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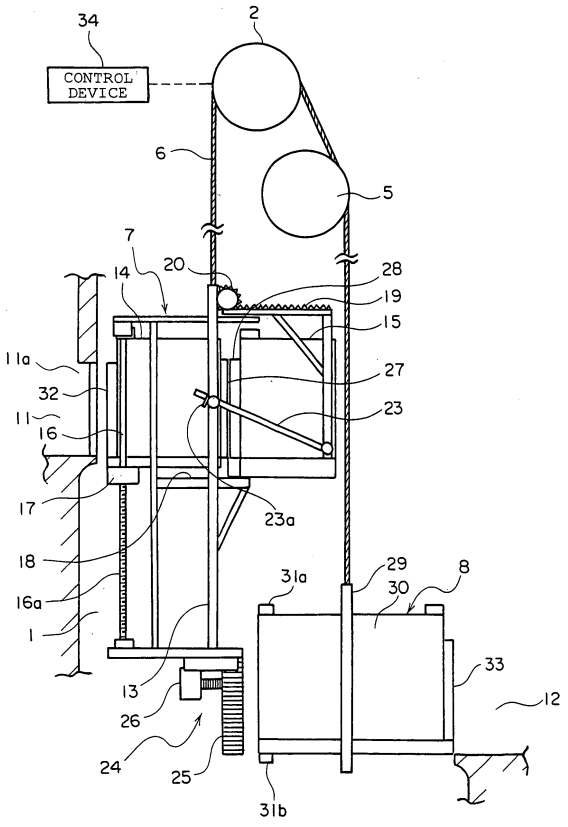
(54) ELEVATOR DEVICE

(57) In an elevator apparatus, a first elevating body and a second elevating body are suspended by a main rope to be raised/lowered within a hoistway by a drive device. The first elevating body has a first car chamber capable of accommodating passengers, and a second car chamber capable of accommodating passengers. The first car chamber and the second car chamber are each relatively displaceable to a first position at which the first car chamber and the second car chamber are aligned with each other horizontally, and to a second position at which the first car chamber and the second car chamber are aligned with each other vertically. When the first car chamber and the second car chamber are each displaced to the second position, the first elevating body and the second elevating body are allowed to move past each other.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an elevator apparatus having a structure in which a first elevating body and a second elevating body are suspended by a main rope to be raised/lowered within a hoistway.

Background Art

[0002] In a conventional double deck elevator, a first elevator car and a second elevator car, which are disposed so as to vertically align with each other, are suspended from a suspension beam. Owing to a driving force of a motor mounted on the suspension beam, a clearance between the first elevator car and the second elevator car is changed (e.g., see Patent Document 1).

[0003] Patent Document 1: JP 2000-309482 A

Disclosure of the Invention

Problem to be solved by the Invention

[0004] In the conventional double deck elevator constructed as described above, about twice a car floor area can be ensured while a hoistway area is the same as a usual case. However, there are some restrictions. For example, the car located above cannot be stopped at a lowermost floor, and the car located below cannot be stopped at an uppermost floor. That is, the conventional double deck elevator is insufficient in convenience.

[0005] The present invention has been made to solve the above-mentioned problem, and it is therefore an object of the present invention to obtain an elevator apparatus which makes it possible to reduce a space for a hoistway and prevent a deterioration in operational convenience while ensuring a sufficient car floor area.

Means for solving the Problem

[0006] An elevator apparatus according to the present invention includes: a drive device having a drive sheave; a main rope wound around the drive sheave; and first and second elevating bodies suspended by the main rope, for being raised/lowered within a hoistway by the drive device, in which: the first elevating body has a first car chamber capable of accommodating passengers and a second car chamber capable of accommodating passengers; and the first car chamber and the second car chamber are each relatively displaceable to a first position at which the first car chamber and the second car chamber are aligned with each other horizontally, and to a second position at which the first car chamber and the second car chamber are aligned with each other vertically.

Further, an elevator apparatus according to the present invention includes: a first drive device having a first drive sheave; a first main rope wound around the first drive sheave; first and second elevating bodies suspended by the first main rope, for being raised/lowered within a hoistway by the first drive device; a second drive device having a second drive sheave; a second main rope wound around the second drive sheave; and third and fourth elevating bodies suspended by the second main rope, for being raised/lowered within the hoistway by the second drive device, in which: the first elevating body has a first car chamber capable of accommodating passengers and a second car chamber capable of accommodating passengers; the first car chamber and the second car chamber are each relatively displaceable to a first position at which the first car chamber and the second car chamber are aligned with each other horizontally, and to a second position at which the first car chamber and the second car chamber are aligned with each other vertically; the first elevating body overlaps with third elevating body in a vertical projection plane when the first car chamber and the second car chamber are each located at the first position; and the first elevating body is allowed to move past the third elevating body when the first car chamber and the second car chamber are each located at the second position.

Brief Description of the Drawings

[0007]

[Fig. 1] Fig. 1 is a lateral view showing an elevator apparatus according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a plan view showing the elevator apparatus of Fig. 1.

[Fig. 3] Fig. 3 is a front view showing a first car of Fig. 1.

[Fig. 4] Fig. 4 is a lateral view showing the first car of Fig. 3.

[Fig. 5] Fig. 5 is a lateral view showing a state in which a second car chamber of Fig. 4 has moved to a second position.

[Fig. 6] Fig. 6 is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention.

[Fig. 7] Fig. 7 is a lateral view showing an elevator apparatus according to Embodiment 3 of the present invention.

[Fig. 8] Fig. 8 is a lateral view showing an elevator apparatus according to Embodiment 4 of the present invention.

[Fig. 9] Fig. 9 is a lateral view showing an elevator apparatus according to Embodiment 5 of the present invention.

[Fig. 10] Fig. 10 is a plan view showing the elevator apparatus of Fig. 9.

[Fig. 11] Fig. 11 is a lateral view showing an elevator apparatus according to Embodiment 6 of the present invention.

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 lateral view showing an elevator apparatus according to Embodiment 1 of the present invention. Fig. 2 is a plan view showing the elevator apparatus of Fig. 1. Fig. 3 is a front view showing a first car of Fig. 1. Fig. 4 is a lateral view showing the first car of Fig. 3. Fig. 5 is a lateral view showing a state in which a second car chamber of Fig. 4 has moved to a second position.

[0010] Referring to Figs. 1 to 5, a drive device 2 is installed in an upper portion of a hoistway 1. The drive device 2 has a drive device body 3 including a motor and a brake, and a drive sheave 4 rotated by the drive device body 3. A low-profile hoisting machine whose dimension is smaller in an axial direction than in a direction perpendicular to the axial direction is employed as the drive device 2. The drive device 2 is disposed such that a rotational shaft of the drive sheave 4 extends horizontally. In addition, the drive device 2 is supported by a plurality of support beams (not shown) fixed to the upper portion of the hoistway 1.

[0011] A deflector pulley 5 is installed in the vicinity of the drive device 2. A plurality of main ropes 6 are wound around the drive sheave 4 and the deflector pulley 5.

[0012] A first car 7 as a first elevating body is connected to first ends of the main ropes 6. A second car 8 as a second elevating body is connected to second ends of the main ropes 6. The first car 7 and the second car 8, which are suspended within the hoistway 1 according to a 1:1 roping method by the main ropes 6, are raised/lowered within the hoistway 1 owing to a driving force of the drive device 2.

[0013] A pair of first guide rails 9a and 9b for guiding the raising/lowering of the first car 7 and a pair of second guide rails 10a and 10b for guiding the raising/lowering of the second car 8 are installed within the hoistway 1.

[0014] A building in which this elevator apparatus is installed is provided with a plurality of first landings 11 for utilizing the first car 7, and a plurality of second landings 12 for utilizing the second car 8. A first landing doorway 11a is provided between each of the first landings 11 and the hoistway 1. A second landing doorway 12a is provided between each of the second landings 12 and the hoistway 1.

[0015] The first landing doorway 11a is disposed facing a front surface of the first car 7 and a back surface of the second car 8. The second landing doorway 12a is disposed facing a front surface of the second car 8 and a back surface of the first car 7.

[0016] The first car 7 has a first car frame 13 to which the main ropes 6 are connected, and a first car chamber 14 and a second car chamber 15 (front car chamber and rear car chamber), which are supported by the first car frame 13 and can accommodate passengers, respectively. The first car chamber 14 and the second car chamber 15 are each relatively displaceable to a first position (Figs. 1 to 4) at which the first car chamber 14 and the second car chamber 15 are aligned with each other horizontally, and to a second position (Fig. 5) at which the first car chamber 14 and the second car chamber 15 are aligned with each other vertically.

[0017] To be more specific, the second car chamber 15 is adjacently disposed behind the first car chamber 14 when being located at the first position. The first car chamber 14 is vertically movable with respect to the second car chamber 15, and the second car chamber 15 is longitudinallymovable. The secondcar chamber 15 is adjacently disposed above the first car chamber 14 when being located at the second position.

[0018] When the first car chamber 14 and the second car chamber 15 are each located at the first position, the second car chamber 15 overlaps with the second car 8 in a vertical projection plane. By moving the first car chamber 14 and the second car chamber 15 to the second position, the vertical projection area of the first car 7 is reduced to about half of that of the first car 7 at the time when the first car chamber 14 and the second car chamber 15 are each located at the first position, so the first car 7 is allowed to move past the second car 8. The first car 7 is provided with a plurality of car chamber position sensors (not shown) for detecting the completion of displacement of the first car chamber 14 and the second car chamber 15.

