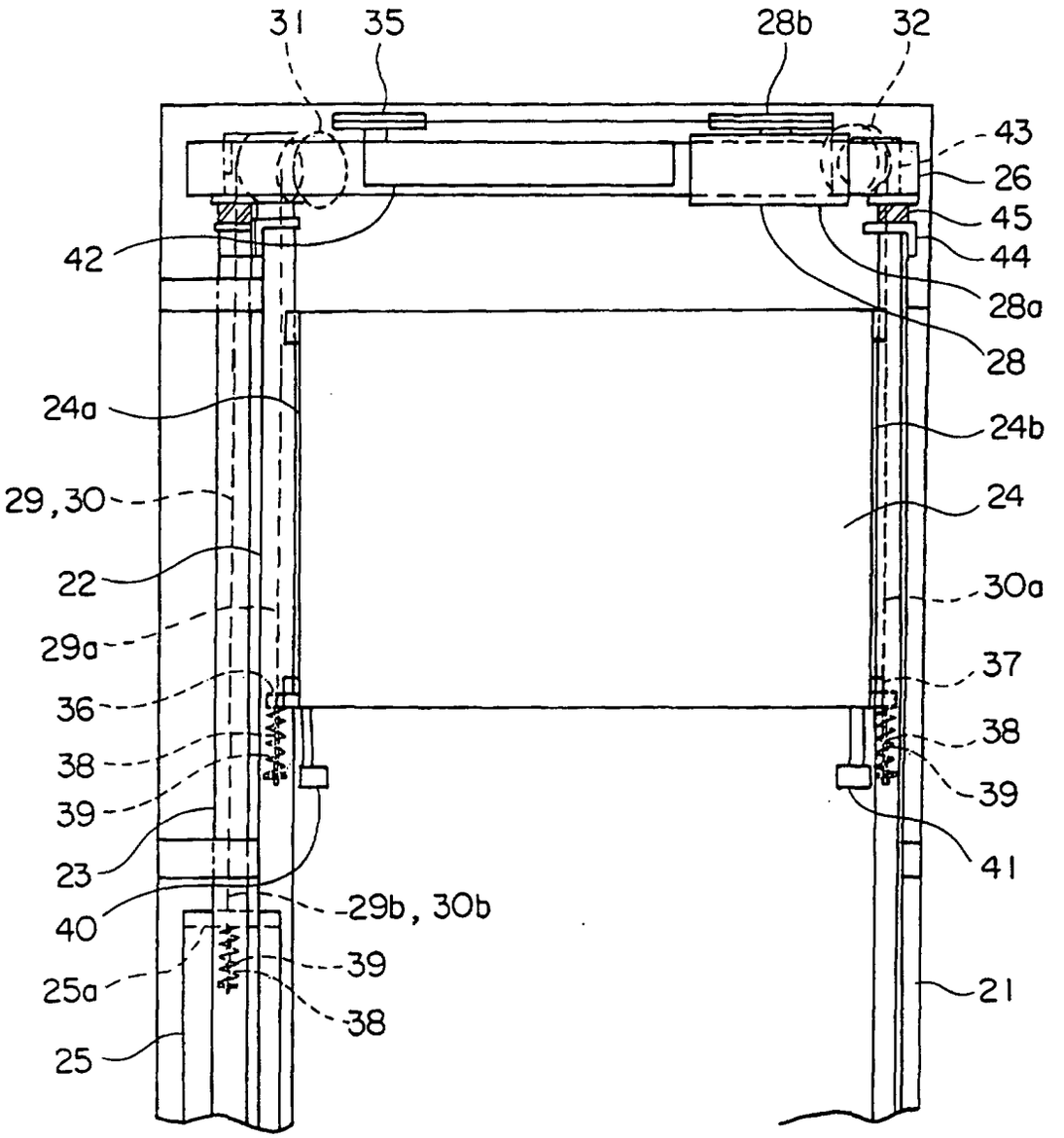
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FIG. 3

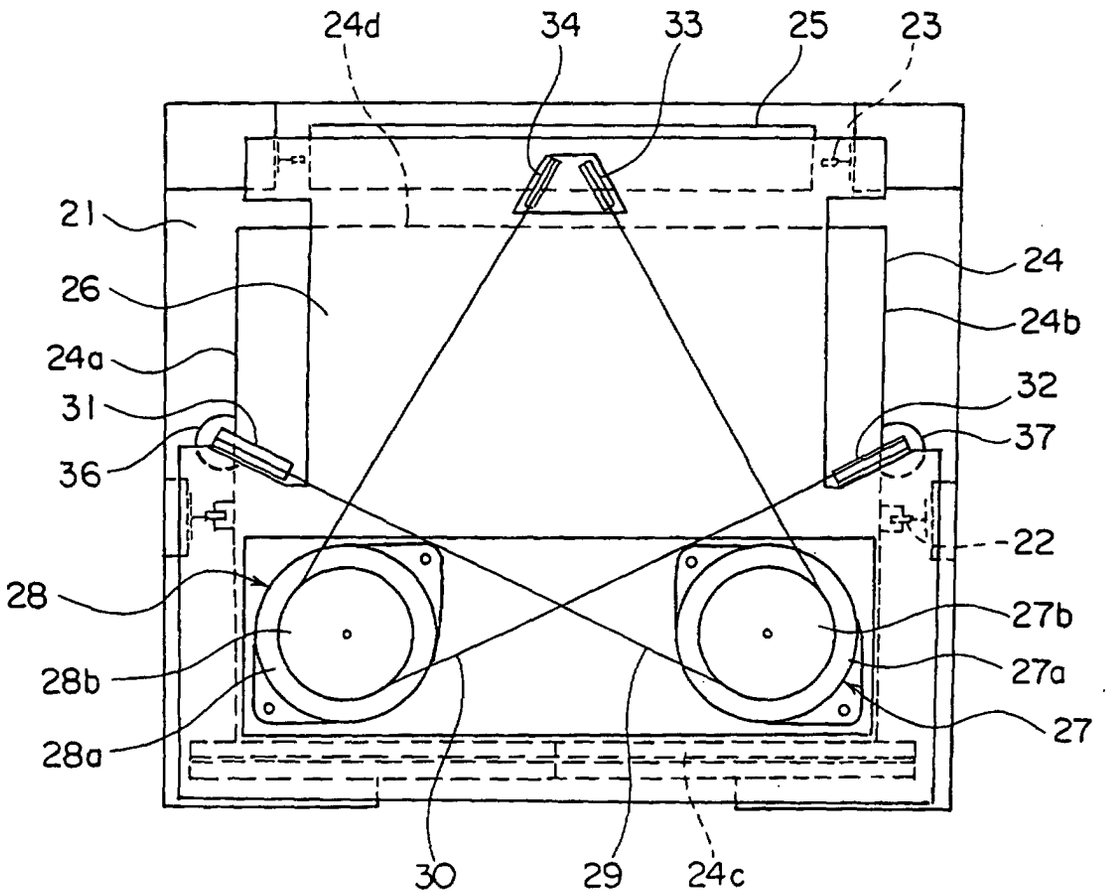
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FIG. 4

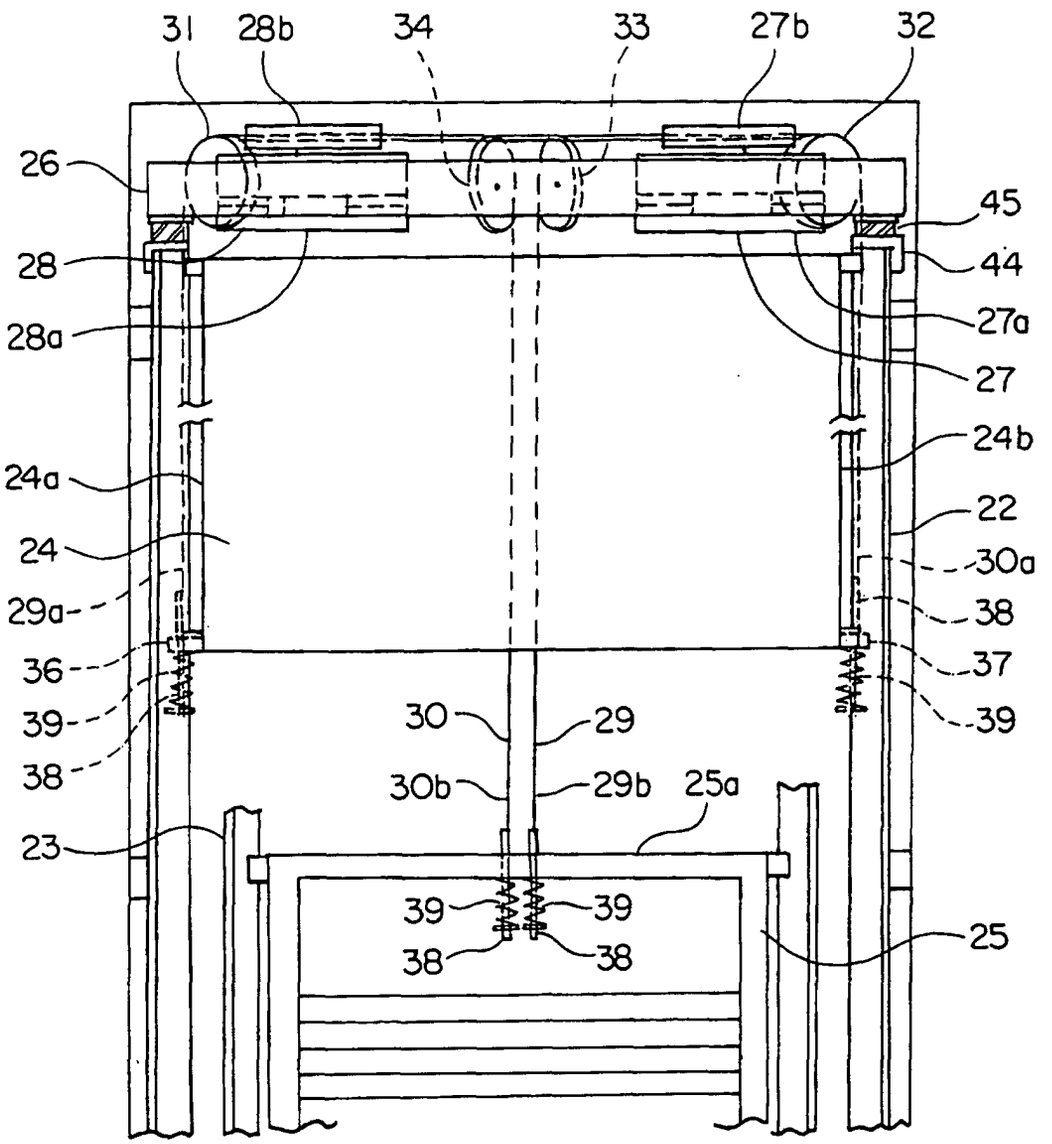
