(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 803 676 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
04.07.2007 Bulletin 2007/27

(21) Application number: **04792660.5**

(22) Date of filing: **20.10.2004**

(51) Int Cl.:
B66B 7/08 *(2006.01)*

(86) International application number:
PCT/JP2004/015494

(87) International publication number:
WO 2006/043317 (27.04.2006 Gazette 2006/17)

(84) Designated Contracting States:
DE

(71) Applicant: **MITSUBISHI DENKI KABUSHIKI KAISHA**
Chiyoda-ku
Tokyo 100-8310 (JP)

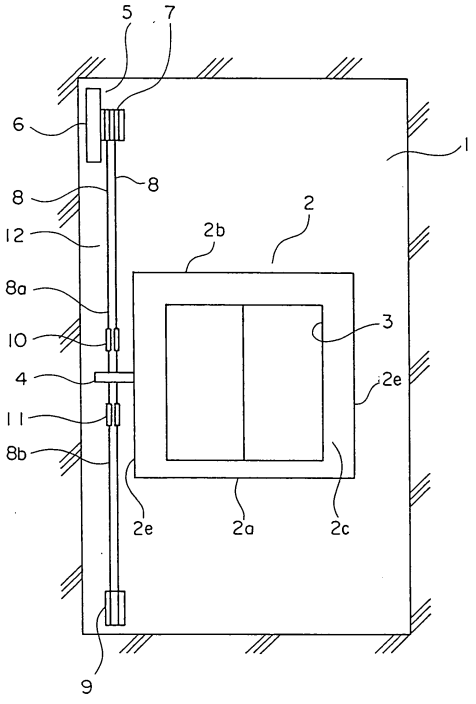
(72) Inventor: **KURAOKA, Hisao,**
Mitsubishi Denki Kabushiki Kaisha
Tokyo 100-8310 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) **ELEVATOR APPARATUS**

(57) An elevating body that can be raised/lowered is provided in a hoistway. The elevating body is raised/lowered by a raising/lowering mechanism installed in the hoistway. The raising/lowering mechanism has a driving device including a driving sheave, a main rope, which is looped around the driving sheave, for suspending the elevating body within the hoistway, and a tension pulley, around which the main rope is looped for applying a tensile force to the main rope. The elevating body is provided with a protrusion portion protruding from a lateral surface portion of the elevating body. The main rope is connected at one end of the main rope and the other end of the main rope to the protrusion portion.

FIG. 1



EP 1 803 676 A1

Description

Technical Field

[0001] The present invention relates to a traction-type elevator apparatus having a structure in which an elevating (raising/lowering) body is suspended by a main rope.

Background Art

[0002] Conventionally, in order to reduce a horizontal cross-sectional area of a hoistway, there has been proposed a counterweight-less elevator apparatus having no counterweight. In the conventional counterweight-less elevator apparatus, a driving rope for suspending a car is secured at one end thereof to an upper portion of the car and at the other end thereof to a lower portion of the car. Three driven sheaves and one driving sheave are provided within the hoistway. The driving rope, which extends from the aforementioned one end thereof to the other end thereof, is looped around the three driven sheaves and the driving sheave (see Patent Document 1).

[0003] Patent Document 1: JP 2004-67365 A

Disclosure of the Invention

Problem to be solved by the Invention

[0004] In the conventional elevator apparatus constructed as described above, however, rope fastening devices for securing the ends of the driving rope to the car need to be provided at the upper portion and the lower portion of the car, respectively. Accordingly, a substantial height dimension of the car increases by height dimensions of the rope fastening devices, so a dimension of the hoistway in a height direction thereof increases.

[0005] The present invention has been made to solve the problem discussed above, and it is therefore an object of the invention to obtain an elevator apparatus capable of allowing a reduction in the dimension of a hoistway in the height direction thereof.

Means for solving the Problem

[0006] An elevator apparatus according to the present invention includes: an elevating body that can be raised/lowered within a hoistway; and a raising/lowering mechanism having a driving device including a driving sheave, a main rope, which is looped around the driving sheave, for suspending the elevating body within the hoistway, a tension pulley, around which the main rope is looped for applying a tensile force to the main rope, for raising/lowering the elevating body by a driving force of the driving device. The elevating body is provided with a protrusion portion protruding from a lateral surface portion of the elevating body, and the main rope is connected at one end of the main rope and the other end of the main rope to the protrusion portion.

Brief Description of the Drawings

[0007]

Fig. 1 is a front view showing an elevator apparatus according to Embodiment 1 of the present invention.
Fig. 2 is a lateral view showing the elevator apparatus of Fig. 1.
Fig. 3 is a front view showing an elevator apparatus according to Embodiment 2 of the present invention.
Fig. 4 is a lateral view showing the elevator apparatus of Fig. 3.
Fig. 5 is a lateral view showing an elevator apparatus according to Embodiment 3 of the present invention.
Fig. 6 is a lateral view showing an elevator apparatus according to Embodiment 4 of the present invention.
Fig. 7 is a lateral view showing an elevator apparatus according to Embodiment 5 of the present invention.
Fig. 8 is a front view showing an elevator apparatus according to Embodiment 6 of the present invention.
Fig. 9 is a lateral view showing the elevator apparatus of Fig. 8.

Best Modes for carrying out the Invention

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

Embodiment 1

[0009] Fig. 1 is a front view showing an elevator apparatus according to Embodiment 1 of the present invention. Fig. 2 is a lateral view showing the elevator apparatus of Fig. 1. Referring to the figures, a car 2 as an elevating body is disposed within a hoistway 1 such that the car 2 can be raised/lowered therein. A pair of car guide rails (not shown) for guiding the car 2 are installed within the hoistway 1. The car 2 is raised/lowered within the hoistway 1 while being guided by the car guide rails.

[0010] The car 2 has a floor portion 2a, a ceiling portion 2b disposed above the floor portion 2a, a front surface portion 2c provided with a car doorway 3, a back surface portion 2d opposed to the front surface portion 2c, and a pair of lateral surface portions 2e opposed to each other with respect to a frontage direction of the car doorway 3. The car 2 is disposed within the hoistway 1 such that the frontage direction of the car doorway 3 extends parallel to a width direction of the hoistway 1. The lateral surface portions 2e are disposed between the car guide rails, respectively. A line connecting the respective car guide rails extends parallel to the width direction of the hoistway 1 when the hoistway 1 is vertically projected.

[0011] A protrusion portion 4 protruding outside the car 2 is provided on an intermediate portion of one of the lateral surface portions 2e. The protrusion portion 4 ex-

tends horizontally from the car 2. The protrusion portion 4 is disposed outside a region of the car 2 on a vertical projection plane of the hoistway 1.

[0012] A driving device (hoisting machine) 5 for generating a driving force for raising/lowering the car 2 is provided in an upper portion of the hoistway 1. The driving device 5 has a driving device body 6 including a motor, and a driving sheave 7 rotated by the driving device body 6. The driving device 5 is designed as a low-profile hoisting machine having an axial dimension that is smaller than a radial dimension of the driving device body 6 or the driving sheave 7. The driving device 5 is disposed such that the axial direction thereof coincides with the width direction of the hoistway 1.

[0013] A plurality of main ropes 8 are looped around the driving sheave 7. The car 2 is suspended within the hoistway 1 by means of the respective main ropes 8. An outer peripheral portion of each of the main ropes 8 is covered with a material having a high coefficient of friction. Thus, a frictional force between the driving sheave 7 and each of the main ropes 8 is ensured.