[0019] A pair of guide rods 16, which extend parallel to each other to guide vertical movements of the first car chamber 14, are fixed to the first car frame 13. The guide rods 16 are provided with threaded portions 16a, respectively. A pair of screw-type raising/lowering devices 17, which are screwed onto the threaded portions 16a respectively to vertically move the first car chamber 14 along the guide rods 16, are mounted on the first car chamber 14. The screw-type raising/lowering devices 17 may be designed to rotate either the guide rods 16 or nut portions (not shown) screwed onto the threaded portions 16a.

[0020] A pair of support beams 18 for supporting the second car chamber 15 and guiding longitudinal movements of the second car chamber 15 are horizontally fixed to the first car frame 13. A pair of racks 19 are fixed to an upper portion of the second car chamber 15. A pair of gear-type feed devices 20 for longitudinally moving the second car chamber 15 are mounted on the first car frame 13. Each of the gear-type feed devices 20 has a pinion 21 engaged with each of the racks 19, and a motor 22 for rotating the pinion 21.

[0021] The support beam 18 is not provided over an entire moving range of the second car chamber 15, so as to prevent the first car 7 from interfering with the second car 8 in moving past the second car 8. Accordingly, when the second car chamber 15 is located at the first

position, only a front end of the second car chamber 15 is located on the support beam 18, and the other portion of the second car chamber 15 protrudes backward from the support beam 18. Thus, a pair of coupling members 23 for holding the second car chamber 15 horizontal when the second car chamber 15 is located at the first position are coupled between the second car chamber 15 and the first car frame 13.

[0022] The coupling members 23 are disposed on both sides of the second car chamber 15, respectively. The respective coupling members 23 are turnably coupled to the second car chamber 15. Further, the respective coupling members 23 are turnably and slidably coupled to the first car frame 13. Still further, the respective coupling members 23 are provided with stoppers 23a for preventing the coupling members 23 from falling out from their coupling portions to the first car frame 13.

[0023] A balance adjusting device 24 is mounted on a lower portion of the first car frame 13. The balance adjusting device 24 has a balance adjusting weight 25 displaceable in a longitudinal direction of the first car 7, and a motor 26 for longitudinally moving the balance adjusting weight 25 in accordance with the position of the second car chamber 15. The balance adjusting device 24 restrains the center of gravity of the first car 7 from moving through displacement of the first car chamber 14 and the second car chamber 15.

[0024] The first car chamber 14 and the second car chamber 15 are provided respectively with a first inner doorway and a second inner doorway, which face each other when the first car chamber 14 and the second car chamber 15 are each located at the first position. The first car chamber 14 is provided with a first inner door 27 for opening/closing the first inner doorway. The second car chamber 15 is provided with a second inner door 28 for opening/closing the second inner doorway.

[0025] The second car 8 has a second car frame 29 to which the main ropes 6 are connected, and a third car chamber 30 which is supported by the second car frame 29 and can accommodate passengers. Distance sensors 31a and 31b for detecting a distance between the second car 8 and the first car 7 are mounted on an upper portion and a lower portion of the second car 8, respectively. For example, sensors utilizing infrared rays or ultrasonic waves are used as the distance sensors 31a and 31b.

[0026] The first car frame 13 is provided with a plurality of first guide shoes engaged with the first guide rails 9a and 9b. The second car frame 29 is provided with a plurality of second guide shoes engaged with the second guide rails 10a and 10b.

[0027] A front surface of the first car chamber 14 is provided with a first car doorway, which faces the first landing doorway 11a when the elevator apparatus is located on a floor. The first car chamber 14 is provided with a first car door 32 for opening/closing the first car doorway. A front surface of the third car chamber 30 is provided with a second car doorway, which faces the second landing doorway 12a when the elevator apparatus is located on a floor. The third car chamber 30 is provided with a second car door 33 for opening/closing the second car doorway.

[0028] The drive device 2, the screw-type raising/lowering device 17, the gear-type feed device 20, and the balance adjusting device 24 are controlled by a control device 34. The first car 7 is provided with a first car door control portion (not shown) for controlling the opening/closing of the first car door 32, and a first inner door control portion (not shown) for controlling the opening/closing of the first inner door 27 and a second inner door control portion (not shown) for controlling the opening/closing of the second inner door 28. The first inner door 27 and the second inner door 28 are controlled to be opened/closed independently of each other. The second car 8 is provided with a second car door control portion (not shown) for controlling the opening/closing of the second car door 33.

[0029] The first car door control portion, the second car door control portion, the first inner door control portion, and the second inner door control portion are controlled by the control device 34. Signals from various sensors (car chamber position sensors, distance sensors 31a and 31b, car speed sensors, door sensors, and the like) are input to the control device 34.

[0030] Next, an operation will be described. The first car 7 and the second car 8 are raised/lowered within the hoistway 1 owing to a driving force of the drive device 2. The first car chamber 14 and the second car chamber 15 are each normally located at the first position and aligned with each other longitudinally. On the other hand, when the first car 7 and the second car 8 move past each other, the first car chamber 14 and the second car chamber 15 are each moved to the second position to be adjacent to each other vertically.

[0031] In a case where, for example, shuttle operation is performed in a high-rise building, the first car chamber 14 and the second car chamber 15 can be displaced relatively gently. As a result, a deterioration in riding comfort can be prevented.

[0032] In moving the first car chamber 14 and the second car chamber 15 from the first position to the second position, the first car chamber 14 is first moved downward by the screw-type raising/lowering devices 17. After that, the second car chamber 15 is moved forward by the gear-type feed devices 20. On the contrary, in moving the first car chamber 14 and the second car chamber 15 from the second position to the first position, the second car chamber 15 is first moved backward by the gear-type feed devices 20. After that, the first car chamber 14 is moved upward by the screw-type raising/lowering devices 17.

[0033] As a matter of course, the inner doors 27 and 28 are closed while the first car chamber 14 and the second car chamber 15 are in operation as described above. On the contrary, the first car chamber 14 and the second car chamber 15 are prohibited from being moved until it is confirmed by the door sensors or the like that the inner doors 27 and 28 have been closed. The inner doors 27 and 28 may be closed in principle except when the first

car chamber 14 and the second car chamber 15 are stopped at a landing floor, or be open when the first car chamber 14 and the second car chamber 15 are each located at the first position.

[0034] In a case where the first car chamber 14 and the second car chamber 15 have not each moved to the second position when the distance between the first car 7 and the second car 8, which has been detected by the distance sensors 31a and 31b, is within a predetermined range, the first car 7 and the second car 8 are stopped as an emergency measure (or stopped at a nearest floor if possible).

Further, when the first car 7 and the second car 8 are stopped at different floors, the first car chamber 14 and the second car chamber 15 may each be moved to the first position regardless of the distance between the first car 7 and the second car 8. However, when the distance between the first car 7 and the second car 8 is within the predetermined range, the first car 7 and the second car 8 are prohibited from running until the first car chamber 14 and the second car chamber 15 are each moved to the second position.

[0035] In the elevator apparatus constructed as described above, when the first car chamber 14 and the second car chamber 15 are each located at the first position, the first car 7 can thereby be so disposed as to overlap with the second car 8 in the vertical projection plane. When the first car chamber 14 and the second car chamber 15 are each displaced to the second position, the first car 7 is thereby allowed to move past the second car 8. Accordingly, the space for the hoistway can be reduced while ensuring a sufficient car floor area. In addition, when the first car chamber 14 and the second car chamber 15 are each located at the first position, they can be stopped at both an uppermost floor and a lowermost floor. As a result, a deterioration in operational convenience can be prevented.

[0036] The first car chamber 14 and the second car chamber 15 respectively have the first inner doorway and the second inner doorway, which face each other when the first car chamber 14 and the second car chamber 15 are each located at the first position, and the first inner door 27 and the second inner door 28 for opening/closing the first inner doorway and the second inner doorway, respectively. Therefore, permission for a movement between the first car chamber 14 and the second car chamber 15 can be appropriately supervised.

[0037] In addition, the first inner door 27 and the second inner door 28 are controlled to be opened/closed independently of each other. Therefore, passengers can be loaded/unloaded from/onto the first landing 11 as is the case with the double deck elevator with the first car chamber 14 and the second car chamber 15 each located at the second position. That is, passengers can be loaded/unloaded regardless of whether the first car chamber 14 and the second car chamber 15 are each located at the first position or the second position, so the degree of freedom of an operational method can be enhanced. When the elevator apparatus arrives on a floor with the first car chamber 14 and the second car chamber 15 each located at the second position, the clearance between the first car chamber 14 and the second car chamber 15 can also be adjusted in accordance with an inter-floor dimension.

[0038] Moreover, the second car 8 having the third car chamber 30 is suspended at the second ends of the main ropes 6, so the transport capacity of the elevator apparatus can be enhanced drastically. In this case, twice the transport capacity can be obtained with about 1.5 times the space for a hoistway, in comparison with an elevator having a general structure.

[0039] The first car 7 is provided with the balance adjusting device 24 of a movable type, so a balance can be restrained from being upset through displacement of the first car chamber 14 and the second car chamber 15. The balance adjusting device 24 may detect not only the positions of the first car chamber 14 and the second car chamber 15 but also, for example, the loads within the first car chamber 14 and the second car chamber 15 so as to carry out a balance adjustment more appropriately.

[0040] In the foregoing example, the first car chamber 14 and the second car chamber 15 are displaced independently of each other. However, the first car chamber and the second car chamber may be displaced in an interlocking manner.

Displacement of the first car chamber 14 and the second car chamber 15 may be controlled to be completed before the first car 7 and the second car 8 start running, or to be realized while the first car 7 and the second car 8 are running.