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FIG. 5

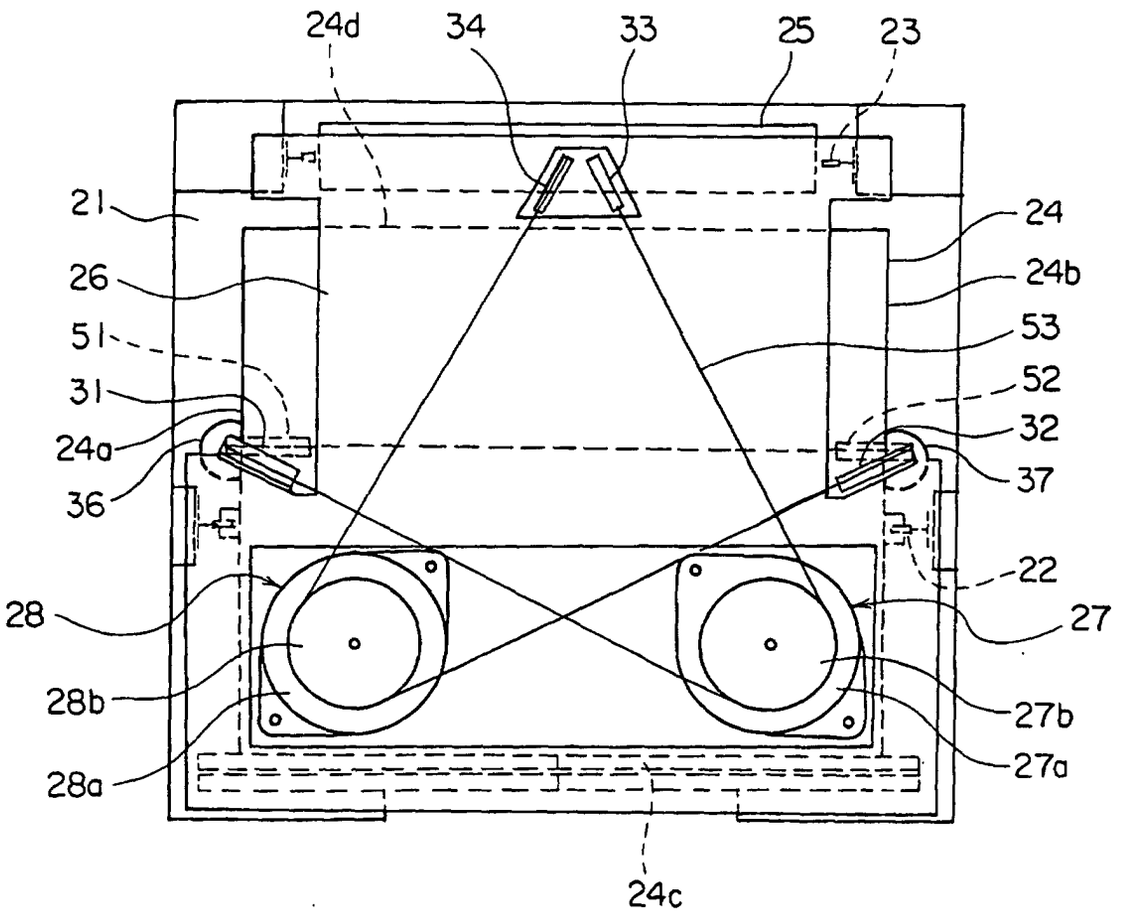
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FIG. 6

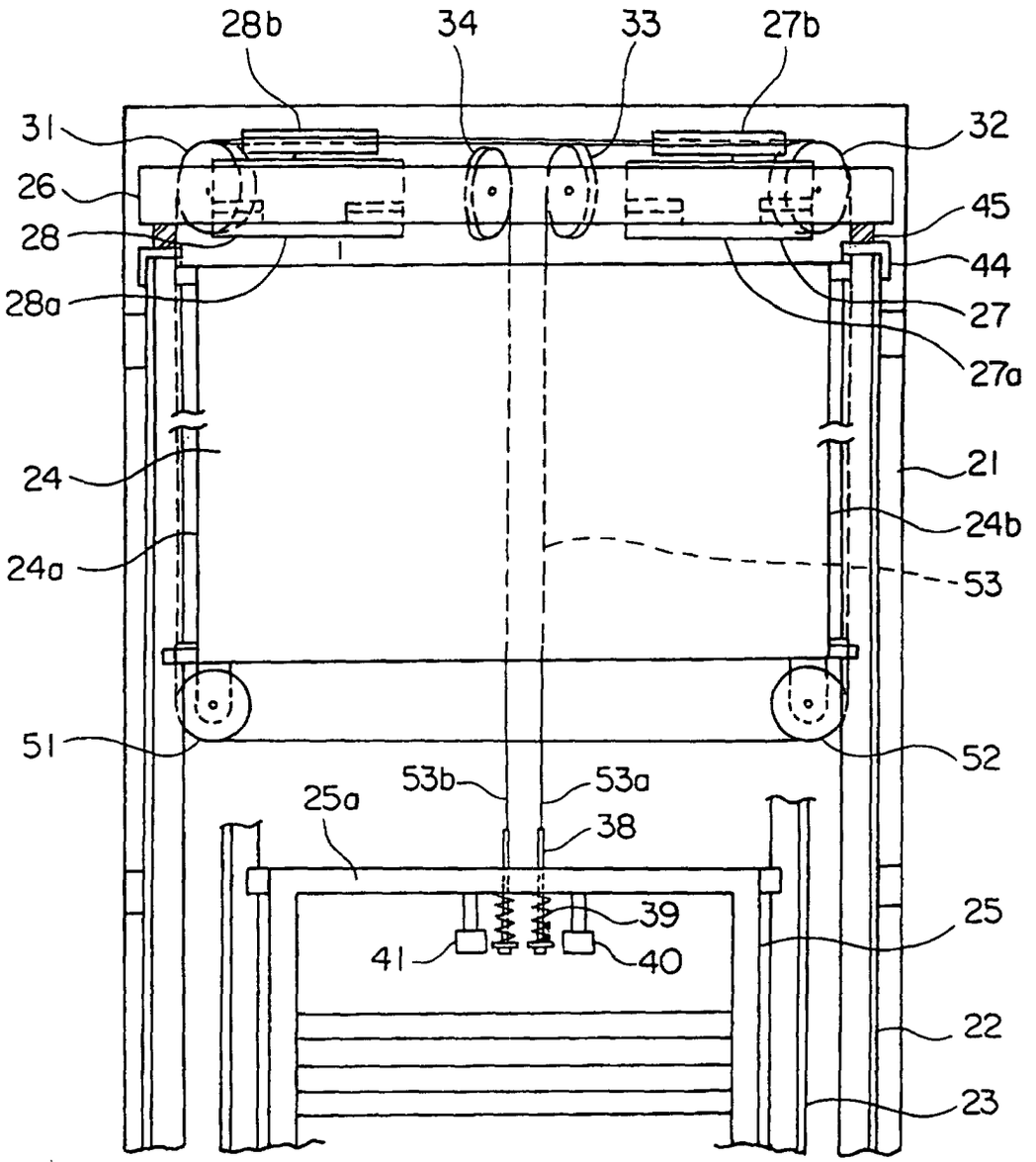