[0014] A tension pulley 9 around which the respective main ropes 8 are looped is provided in a lower portion of the hoistway 1. The tension pulley 9 can be displaced with respect to the car guide rails. In this example, the tension pulley 9 is mounted to a rotating member that can rotate vertically with respect to the car guide rails. The tension pulley 9 is suspended by the respective main ropes 8. The tension pulley 9 thus applies a tensile force to each of the main ropes 8. Further, the tension pulley 9 is provided with a weight (not shown) for ensuring a predetermined magnitude of a tensile force to be applied to the main ropes 8.

[0015] The protrusion portion 4 is provided with an upper rope fastening portion 10 for connecting the respective main ropes 8 to the protrusion portion 4 above the protrusion portion 4, and a lower rope fastening portion 11 for connecting the respective main ropes 8 to the protrusion portion 4 below the protrusion portion 4. Each of the main ropes 8 has a first connection portion (one end) 8a connected to the upper rope fastening portion 10, and a second connection portion (the other end) 8b connected to the lower rope fastening portion 11. Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is sequentially looped around the driving sheave 7 and the tension pulley 9. That is, the elevator apparatus according to Embodiment 1 of the present invention is a counterweight-less elevator apparatus having no counterweight.

[0016] The driving device 5 and the tension pulley 9 are disposed outside the region of the car 2 on a vertical projection plane of the hoistway 1. The car 2 can be raised/lowered between an upper-limit position at which the ceiling portion 2b is higher than the position of the driving device 5 and a lower-limit position at which the position of the floor portion 2a is lower than the position of the tension pulley 9.

[0017] Note that, a raising/lowering mechanism 12 raising/lowering the car 2 within the hoistway 1 while suspending the car 2 has the driving device 5, the main ropes 8, and the tension pulley 9. The raising/lowering mechanism 12 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1.

[0018] Next, an operation will be described. When the driving device 5 is driven, the driving sheave 7 is rotated. The respective main ropes 8 are thus moved in a circulating manner, so the car 2 is raised/lowered within the hoistway 1. At this time, the car 2 is stably guided by the car guide rails.

[0019] In the elevator apparatus constructed as described above, the car 2 is provided with the protrusion portion 4 protruding from the lateral surface portion 2e of the car 2, and the first connection portion 8a and the second connection portion 8b of each of the main ropes 8 are connected to the protrusion portion 4. Therefore, the positions of the upper rope fastening portion 10 and the lower rope fastening portion 11, for connecting the respective main ropes 8 to the car 2, can be confined within a range of the height dimension of the car 2. Accordingly, spaces above and below the car 2 can be reduced by the height dimensions of the rope fastening portions 10 and 11, respectively. As a result, the dimension of the hoistway 1 in the height direction thereof can be reduced.

[0020] The raising/lowering mechanism 12 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. Therefore, while the car 2 is raised/lowered within the hoistway 1, neither the driving device 5 nor the tension pulley 9 interferes with the car 2 even when a part of the car 2 has reached a height at which the driving device 5 or the tension pulley 9 is installed. Accordingly, the range in which the car 2 can be raised/lowered can be enlarged within the hoistway 1. As a result, the dimension of the hoistway 1 in the height direction thereof can further be reduced.

[0021] The tension pulley 9, which is suspended by the respective main ropes 8, thereby applies a tensile force to each of the main ropes 8. Therefore, the tensile force can be applied to each of the main ropes 8 with a simple construction. As a result, a reduction in cost can be achieved.

[0022] The material having the high coefficient of friction is provided on the outer peripheral portion of each of the main ropes 8. Therefore, a frictional force between each of the main ropes 8 and the driving sheave 7 can be ensured. As a result, the main ropes 8 can be prevented from slipping with respect to the driving sheave 7.

Embodiment 2

[0023] Fig. 3 is a front view showing an elevator apparatus according to Embodiment 2 of the present invention. Fig. 4 is a lateral view showing the elevator apparatus of Fig. 3. Referring to the figures, the driving device 5 and the tension pulley 9 are disposed in the lower por-

tion of the hoistway 1. The driving device 5 is fixed with respect to the car guide rails (not shown). The tension pulley 9 can be displaced vertically with respect to the car guide rails. The tension pulley 9 is suspended by the respective main ropes 8.

[0024] A first return pulley 21 around which the respective main ropes 8 are looped is provided above the driving device 5 and the tension pulley 9. A second return pulley 22 around which the respective main ropes 8 are looped is provided in the upper portion of the hoistway 1. Each of the first return pulley 21 and the second return pulley 22 can rotate around a horizontal shaft fixed to the car guide rails. The driving device 5, the tension pulley 9, the first return pulley 21, and the second return pulley 22 are disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1.

[0025] The portion of each of the main ropes 8 between the driving sheave 7 and the tension pulley 9 is looped around the first return pulley 21. The portion of each of the main ropes 8 between the driving sheave 7 and the first connection portion 8a is looped around the second return pulley 22. That is, each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is sequentially looped around the second return pulley 22, the driving sheave 7, the first return pulley 21, and the tension pulley 9. Each of the main ropes 8 is guided from the driving sheave 7 to the first return pulley 21 and the second return pulley 22, so the looping angle of each of the main ropes 8 with respect to the driving sheave 7 is held equal to a predetermined angle.

[0026] A raising/lowering mechanism 23 for raising/lowering the car 2 within the hoistway 1 while suspending the car 2 has the driving device 5, the main ropes 8, the tension pulley 9, the first return pulley 21, and the second return pulley 22. The raising/lowering mechanism 23 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0027] In the elevator apparatus constructed as described above, the portion of each of the main ropes 8 between the driving sheave 7 and the tension pulley 9 is looped around the first return pulley 21. Therefore, the looping angle of each of the main ropes 8 with respect to the driving sheave 7 can be held equal to the predetermined angle, so each of the main ropes 8 can be prevented from slipping with respect to the driving sheave 7.

[0028] Since the driving device 5 is disposed in the lower portion of the hoistway 1, an operation of maintenance/inspection of the driving device 5 can be performed with ease. Further, components in the upper portion of the hoistway 1 can be disposed with ease while circumventing the car 2.

Embodiment 3

[0029] Fig. 5 is a lateral view showing an elevator apparatus according to Embodiment 3 of the present invention. Referring to the figure, a turning sheave 31, which is disposed apart from the driving sheave 7, is provided within the hoistway 1. The turning sheave 31 is disposed above the driving sheave 7. The turning sheave 31 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. In addition, the turning sheave 31 can rotate around a horizontal shaft fixed with respect to the car guide rails.

[0030] Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is sequentially looped around the second return pulley 22, the driving sheave 7, the turning sheave 31, the driving sheave 7, the first return pulley 21, and the tension pulley 9. That is, each of the main ropes 8 extending from the second return pulley 22 is looped around the driving sheave 7, then around the turning sheave 31, then around the driving sheave 7 again, and then is guided to the first return pulley 21.

[0031] Note that, a raising/lowering mechanism 32 for raising/lowering the car 2 within the hoistway 1 while suspending the car 2 has the driving device 5, the main ropes 8, the tension pulley 9, the first return pulley 21, the second return pulley 22, and the turning sheave 31. The raising/lowering mechanism 32 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. Embodiment 3 of the present invention is identical to Embodiment 2 of the present invention in other constructional details.

[0032] In the elevator apparatus constructed as described above, each of the main ropes 8 is looped around the driving sheave 7, then around the turning sheave 31, and then around the driving sheave 7 again. Therefore, the looping angle of each of the main ropes 8 with respect to the driving sheave 7 can further be increased, so each of the main ropes 8 can be prevented more reliably from slipping with respect to the driving sheave 7. In addition, a traction ability for raising/lowering the car 2 is enhanced. As a result, masses of the tension pulley 9 and the weight can be reduced, so the hoistway 1 can further be reduced in size.