In addition, displacement of the first car chamber 14 and the second car chamber 15 may be realized in accordance with a call registration at a landing or within the first car chamber 14 or the second car chamber 15. A determination on the opening/closing of the inner doors 27 and 28 may also be made in accordance with a call registration at a landing or within the first car chamber 14 or the second car chamber 15.

Embodiment 2

[0041] Reference will be made next to Fig. 6, which is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention. Referring to Fig. 6, a second car 35 as the second elevating body is suspended at the second ends of the main ropes 6. The second car 35, as well as the first car 7, has the first car chamber 14 and the second car chamber 15, which are each displaceable to the first position and the second position. In other words, the second car 35, which is identical in structure to the first car 7, is disposed back to back with the first car 7 within the hoistway 1.

[0042] When the first car chamber 14 and the second car chamber 15 of the first car 7 and the first car chamber 14 and the second car chamber 15 of the second car 35 are each located at the first position, the second car

chamber 15 of the first car 7 and the second car chamber 15 of the second car 35 overlap with each other in the vertical projection plane. When the first car chamber 14 and the second car chamber 15 of the first car 7 and the first car chamber 14 and the second car chamber 15 of the second car 35 are each moved to the second position, the first car 7 is thereby allowed to move past the second car 35 . Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0043] In the elevator apparatus constructed as described above, the second car 35 is also structured to have the first car chamber 14 and the second car chamber 15. Therefore, about twice the transport capacity can be obtained with substantially the same space for a hoistway as in an elevator having a general structure.

Embodiment 3

[0044] Reference will be made next to Fig. 7, which is a lateral view showing an elevator apparatus according to Embodiment 3 of the present invention. Referring to Fig. 7, a counterweight 36 as the second elevating body is suspended at the second ends of the main ropes 6. When the first car chamber 14 and the second car chamber 15 are each located at the first position, the second car chamber 15 and the counterweight 36 overlap with each other in the vertical projection plane. When the first car chamber 14 and the second car chamber 15 are each moved to the second position, the first car 7 is thereby allowed to move past the counterweight 36. Embodiment 3 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0045] In the elevator apparatus constructed as described above, operational control can be performed only in accordance with a call registration for the car 7. Therefore, an efficient service can be provided to passengers utilizing the car 7.

Embodiment 4

[0046] Reference will be made next to Fig. 8, which is a lateral view showing an elevator apparatus according to Embodiment 4 of the present invention. Referring to Fig. 8, a plurality of first car suspending pulleys 37a are provided on a lower portion of the first car 7. A plurality of second car suspending pulleys 37b are provided on a lower portion of the second car 35. The first ends and the second ends of the main ropes 6 are connected to a cleat beam 38, which is fixed to the upper portion of the hoistway 1.

[0047] Each of the main ropes 6 is sequentially wound, from the first end side, around the first car suspending pulley 37a, the drive sheave 4, the deflector pulley 5, and the second car suspending pulley 37b. That is, the first car 7 and the second car 35 are suspended within the hoistway 1 according to a 2:1 roping method by the main ropes 6. Embodiment 4 of the present invention is identical to Embodiment 2 of the present invention in other constructional details.

[0048] Even in the elevator apparatus constructed as described above according to the 2: 1 roping method, adoption of the first car chamber 14 and the second car chamber 15, which are each displaceable to the first position and the second position, makes it possible to reduce the space for the hoistway 1 while ensuring a sufficient car floor area.

[0049] The 2:1 roping method may also be applied to the elevator apparatuses according to Embodiments 1 and 3 of the present invention.

The roping method in the elevator apparatus according to the present invention should not be limited to the 1:1 roping method or the 2:1 roping method.

Embodiment 5

[0050] Reference will be made next to Figs. 9 and 10, which are a lateral view showing an elevator apparatus according to Embodiment 5 of the present invention and a plan view showing the elevator apparatus of Fig. 9, respectively. A first drive device 40 and a second drive device 41 for raising/lowering the first car 7 and the second car 35 are disposed in the upper portion of the hoistway 1. The first drive device 40 and the second drive device 41, which are constructed as low-profile hoisting machines respectively, are disposed apart from each other in a width direction of the cars 7 and 35.

[0051] The first drive device 40 has a first drive device body 42 including a motor and a brake, and a first drive sheave 43 rotated by the first drive device body 42. The second drive device 41 has a second drive device body 44 including a motor and a brake, and a second drive sheave 45 rotated by the second drive device body 44. The first drive device 40 and the second drive device 41 are disposed such that rotational shafts of the drive sheaves 43 and 45 extend horizontally, and that the drive device bodies 42 and 44 face each other.

[0052] A first main rope 46 is wound around the first drive sheave 43. A second main rope 47 is wound around the second drive sheave 45. The first main rope 46 and the second main rope 47 are connected at first ends thereof to a lower portion of the first car 7 via both sides thereof. The first main rope 46 and the second main rope 47 are connected at second ends thereof to a lower portion of the second car 35 via both sides thereof. That is, the first car 7 and the second car 35 are suspended according to the 1:1 roping method by the first main rope 46 and the second main rope 47.

[0053] A first upper shock absorber 48 for absorbing a shock caused in an unlikely event of a collision of the first car 7 with a top portion of the hoistway 1 is mounted on an upper of the first car 7. A first lower shock absorber 49 for absorbing a shock caused in the unlikely event of a collision of the first car 7 with the second car 35 is mounted on a lower portion of the first car 7.

[0054] A second upper shock absorber 50 for absorb-

ing a shock caused in an unlikely event of a collision of the second car 35 with the first car 7 is mounted on an upper portion of the second car 35. A second lower shock absorber 51 for absorbing a shock caused in the unlikely event of a.collision of the second car 35 with a bottom portion of the hoistway 1 is mounted on a lower portion of the second car 35. It is possible to use as these shock absorbers 48 to 51, for example, spring-loaded shock absorbers, pneumatic shock absorbers, or hydraulic shock absorbers. Embodiment 5 of the present invention is identical to Embodiment 2 of the present invention in other constructional details.

[0055] Even in the twin-drive type elevator apparatus employing the first drive device 40 and the second drive device 41 as described above, adoption of the first car chamber 14 and the second car chamber 15, which are each displaceable to the first position and the second position, makes it possible to reduce the space for the hoistway 1 while ensuring a sufficient car floor area.
The shock absorbers 49 and 50 for absorbing a shock caused upon a collision between the first car 7 and the second car 35 are used, so components can be prevented from being damaged should the first car 7 and the second car 35 collide with each other for some reason.

Embodiment 6

[0056] Reference will be made next to Fig. 11, which is a lateral view showing an elevator apparatus according to Embodiment 6 of the present invention. Referring to Fig. 11, a first drive device 52 and a second drive device 53 are installed within the hoistway 1. The first drive device 52 has a first drive device body including a motor and a brake, and a first drive sheave rotated by the first drive device body. The second drive device 53 has a second drive device body including a motor and a brake, and a second drive sheave rotated by the second drive device body.

[0057] A first deflector pulley 54 is installed in the vicinity of the first drive device 52. A plurality of first main ropes 55 are wound around the first drive sheave and the first deflector pulley 54. A second deflector pulley 56 is installed in the vicinity of the second drive device 53. A plurality of second main ropes 57 are wound around the second drive sheave and the second deflector pulley 56.

[0058] A first car 58 as the first elevating body is connected to first ends of the first main ropes 55. A first counterweight 59 as the second elevating body is connected to second ends of the first main ropes 55. The first car 58 and the first counterweight 59, which are suspended within the hoistway 1 according to the 1:1 roping method by the first main ropes 55, are raised/lowered within the hoistway 1 owing to a driving force of the first drive device 52.

[0059] A second car 60 as a third elevating body is connected to first ends of the second main ropes 57. A second counterweight 61 as a fourth elevating body is connected to second ends of the second main ropes 57. The second car 60 and the second counterweight 61, which are suspended within the hoistway 1 according to the 1:1 roping method by the second main ropes 57, are raised/lowered within the hoistway 1 owing to a driving force of the second drive device 53.

[0060] The first counterweight 59 is so disposed beside the first car 58 as to face a lateral surface of the first car 58 when being located at the same height as the first car 58. The second counterweight 61 is so disposed beside the second car 60 as to face a lateral surface of the second car 60 when being located at the same height as the second car 60.

[0061] The first car 58 and the second car 60 are identical in structure to the first car 7 according to Embodiment 1 of the present invention, so description of the first car 58 and the second car 60 is omitted herein. The first car 58 and the second car 60 overlap with each other in the vertical projection plane when the first car chamber 14 and the second car chamber 15 in the first car 58 and the first car chamber 14 and the second car chamber 15 in the second car 60 are both located at the first position. Conversely, the first car 58 and the second car 60 can move past each other when the first car chamber 14 and the second car chamber 15 in the first car 58 and the first car chamber 14 and the second car chamber 15 in the second car 60 are both located at the second position.

[0062] In the elevator apparatus constructed as described above, when the first car chamber 14 and the second car chamber 15 are each located at the first position, the first car 58 and the second car 60 can thereby be so disposed as to overlap with each other in the vertical projection plane. When the first car chamber 14 and the second car chamber 15 are each displaced to the second position, the first car 58 and the second car 60 are thereby allowed to move past each other. Accordingly, the space for the hoistway 1 can be reduced while ensuring a sufficient car floor area. Besides, when the first car chamber 14 and the second car chamber 15 are each located at the first position, they can be stopped at both the uppermost floor and thelowermostfloor. As a result, a deterioration in operational convenience can be prevented.