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FIG. 7

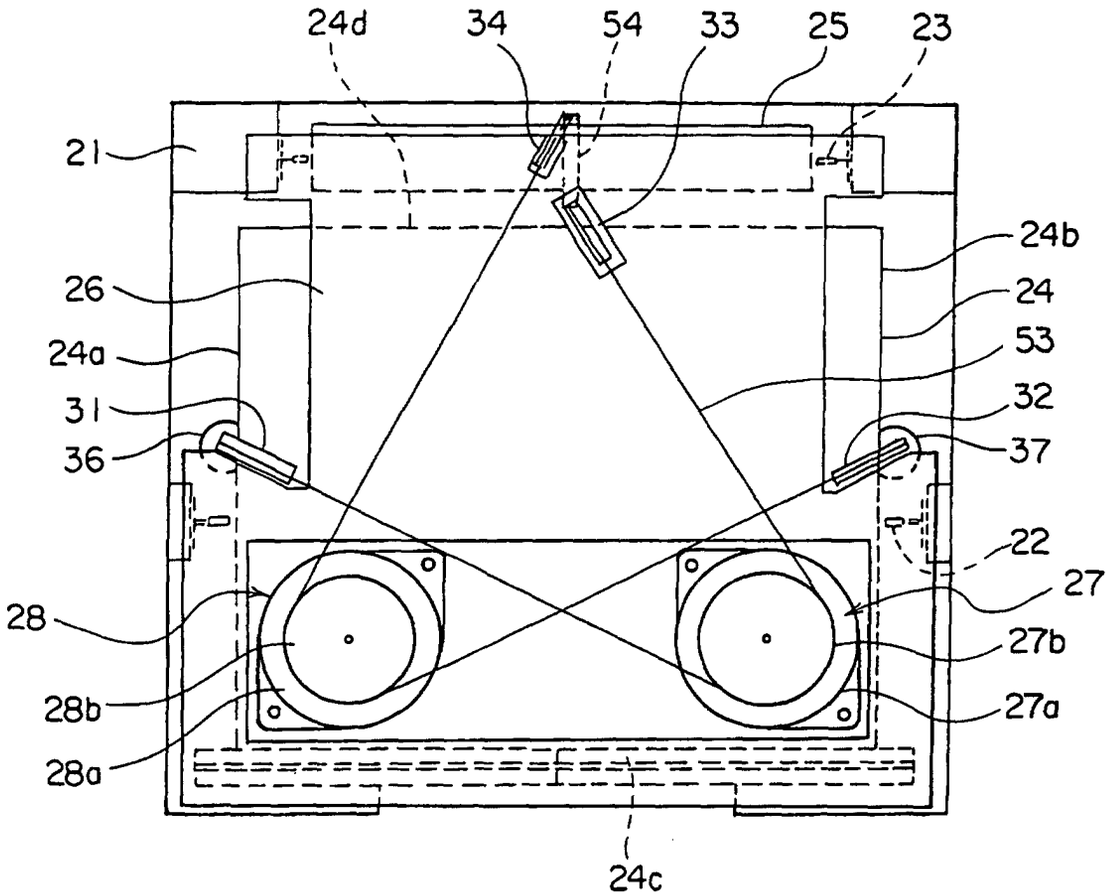
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FIG. 8

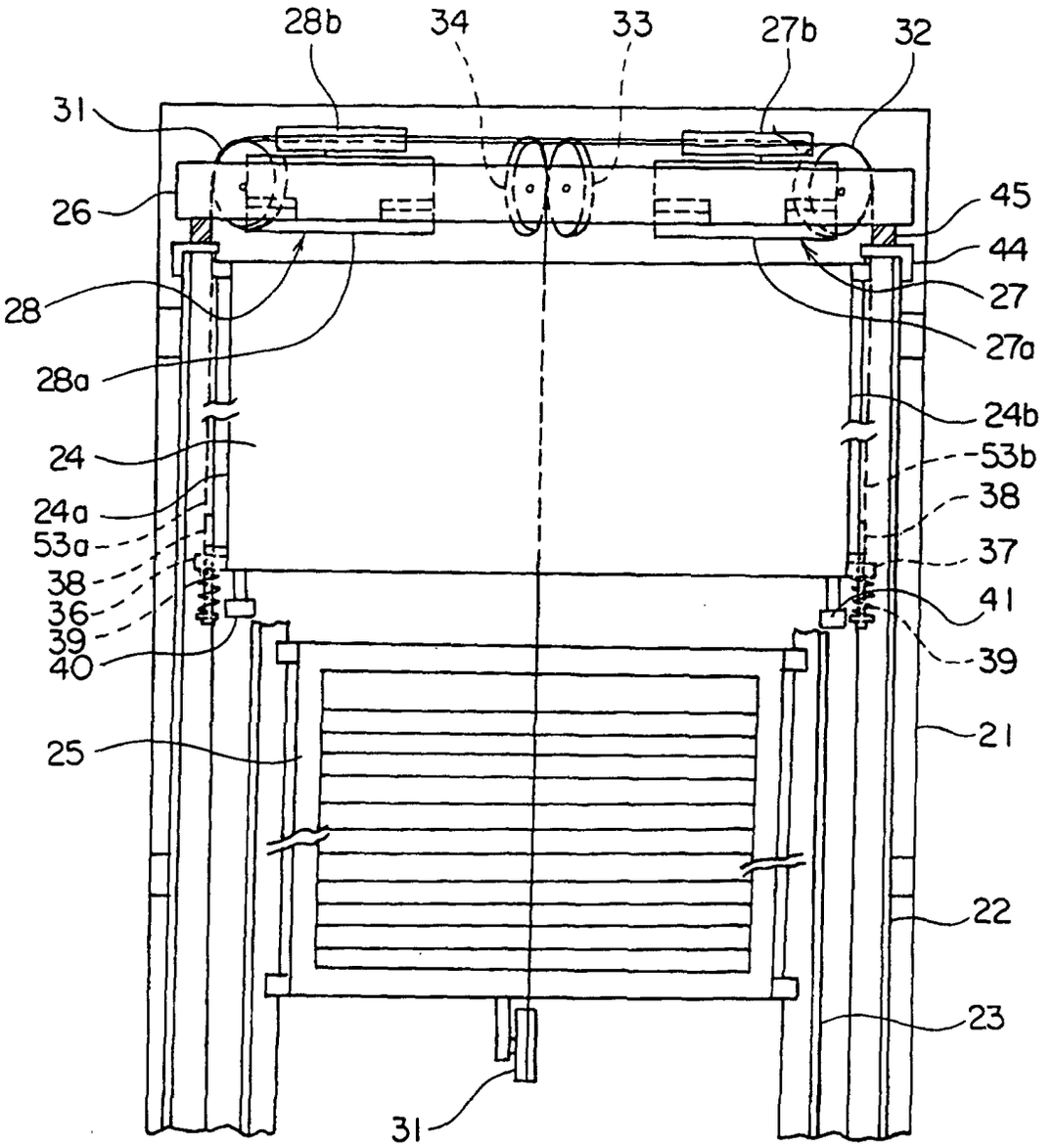
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