Embodiment 4

[0033] Fig. 6 is a lateral view showing an elevator apparatus according to Embodiment 4 of the present invention. Referring to the figure, the driving device 5 and the turning sheave 31 are provided in the upper portion of the hoistway 1. The turning sheave 31 is disposed below the driving sheave 7. The turning sheave 31 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1.

[0034] Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is sequentially looped around the driving sheave 7, the turning sheave 31, the driving sheave 7, and the tension pulley 9. That is, each of the main ropes 8 extending from the first connection portion 8a is looped

around the driving sheave 7, then around the turning sheave 31, then around the driving sheave 7 again, and then is guided to the tension pulley 9.

[0035] A raising/lowering mechanism 41 for raising/lowering the car 2 within the hoistway 1 while suspending the car 2 has the driving device 5, the main ropes 8, the tension pulley 9, and the turning sheave 31. The raising/lowering mechanism 41 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. Embodiment 4 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0036] Even in the elevator apparatus constructed as described above, each of the main ropes 8 is looped around the driving sheave 7, then around the turning sheave 31, and then around the driving sheave 7 again. Therefore, the looping angle of each of the main ropes 8 with respect to the driving sheave 7 can further be increased, so each of the main ropes 8 can be prevented more reliably from slipping with respect to the driving sheave 7. In addition, the traction ability for raising/lowering the car 2 is enhanced. Therefore, the masses of the tension pulley 9 and the weight can be reduced, so the hoistway 1 can also be reduced in size.

Embodiment 5

[0037] Fig. 7 is a lateral view showing an elevator apparatus according to Embodiment 5 of the present invention. Referring to the figure, a return pulley 51 is provided in the upper portion of the hoistway 1. The return pulley 51 can rotate around a horizontal shaft fixed with respect to the car guide rails.

[0038] The driving device 5 and the tension pulley 9 are provided in the lower portion of the hoistway 1. The tension pulley 9 is disposed apart from the driving sheave 7. The tension pulley 9 is disposed above the driving sheave 7. The driving device 5 is fixed to the car guide rails. The tension pulley 9 can be displaced with respect to the car guide rails.

[0039] Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is sequentially looped around the return pulley 51, the driving sheave 7, the tension pulley 9, and the driving sheave 7. That is, each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is looped around the driving sheave 7 via the return pulley 51, then around the tension pulley 9, and then around the driving sheave 7 again.

[0040] An urging device 52 for urging the tension pulley 9 in such a direction as to apply a tensile force to each of the main ropes 8 is provided within the hoistway 1. In this example, the urging device 52 has an urging spring 53 as an elastic body for urging the tension pulley 9 in a direction away from the driving sheave 7.

[0041] Note that, a raising/lowering mechanism 54 for raising/lowering the car 2 within the hoistway 1 while suspending the car 2 has the driving device 5, the main ropes 8, the tension pulley 9, and the urging device 52. The raising/lowering mechanism 54 is disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. Embodiment 5 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0042] In the elevator apparatus constructed as described above, the urging device 52 urges the tension pulley 9 in such a direction as to apply a tensile force to each of the main ropes 8, so the tension pulley 9 can be urged in an arbitrary direction with a predetermined urging force. Thus, the return pulley or the like for allowing the tension pulley 9 to be suspended by the respective main ropes 8 can be omitted. The weight for ensuring a predetermined magnitude of a tensile force to be applied to each of the main ropes 8 can also be omitted. Accordingly, the number of parts can be reduced. As a result, a reduction in cost and space of the hoistway 1 can be achieved.

[0043] Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is looped around the driving sheave 7 via the return pulley 51, then around the tension pulley 9, and then around the driving sheave 7 again. Therefore, the main ropes 8 can be provided within the hoistway 1 such that they are always bent in the same direction. That is, the main ropes 8 can be prevented from being bent reversely. Thus, life of the respective main ropes 8 can be prolonged.

[0044] Each of the main ropes 8 is looped around the driving sheave 7, then around the tension pulley 9, and then around the driving sheave 7 again. Therefore, the looping angle of each of the main ropes 8 with respect to the driving sheave 7 can be increased, so each of the main ropes 8 can be prevented from slipping with respect to the driving sheave 7.

[0045] Note that, while in the foregoing example the driving device 5 and the tension pulley 9 are disposed in the lower portion of the hoistway 1, and the return pulley 51 is disposed in the upper portion of the hoistway 1, it is also appropriate that the return pulley 51 be disposed in the lower portion of the hoistway 1, and that the driving device 5 and the tension pulley 9 be disposed in the upper portion of the hoistway 1. In this case, the tension pulley 9 is disposed below the driving sheave 7. Each of the main ropes 8, which extends from the first connection portion 8a to the second connection portion 8b, is provided within the hoistway 1 so as to be sequentially looped around the driving sheave 7, the tension pulley 9, the driving sheave 7, and the return pulley 51.

Embodiment 6

[0046] Fig. 8 is a front view showing an elevator apparatus according to Embodiment 6 of the present invention. Fig. 9 is a lateral view showing the elevator apparatus of Fig. 8. Referring to the figures, the car 2 is provided with a plurality of (two in this example) protrusion

portions 61 and 62, which protrude from the lateral surface portions 2e to the outside of the car 2. The protrusion portions 61 and 62 extend horizontally from the car 2 in a direction away from each other. The protrusion portions 61 and 62 are disposed point-symmetrically with respect to the center of gravity of the car 2 on the vertical projection plane of the hoistway 1.

[0047] A plurality of (two in this example) raising/lowering mechanisms 63 and 64 corresponding to the protrusion portions 61 and 62, respectively, are provided in one lateral portion and the other lateral portion, respectively, within the hoistway 1. The raising/lowering mechanisms 63 and 64 are identical in construction to the raising/lowering mechanism 41 according to Embodiment 4 of the present invention. The raising/lowering mechanisms 63 and 64 are disposed outside the region of the car 2 on the vertical projection plane of the hoistway 1. The car 2 is disposed between the raising/lowering mechanisms 63 and 64.

[0048] The protrusion portion 61 is provided with an upper rope fastening portion 65 for connecting the respective main ropes 8 to the protrusion portion 61 above the protrusion portion 61, and a lower rope fastening portion 66 for connecting the respective main ropes 8 to the protrusion portion 61 below the protrusion portion 61. The protrusion portion 62 is provided with an upper rope fastening portion 67 for connecting the respective main ropes 8 to the protrusion portion 62 above the protrusion portion 62, and a lower rope fastening portion 68 for connecting the respective main ropes 8 to the protrusion portion 62 below the protrusion portion 62.

[0049] In the raising/lowering mechanism 63, the first connection portion 8a of each of the main ropes 8 is connected to the upper rope fastening portion 65, and the second connection portion 8b of each of the main ropes 8 is connected to the lower rope fastening portion 66. In the other raising/lowering mechanism 64, the first connection portion 8a of each of the main ropes 8 is connected to the upper rope fastening portion 67, and the second connection portion 8b of each of the main ropes 8 is connected to the lower rope fastening portion 68. The car 2 is suspended within the hoistway 1 by means of the respective main ropes 8 in the respective raising/lowering mechanisms 63 and 64.

[0050] The car 2 is raised/lowered by driving forces of the respective driving devices 5 in the raising/lowering mechanisms 63 and 64. The driving sheaves 7 are rotated in synchronization with each other. Embodiment 6 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0051] Next, an operation will be described. The driving sheaves 7 are driven by the driving devices 5 to be rotated in synchronization with each other. Thus, the main ropes 8 in the raising/lowering mechanisms 63 and 64 are moved in a circulating manner in synchronization with one another. Thus, the car 2 is raised/lowered within the hoistway 1. At this moment, since the main ropes 8 are moved in a circulating manner in synchronization with one another, the car 2 is raised/lowered stably.