[0063] The operation of the first car 58 can be controlled in accordance with only a call registration for the first car 58, and the operation of the second car 60 can be controlled in accordance with only a call registration for the second car 60. Therefore, an efficient service can be provided to passengers utilizing the first car 58 and the second car 60.

[0064] The second car may be structured to have a single car chamber as is the case with the second car 8 according to Embodiment 1 of the present invention.
The second elevating body and the fourth elevating body may not be designed as the counterweights but as cars.

[0065] In addition, the drive devices for displacing the first car chamber and the second car chamber should not be limited to the screw-type raising/lowering devices or the gear-type feed devices. For example, various types

of drive devices such as rope-type drive devices, pantograph-type drive devices, and hydraulic drive devices can be employed.

Claims

1. An elevator apparatus, comprising:

a drive device having a drive sheave;
a main rope wound around the drive sheave; and
first and second elevating bodies suspended by the main rope, for being raised/lowered within a hoistway by the drive device, wherein:

the first elevating body has a first car chamber capable of accommodating passengers and a second car chamber capable of accommodating passengers; and
the first car chamber and the second car chamber are each relatively displaceable to a first position at which the first car chamber and the second car chamber are aligned with each other horizontally, and to a second position at which the first car chamber and the second car chamber are aligned with each other vertically.

2. An elevator apparatus according to Claim 1, wherein the first car chamber and the second car chamber respectively have a first inner doorway and a second inner doorway, which face each other when the first car chamber and the second car chamber are each located at the first position, and a first inner door and a second inner door for opening/closing the first inner doorway and the second inner doorway, respectively.

3. An elevator apparatus according to Claim 1, wherein the second car chamber is adj acently disposed behind the first car chamber when being located at the first position.

4. An elevator apparatus according to Claim 3, wherein the first car chamber is vertically movable with respect to the second car chamber, and
the second car chamber is movable forward and backward.

5. An elevator apparatus according to Claim 4, wherein the second car chamber is adj acently disposed above the first car chamber when being located at the second position.

6. An elevator apparatus according to Claim 1, wherein the second elevating body has a third car chamber capable of accommodating passengers.

7. An elevator apparatus according to Claim 1, wherein the second elevating body, as well as the first elevating body, has the first car chamber and the second car chamber, which are each displaceable to the first position and the second position.

8. An elevator apparatus according to Claim 1, wherein the second elevating body is a counterweight.

9. An elevator apparatus according to Claim 1, wherein at least one of the first elevating body and the second elevating body is mounted with a shock absorber for absorbing a shock caused upon a collision between the first elevating body and the second elevating body.

10. An elevator apparatus, comprising:

a first drive device having a first drive sheave;
a first main rope wound around the first drive sheave;
first and second elevating bodies suspended by the first main rope, for being raised/lowered within a hoistway by the first drive device;
a second drive device having a second drive sheave;
a second main rope wound around the second drive sheave; and
third and fourth elevating bodies suspended by the second main rope, for being raised/lowered within the hoistway by the second drive device, wherein:

the first elevating body has a first car chamber capable of accommodating passengers and a second car chamber capable of accommodating passengers;
the first car chamber and the second car chamber are each relatively displaceable to a first position at which the first car chamber and the second car chamber are aligned with each other horizontally, and to a second position at which the first car chamber and the second car chamber are aligned with each other vertically;
the first elevating body overlaps with the third elevating body in a vertical projection plane when the first car chamber and the second car chamber are each located at the first position; and
the first elevating body is allowed to move past the third elevating body when the first car chamber and the second car chamber are each located at the second position.

11. An elevator apparatus according to Claim 10, wherein:

the second elevating body is a first counterweight;
the third elevating body is a car; and
the fourth elevating body is a second counterweight.

12. An elevator apparatus according to Claim 10, wherein the third elevating body, as well as the first elevating body, has the first car chamber and the second car chamber, which are each displaceable to the first position and the second position.

FIG. 1

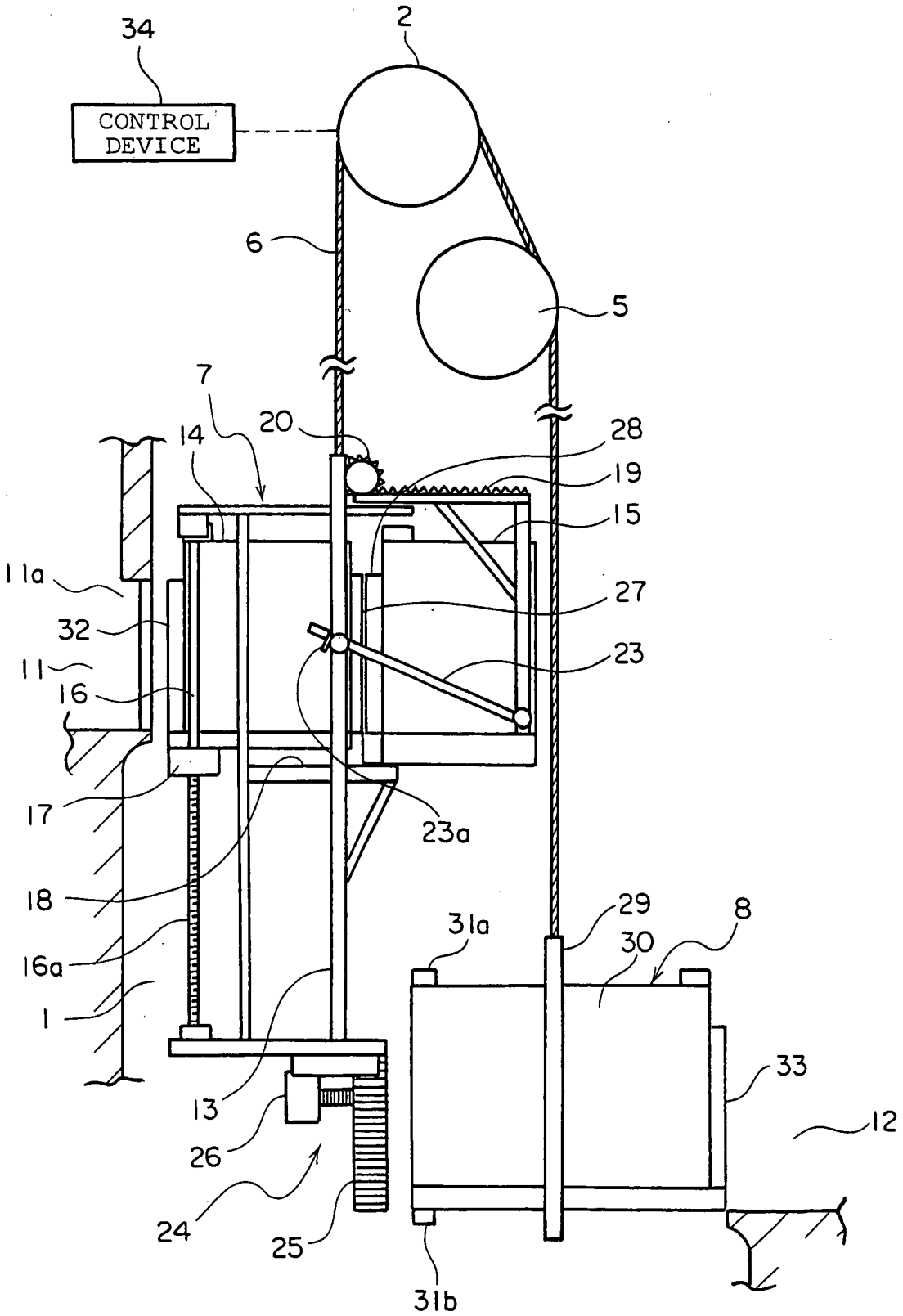
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FIG. 2

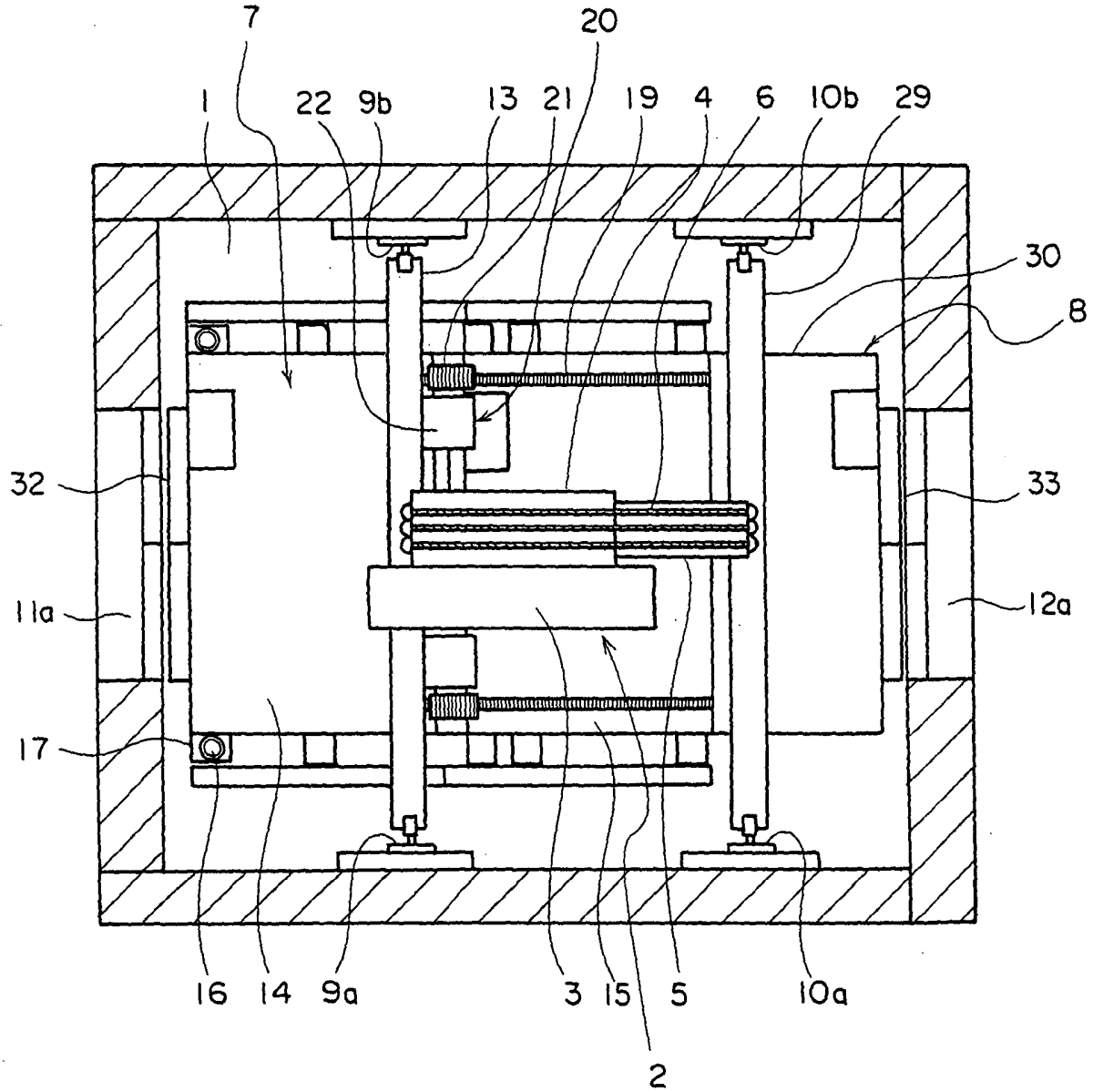
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FIG. 3