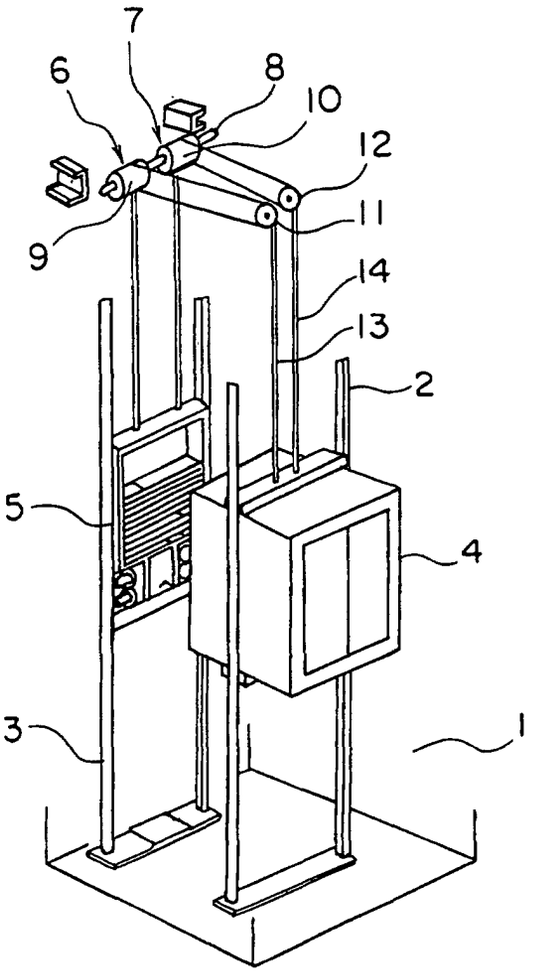
FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/05741

A. *CLASSIFICATION OF SUBJECT MATTER*
Int.Cl[7] B66B7/06, B66B11/08

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	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

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.
A	WO 02/30801 A1 (Mitsubishi Electric Corp.), 18 April, 2002 (18.04.02), (Family: none)	1-10
A	WO 02/22486 A1 (Mitsubishi Electric Corp.), 21 March, 2002 (21.03.02), (Family: none)	1-10
A	JP 2001-261257 A (Mitsubishi Electric Corp.), 26 September, 2001 (26.09.01), (Family: none)	1-10
A	JP 6-64863 A (Mitsubishi Electric Corp.), 08 March, 1994 (08.03.94), Par. No. [0015]; Fig. 2 (Family: none)	5-10

☐ 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
03 March, 2003 (03.03.03)	18 March, 2003 (18.03.03)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
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