[0052] In the elevator apparatus constructed as described above, the car 2 is provided with the plurality of the protrusion portions 61 and 62 protruding from the lateral surface portions 2e of the car 2, and the plurality of the raising/lowering mechanisms 63 and 64 corresponding to the protrusion portions 61 and 62, respectively, are provided within the hoistway 1. The first connection portion 8a and the second connection portion 8b of each of the main ropes 8 in the raising/lowering mechanism 63 are connected to the protrusion portion 61, and the first connection portion 8a and the second connection portion 8b of each of the main ropes 8 in the raising/lowering mechanism 64 are connected to the protrusion portion 62. Therefore, the car 2 can be suspended at a plurality of points, thus making it possible to raise/lower the car 2 stably. The common car 2 is raised/lowered by driving forces of the plurality of the driving devices 5, so the driving devices 5 can be reduced in size. Thus, spaces for installing the driving devices 5 can be reduced. As a result, the entire elevator apparatus can be reduced in size.

[0053] Note that, while in the foregoing example the raising/lowering mechanisms 63 and 64 for suspending the car 2 within the hoistway 1 such that the car 2 can be raised/lowered are identical in construction to the raising/lowering mechanism 41 according to Embodiment 4 of the present invention, the respective raising/lowering mechanisms may adopt the construction of the raising/lowering mechanism 12 according to Embodiment 1 of the present invention, the raising/lowering mechanism 23 according to Embodiment 2 of the present invention, the raising/lowering mechanism 32 according to Embodiment 3 of the present invention, or the raising/lowering mechanism 54 according to Embodiment 5 of the present invention. In this manner as well, the car 2 can be raised/lowered stably, and the entire elevator apparatus can be reduced in size.

[0054] In the foregoing embodiments of the present invention, the material having the high coefficient of friction is provided on the outer peripheral portion of each of the main ropes 8. However, the material having the high coefficient of friction may be provided on an outer peripheral portion of the driving sheave 7. Alternatively, the material having the high coefficient of friction may be provided on the outer peripheral portion of each of the main ropes 8 and the outer peripheral portion of the driving sheave. In this manner as well, the frictional force between each of the main ropes 8 and the driving sheave 7 can be increased, so each of the main ropes can be prevented from slipping with respect to the driving sheave 7. The increase in the frictional force between each of the main ropes 8 and the driving sheave 7 leads to enhancement of traction ability. Therefore, the magnitude of the tensile force applied to the main ropes 8 can be reduced, so the tension pulley 9 and the urging device 52 can also be reduced in size.

Claims

1. An elevator apparatus, **characterized in that** the elevator apparatus comprises:

   an elevating body that can be raised/lowered within a hoistway; and
   a raising/lowering mechanism having a driving device including a driving sheave, a main rope, which is looped around the driving sheave, for suspending the elevating body within the hoistway, a tension pulley, around which the main rope is looped for applying a tensile force to the main rope, for raising/lowering the elevating body by a driving force of the driving device, and **in that**:
   the elevating body is provided with a protrusion portion protruding from a lateral surface portion of the elevating body; and
   the main rope is connected at one end of the main rope and the other end of the main rope to the protrusion portion.

2. The elevator apparatus according to Claim 1, **characterized in that** the raising/lowering mechanism is provided within the hoistway so that the raising/lowering mechanism is disposed outside a region of the elevating body when the hoistway is vertically projected.

3. The elevator apparatus according to Claim 1 or 2, **characterized in that** the tension pulley is suspended by the main rope and thereby applies a tensile force to the main rope.

4. The elevator apparatus according to Claim 3, **characterized in that** the raising/lowering mechanism further comprises a return pulley around which a portion of the main rope between the driving sheave and the tension pulley is looped.

5. The elevator apparatus according to any one of Claims 1 to 4, **characterized in that**:

   the raising/lowering mechanism further comprises a turning sheave disposed apart from the driving sheave; and
   the main rope is looped around the driving sheave, then around the turning sheave, and then around the driving sheave again.

6. The elevator apparatus according to Claim 1 or 2, **characterized in that** the raising/lowering mechanism further comprises an urging device for urging the tension pulley in such a direction as to apply a tensile force to the main rope.

7. The elevator apparatus according to Claim 6, **characterized in that**:

   the tension pulley is disposed apart from the driving sheave; and
   the main rope is looped around the driving sheave, then around the tension pulley, and then around the driving sheave again.

8. The elevator apparatus according to any one of Claims 1 to 7, **characterized in that** an outer peripheral portion of at least one of the main rope and the driving sheave is provided with a material having a high coefficient of friction which is interposed between the main rope and the driving sheave.

9. The elevator apparatus according to any one of Claims 1 to 8, **characterized in that**:

   the elevating body is suspended within the hoistway by a plurality of the raising/lowering mechanisms such that the elevating body can be raised/lowered;
   the elevating body is provided with a plurality of the protrusion portions which protrude from lateral surface portions of the elevating body such that the protrusion portions correspond to the raising/lowering mechanisms, respectively; and the protrusion portions each have one end and another end of the main rope in a corresponding one of the raising/lowering mechanisms connected to the protrusion portions, respectively.