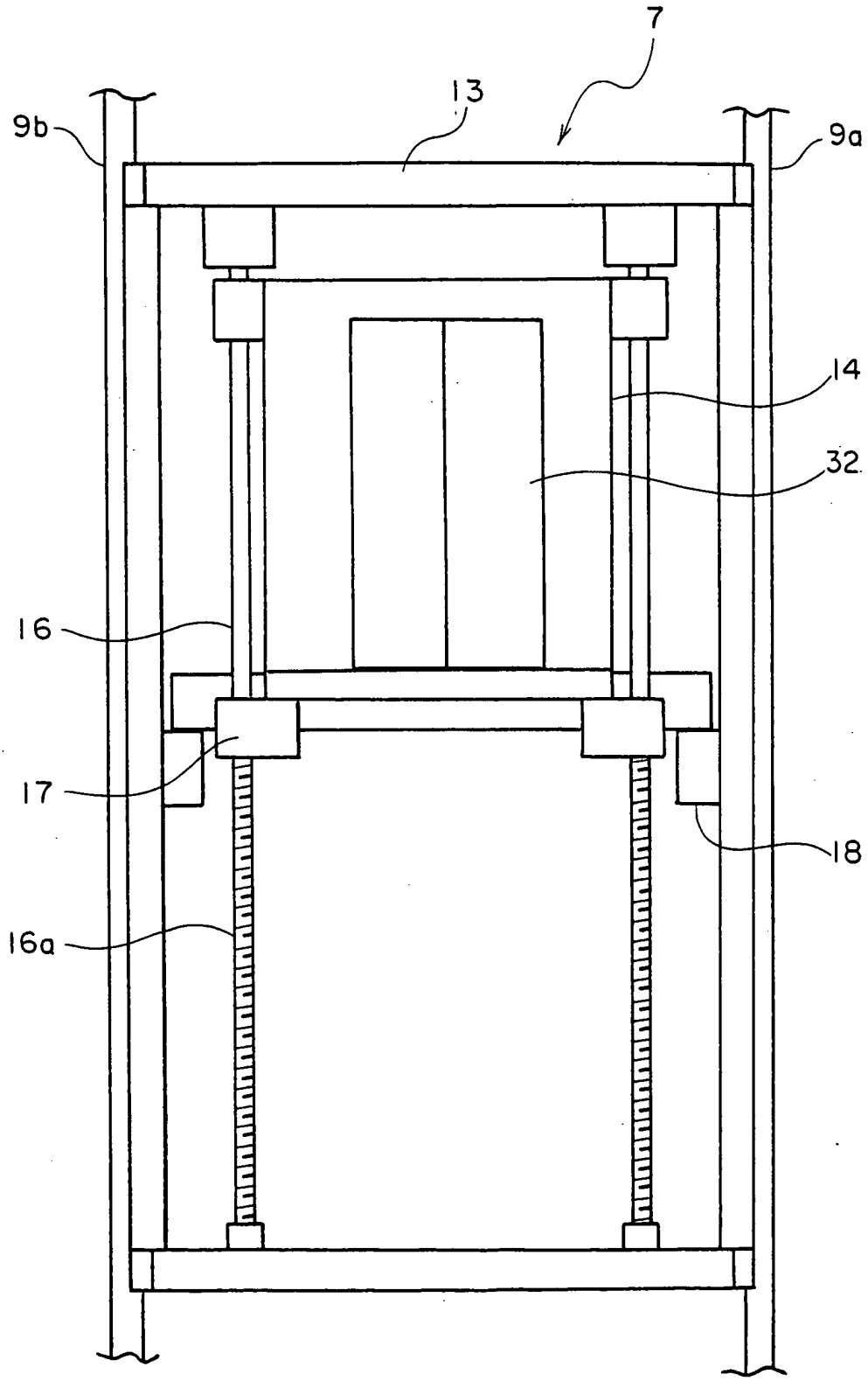
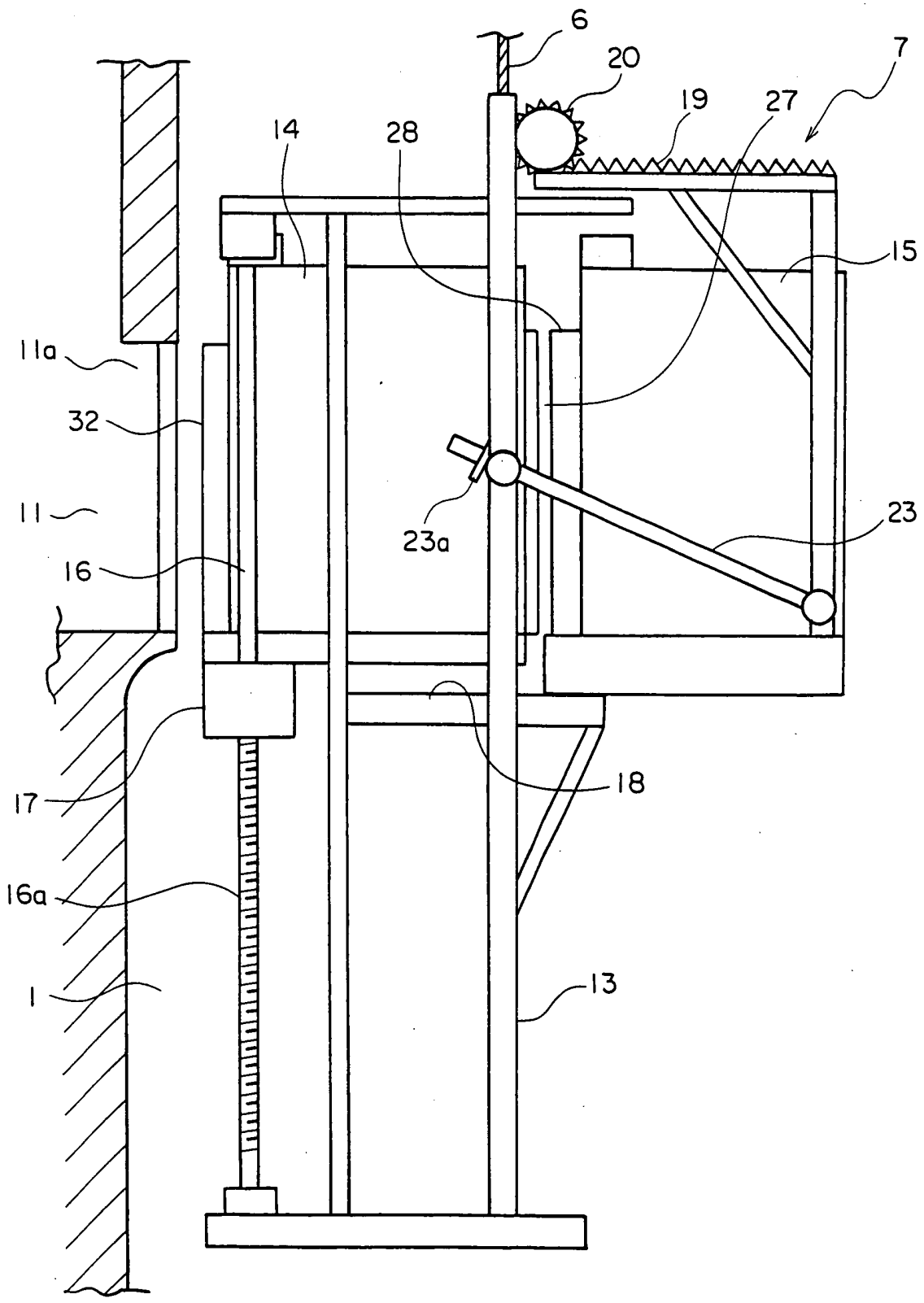