FIG. 1

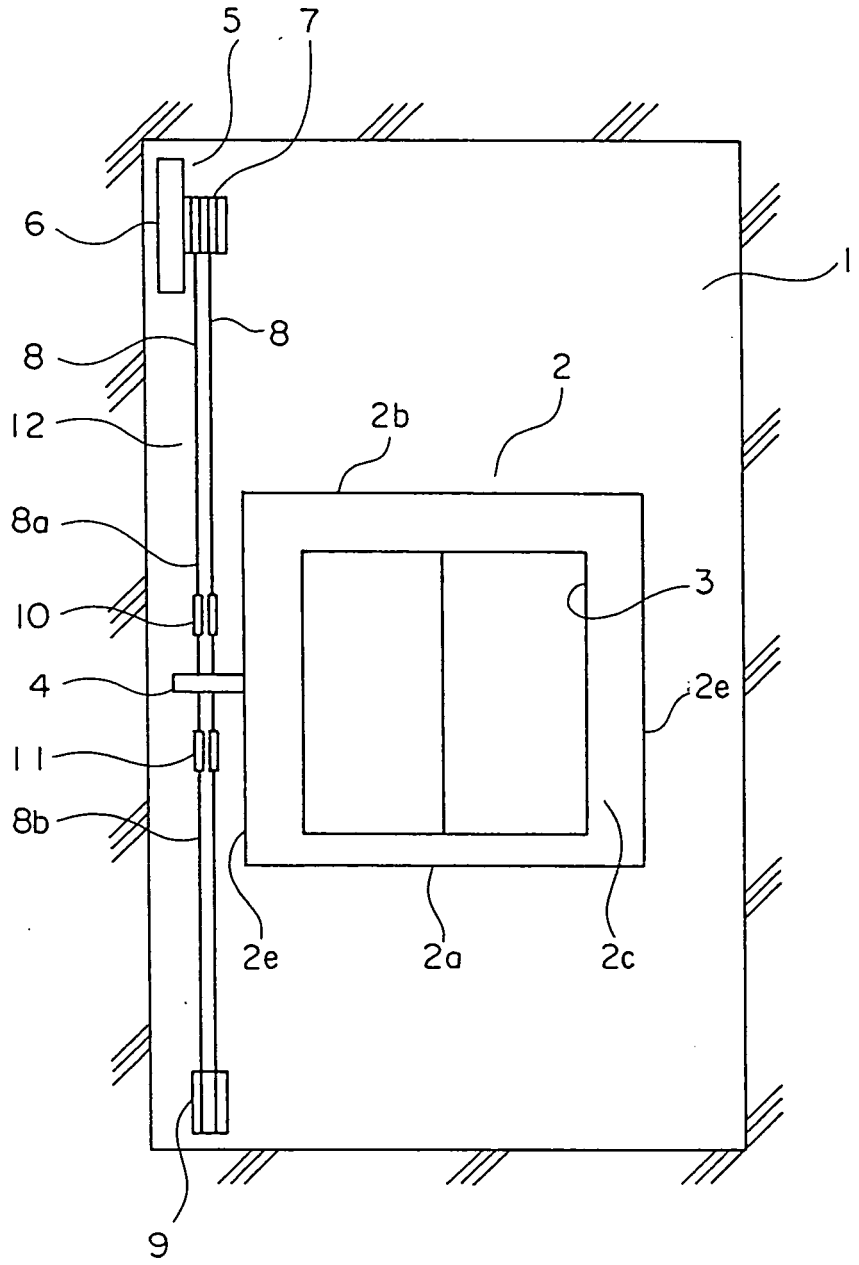


FIG. 2

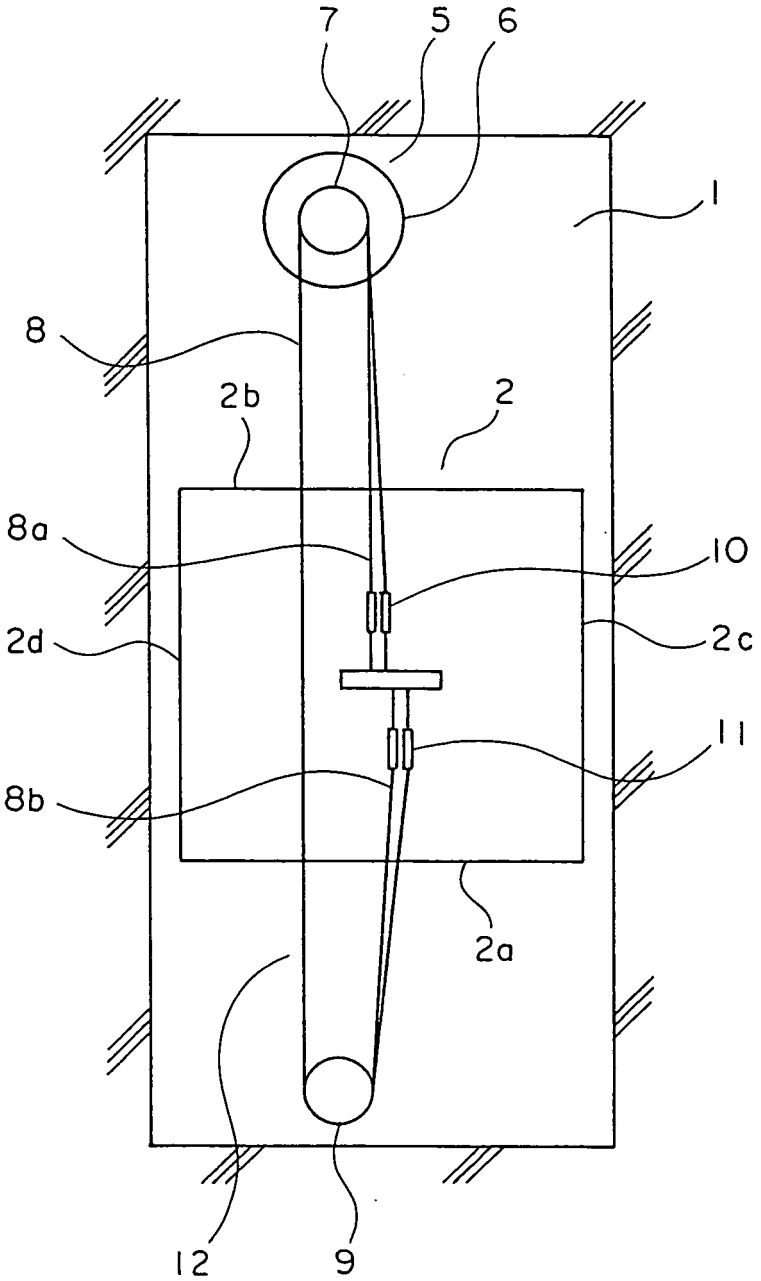


FIG. 3

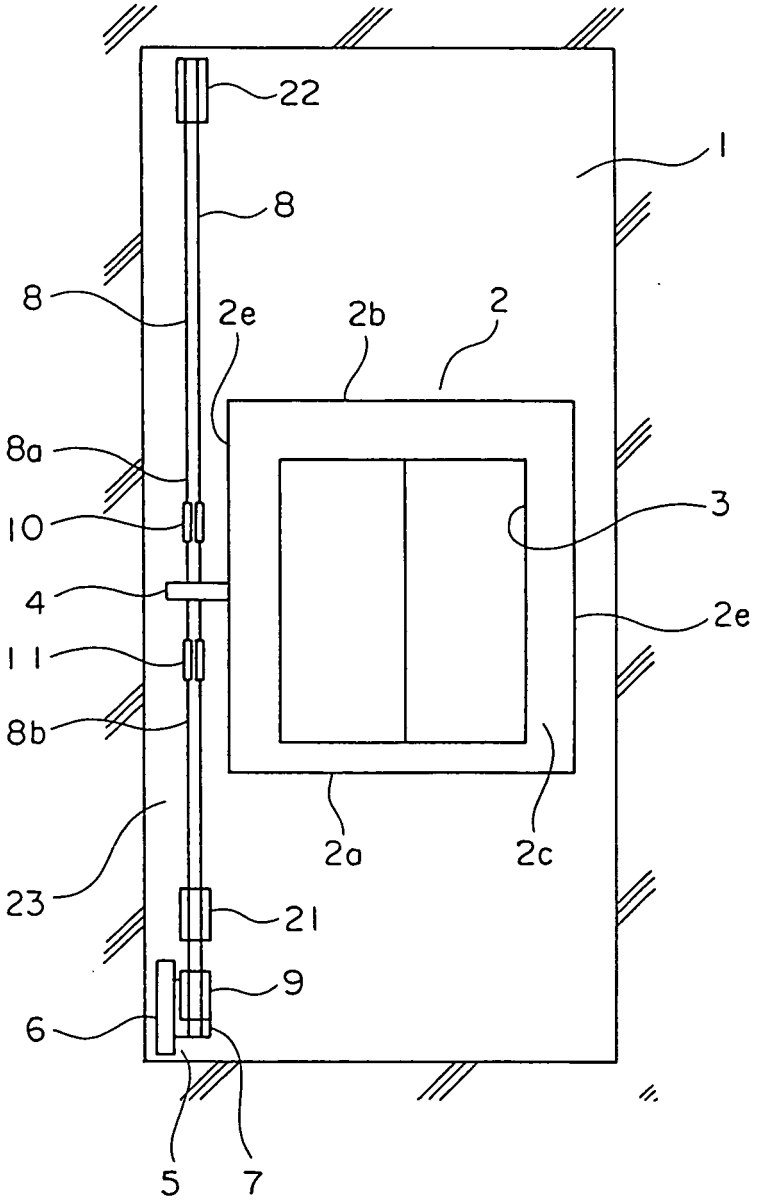


FIG. 4

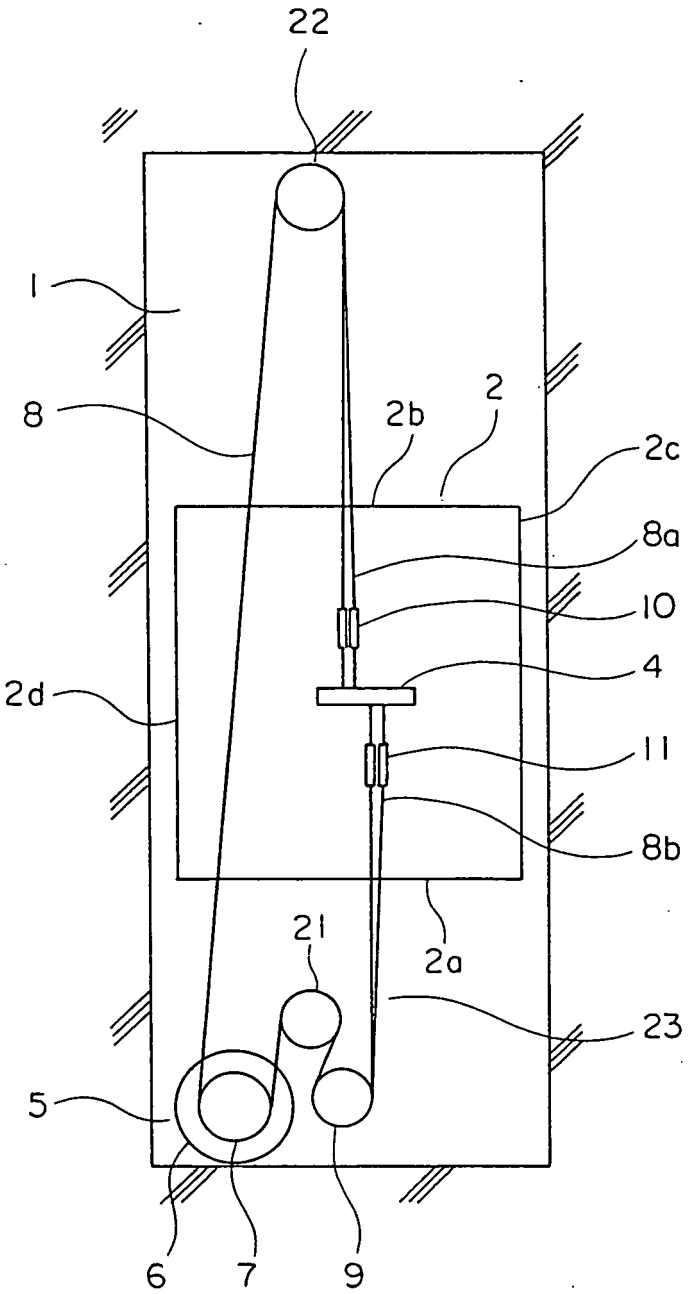


FIG. 5

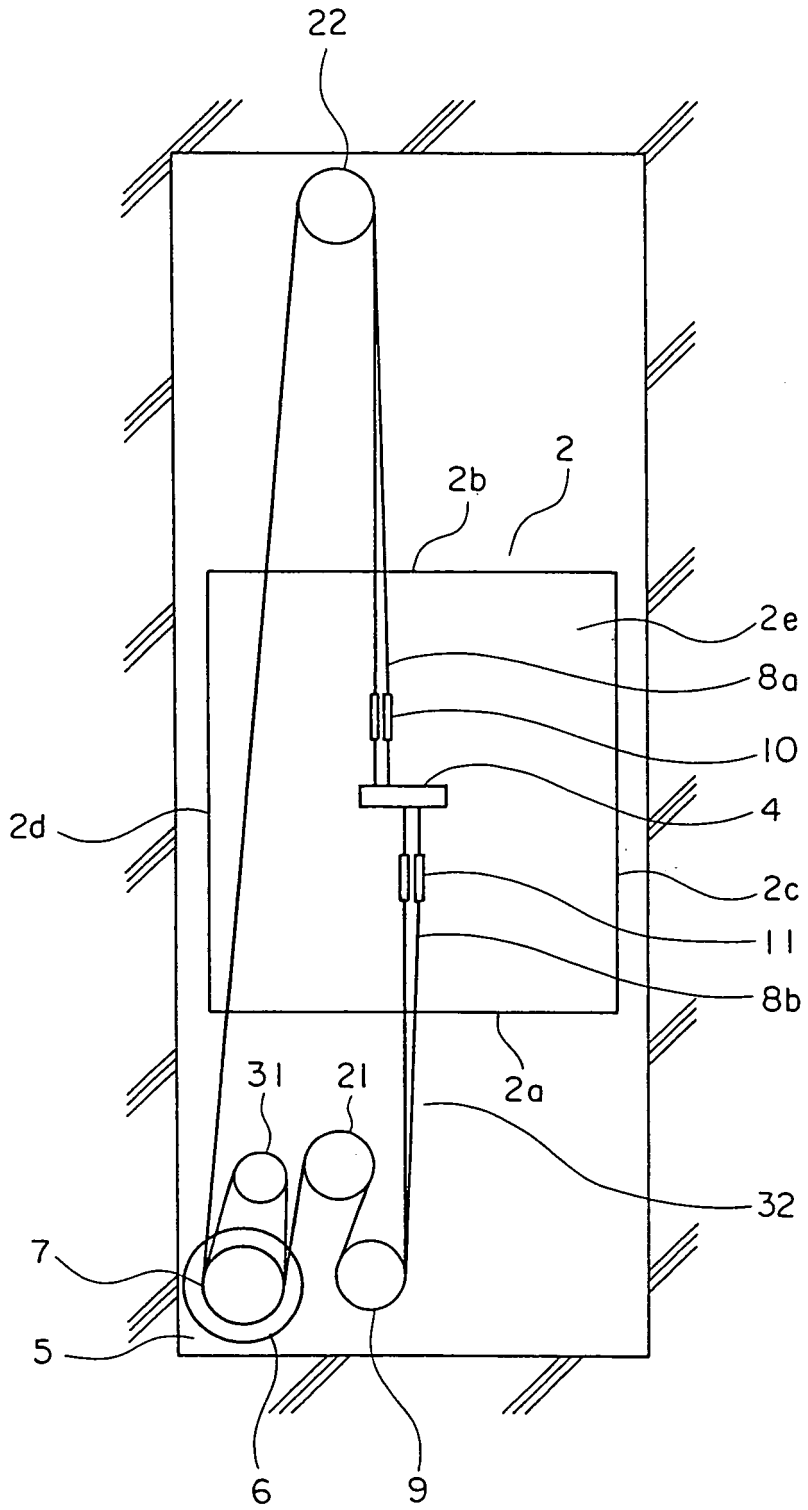


FIG. 6

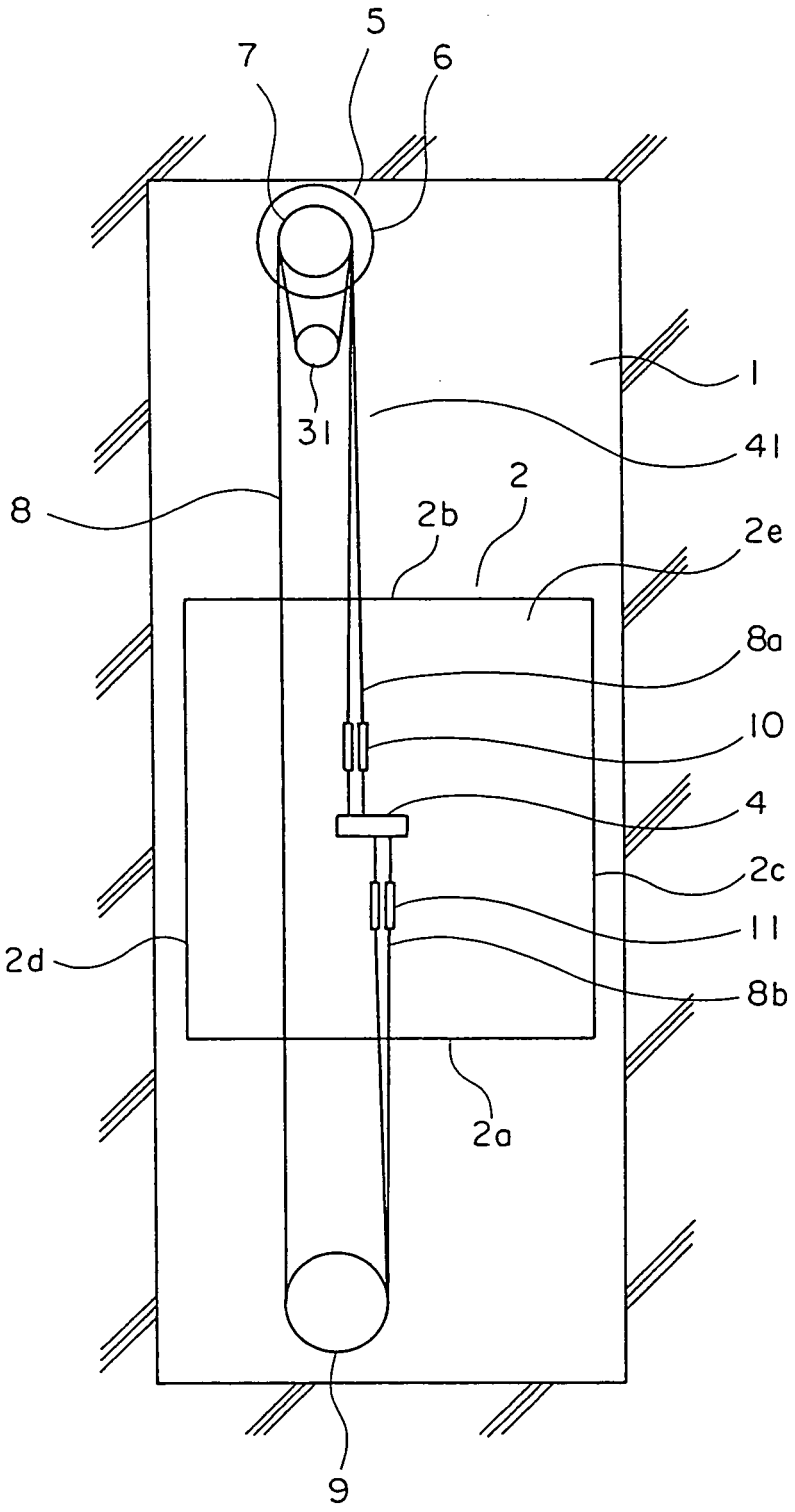


FIG. 7

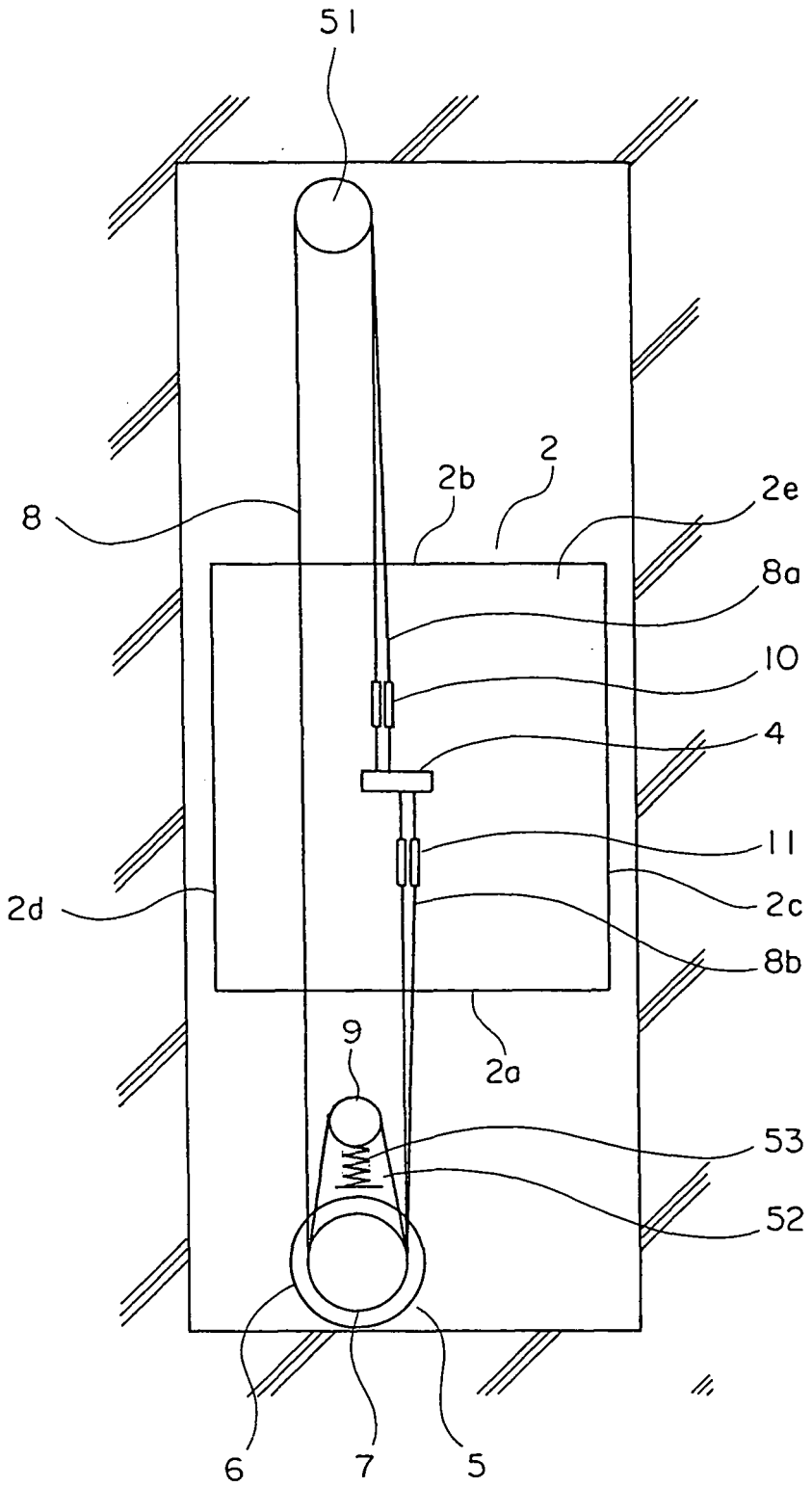


FIG. 8

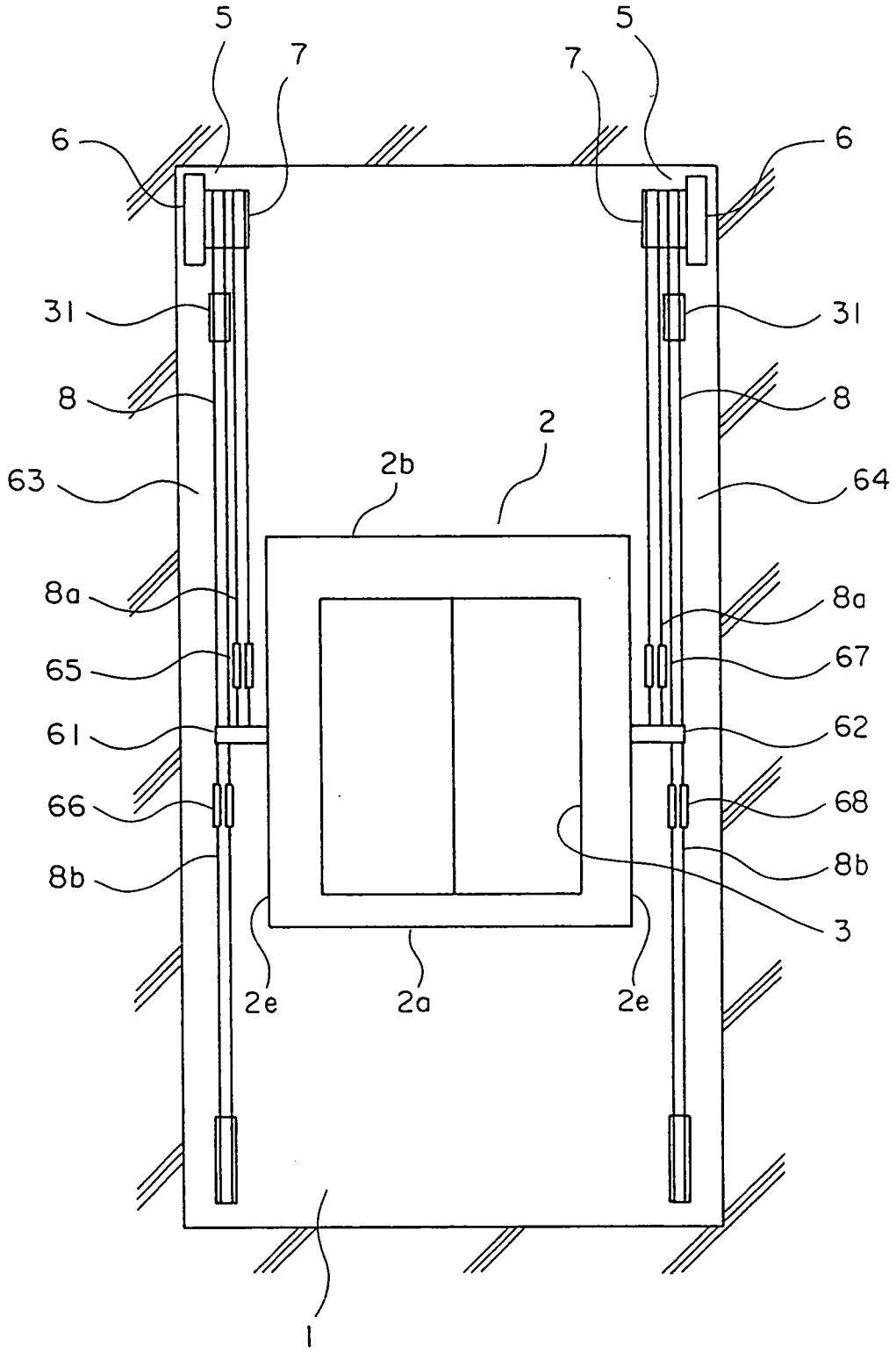
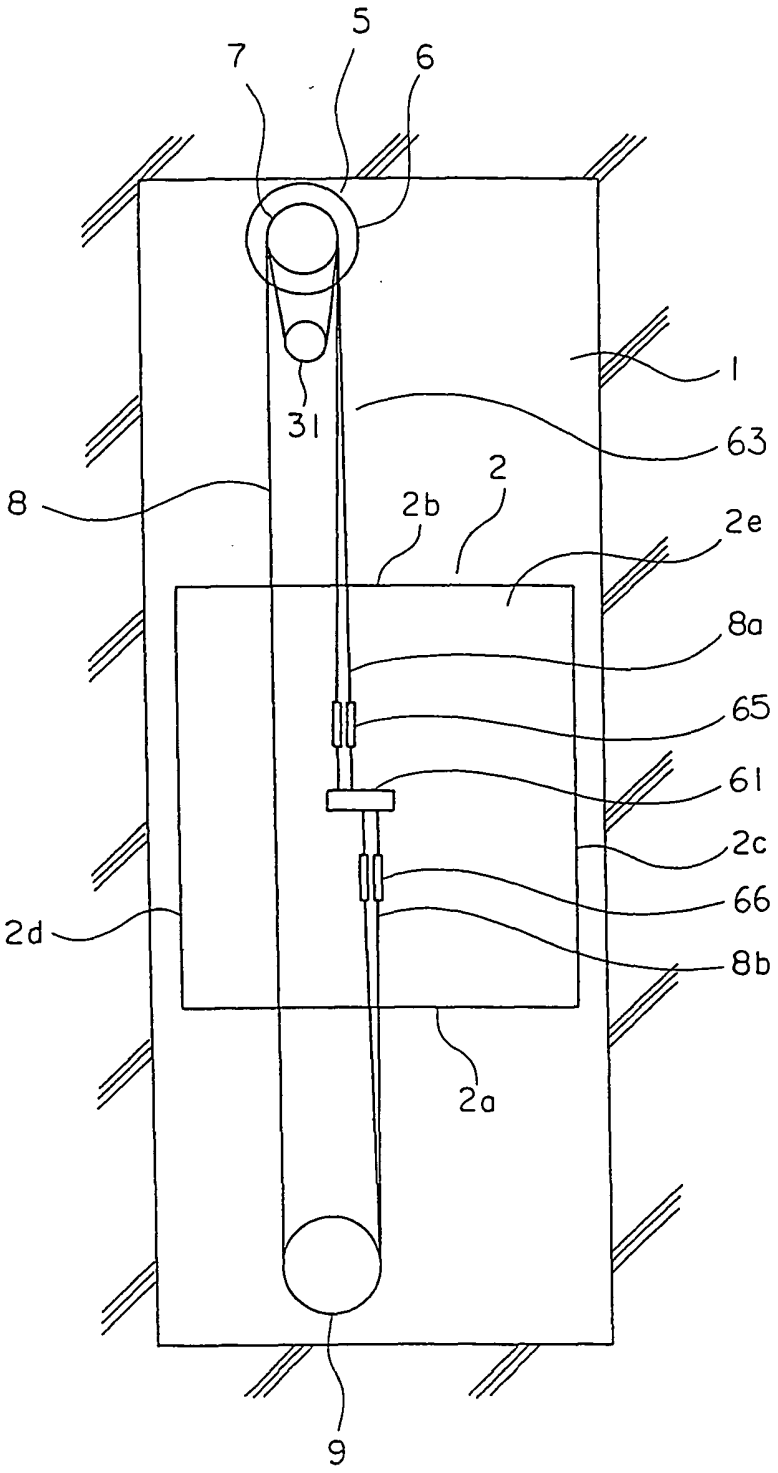