FIG. 4



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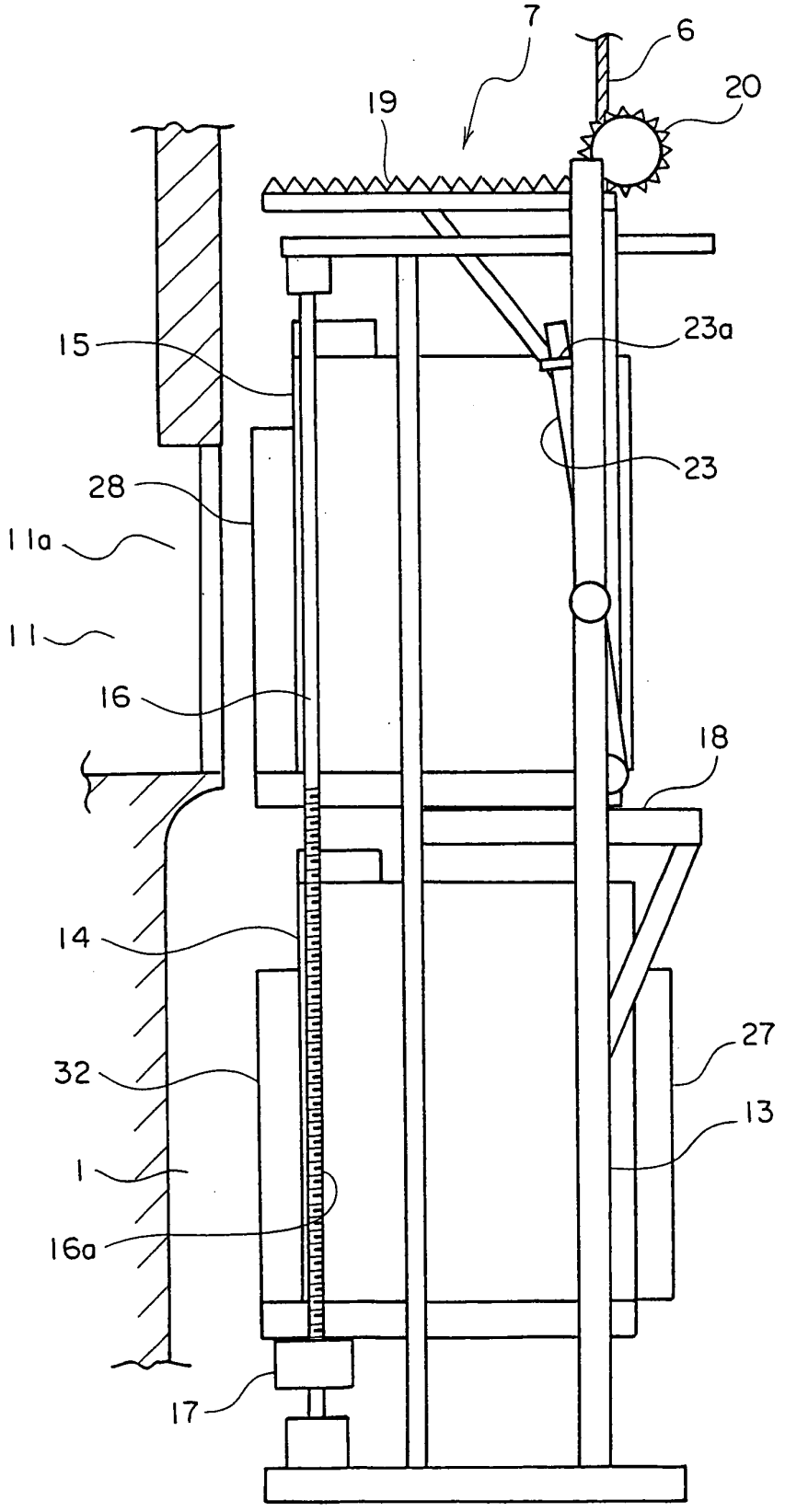

FIG. 6

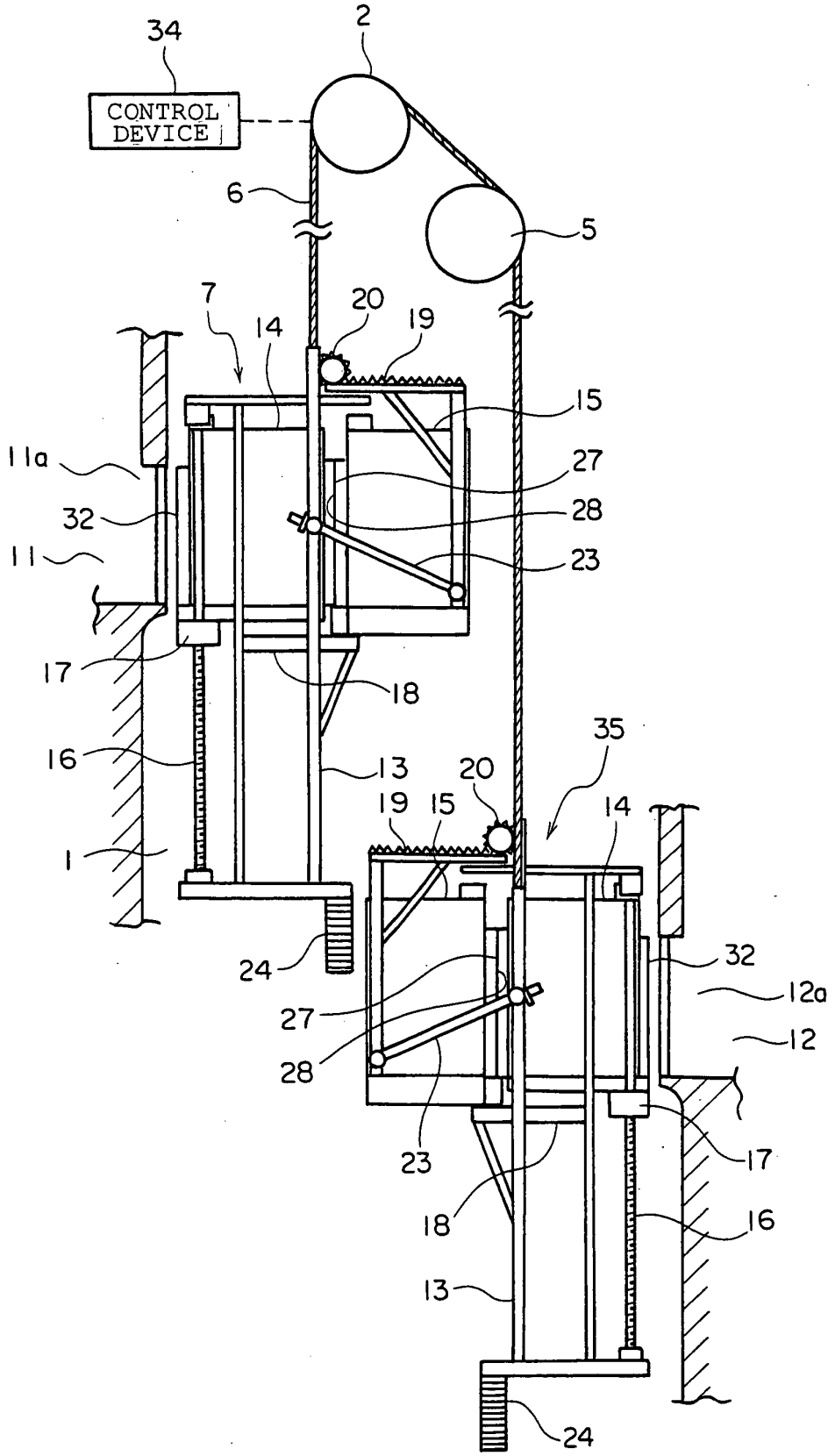
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FIG. 7