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015494

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B7/08

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	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-67365 A (Otis Elevator Co.), 04 March, 2004 (04.03.04), Pay attention to Par. No. [0009]; Fig. 1 (Family: none)	1,4-5
A	JP 2001-524060 A (Kone Corp.), 27 November, 2001 (27.11.01), Pay attention to page 6, line 12 to page 9, line 5; Figs. 1 to 3 & US 6364063 B1 & WO 98/29327 A1	1,3,6-8
A	JP 11-310372 A (Toshiba Elevator and Building Systems Corp.), 09 November, 1999 (09.11.99), Pay attention to Par. Nos. [0066] to [0068]; Figs. 9 to 10 & US 6247557 B1 & EP 0953538 A2	1-2,9

☒ 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	Date of mailing of the international search report
20 July, 2005 (20.07.05)	02 August, 2005 (02.08.05)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/015494

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 42939/1984(Laid-open No. 154652/1985) (NEC Corp.), 15 October, 1985 (15.10.85), Pay attention to Claims; description; page 4, lines 7 to 19; Figs. 1 to 2 (Family: none)	1
A	JP 51-4749 A (JOHNS AND WAYGOOD LTD.), 16 January, 1976 (16.01.76), Page 2, lower left column, line 15 to page 3, upper right column, line 20; Figs. 1 to 3 & GB 1442584 A & DE 2506670 A1 & FR 2266654 A1	1

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2004067365 A **[0003]**