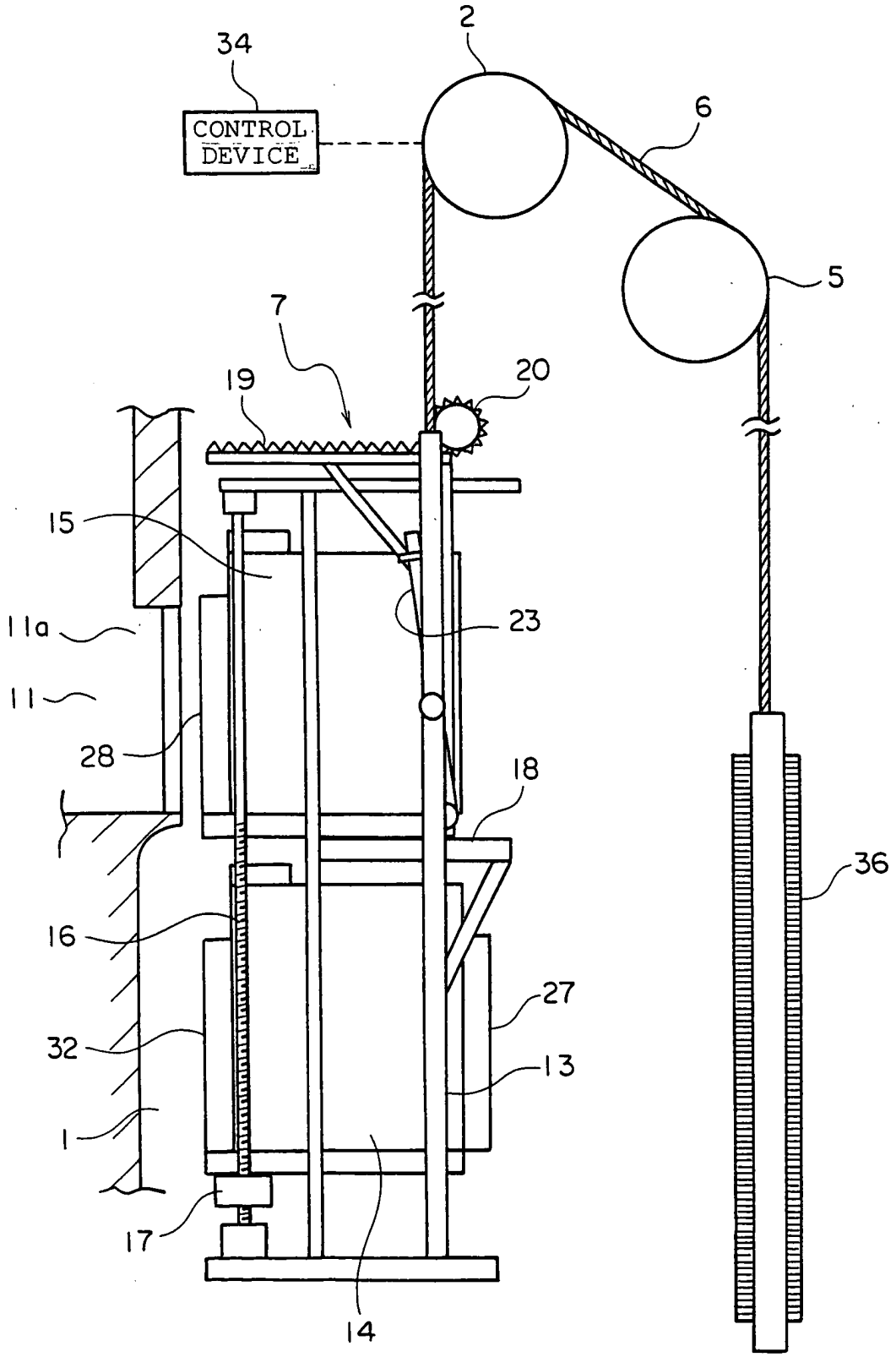
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FIG. 8

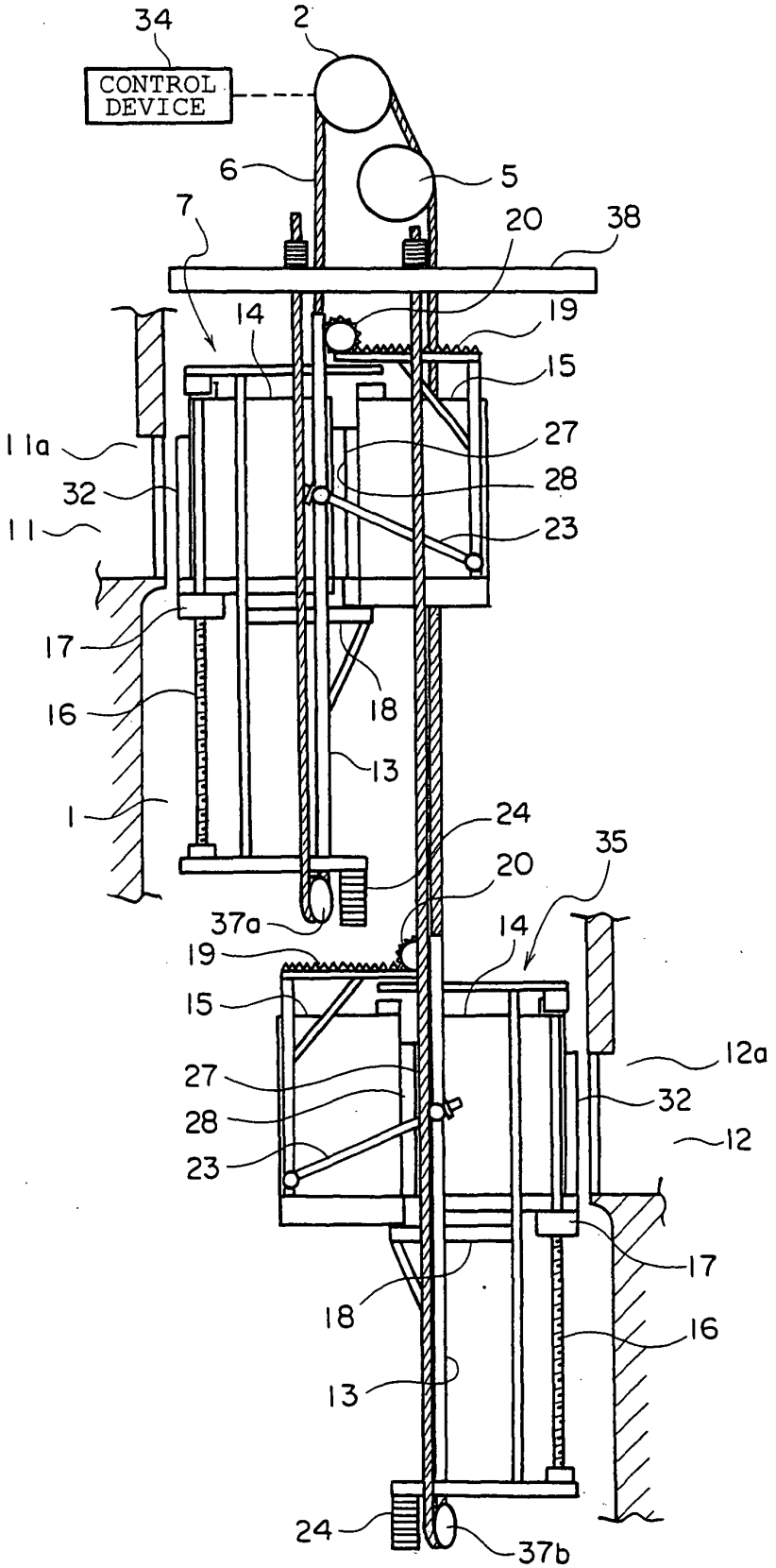
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FIG. 9

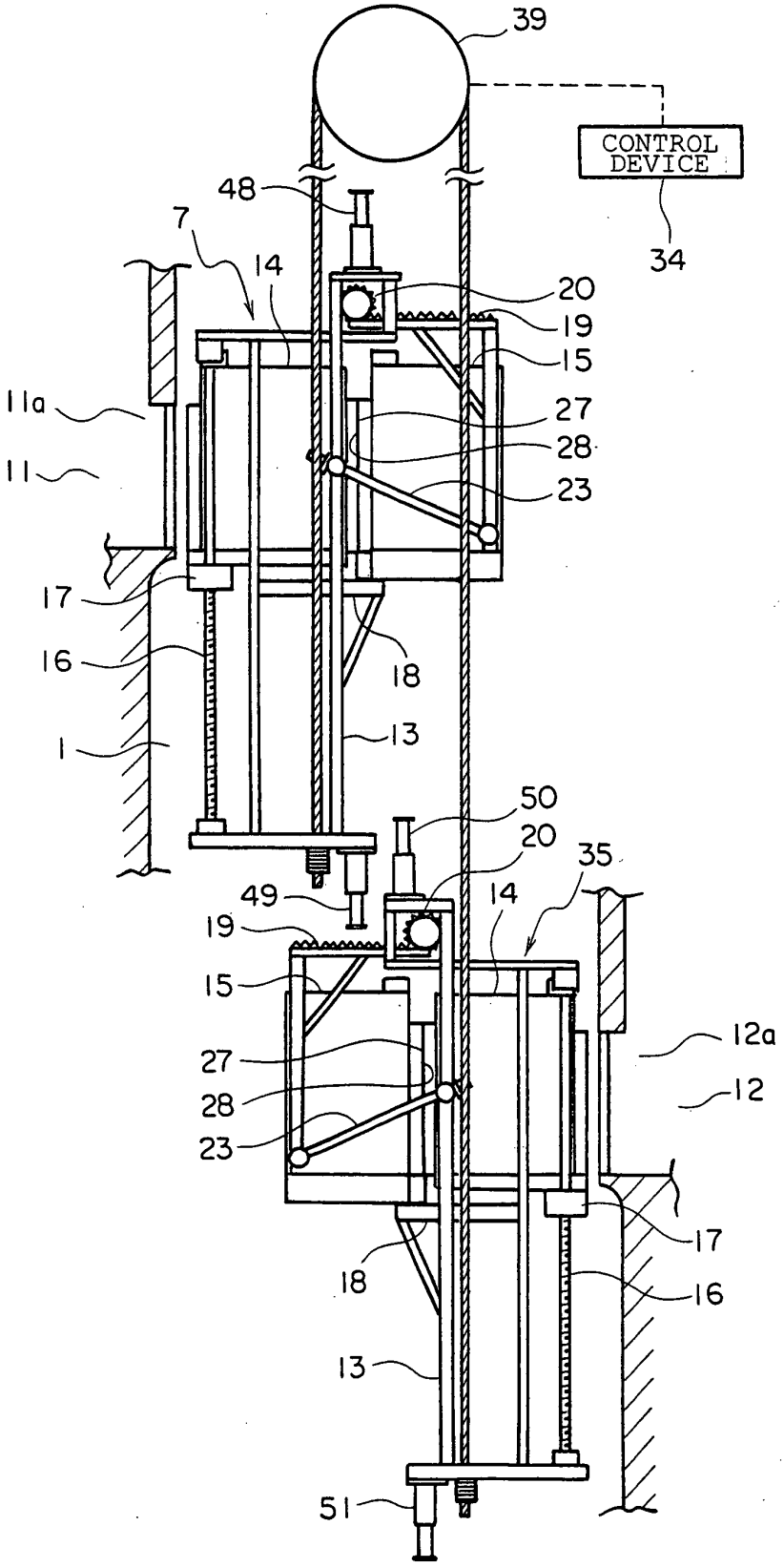
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FIG. 10

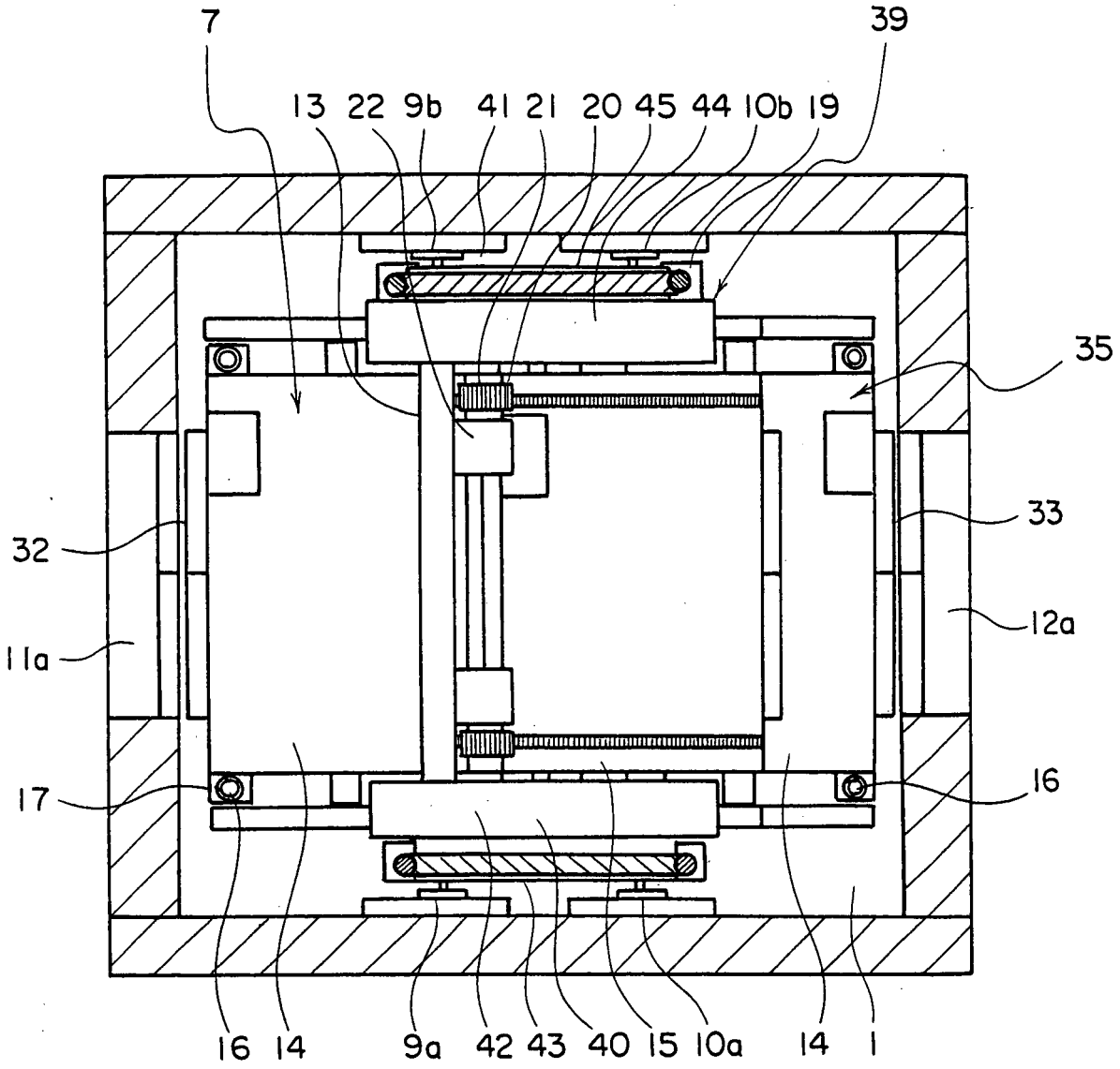
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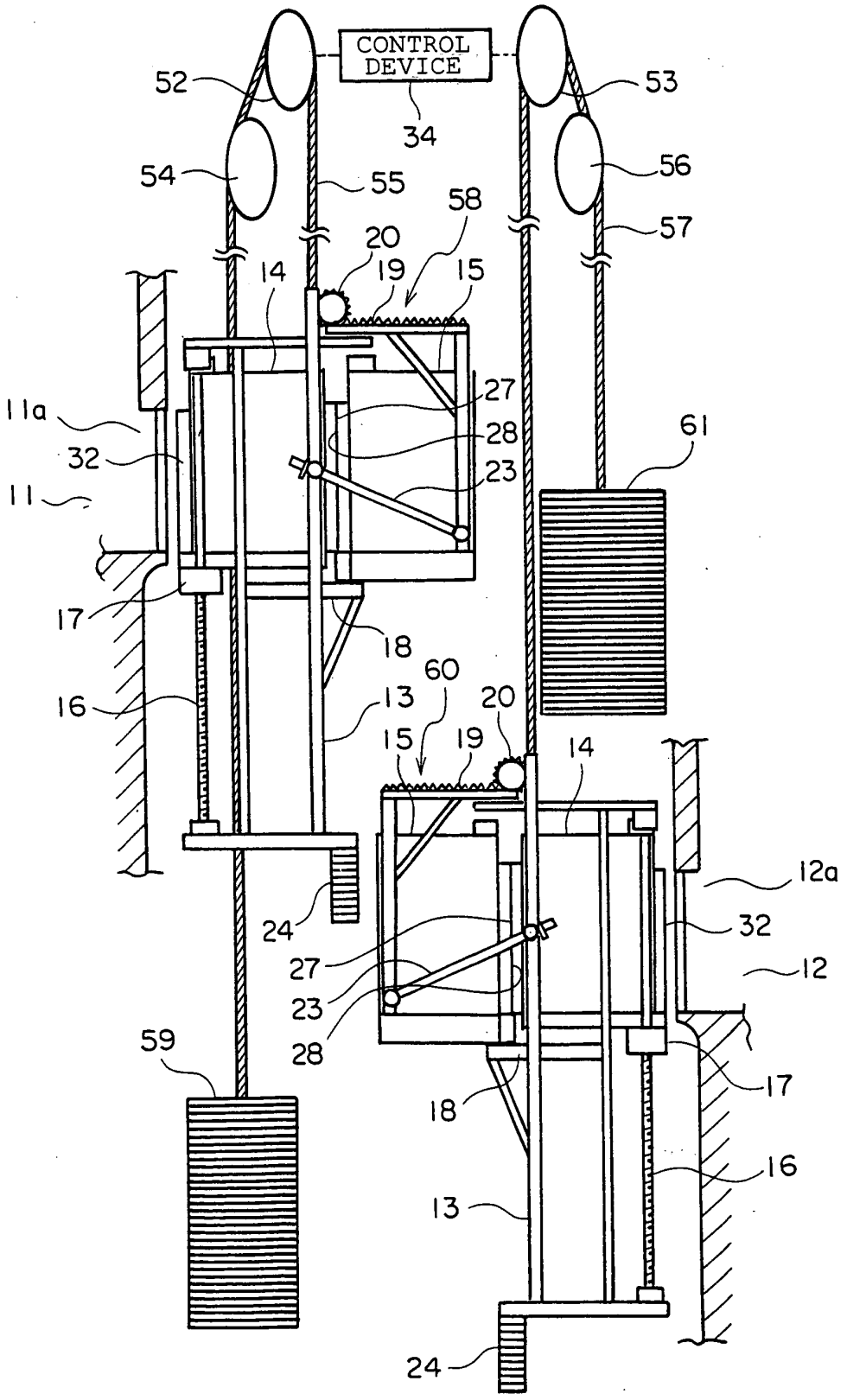
FIG. 11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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/014722

A. CLASSIFICATION OF SUBJECT MATTER
B66B11/02(2006.01), ***B66B1/06***(2006.01)

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)
B66B1/00(2006.01)-***B66B11/08***(2006.01)

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 1996-2006
Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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.
Y A	JP 3-147691 A (Hitachi, Ltd.), 24 June, 1991 (24.06.91), Claims 1 to 2; Figs. 1 to 4 (Family: none)	1-3,6-9 4-5,10-12
Y	JP 59-153773 A (Toshiba Corp.), 01 September, 1984 (01.09.84), Page 1, lower left column, line 14 to lower right column, line 16; Figs. 1 to 2	1-3,6-9
Y	Page 2, lower left column, lines 7 to 17; Figs. 5 to 6 (Family: none)	9
Y	JP 6-255904 A (Toshiba Corp.), 13 September, 1994 (13.09.94), Abstract; Figs. 1 to 3 (Family: none)	2-3

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

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"O" document referring to an oral disclosure, use, exhibition or other means
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"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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 May, 2006 (09.05.06)	16 May, 2006 (16.05.06)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/014722

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 40-12138 B1 (Yaskawa Electric Mfg. Co., Ltd.), 15 June, 1965 (15.06.65), Claim 1; Fig. 1 (Family: none)	6-7
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 633/1987(Laid-open No. 110468/1988) (Takenaka Corp.), 15 July, 1988 (15.07.88), Claims 1 to 2; Figs. 1 to 2 (Family: none)	4-5
A	JP 58-220080 A (Mitsubishi Electric Corp.), 21 December, 1983 (21.12.83), Claim 1; Figs. 1, 4 to 5 (Family: none)	4-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000309482 A **[0003]**