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(54) **ELEVATOR APPARATUS**
AUFZUGSVORRICHTUNG
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Description

Technical Field

[0001] The present invention relates to an elevator apparatus having a drive device disposed in an upper portion within a hoistway.

Background Art

[0002] In a conventional elevator apparatus, there is often adopted a 2:1 roping method as to a main rope for suspending a car and a counterweight, with a view to reducing size of a drive device. In the conventional elevator apparatus thus constructed, the car and the counterweight are provided with a car suspending pulley and a counterweight suspending pulley respectively. The main rope is wound around the car suspending pulley, the counterweight suspending pulley, and a driving sheave of the drive device. The main rope is connected at one end thereof and the other end thereof to an upper portion of a hoistway. Thus, the axial load applied to the drive device is reduced, so the drive device can be reduced in size (see Patent Document 1). WO 03 074 409 discloses an elevator apparatus according to the preamble of claims 1, 2 and 3.

[0003] Patent Document 1: JP 10-139321 A

Disclosure of the Invention

Problem to Be Solved by the Invention

[0004] However, the rotational speed of the driving sheave is higher when the 2:1 roping method is adopted as to the main rope than when a 1:1 roping method is adopted, so a loud noise is made.

[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 the axial load applied to a drive device and abate noise.

Means for solving the Problems

[0006] An elevator apparatus according to the present invention includes: a drive device having a drive device body and a driving sheave rotated around a vertically extending rotational shaft by the drive device body, and disposed in an upper portion within a hoistway; a car for being raised/lowered within the hoistway due to a driving force of the drive device; a counterweight provided with a first counterweight rope connecting portion and a second counterweight rope connecting portion, for being raised/lowered within the hoistway due to a driving force of the drive device; a car suspending pulley provided on the car; a first car side return pulley and a second car side return pulley that are disposed in the upper portion within the hoistway and above the car; a first counter-

weight side return pulley and a second counterweight side return pulley that are disposed in the upper portion within the hoistway and above the counterweight; and a main rope having a first rope end connected to the first counterweight rope connecting portion and a second rope end connected to the second counterweight rope connecting portion, and sequentially wound around the first counterweight side return pulley, the driving sheave, the first car side return pulley, the car suspending pulley, the second car side return pulley, and the second counterweight side return pulley while extending from the first rope end to the second rope end, for suspending the car and the counterweight within the hoistway.

Brief Description of the Drawings

[0007]

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 plan view showing another example of the elevator apparatus according to Embodiment 1 of the present invention.

Fig. 4 is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention.

Fig. 5 is a lateral view showing an elevator apparatus according to Embodiment 3 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. Referring to Figs. 1 and 2, a pair of vertically extending car guide rails 2 and a pair of vertically extending counterweight guide rails 3 are installed within a hoistway 1 (Fig. 2). The respective car guide rails 2 and the respective counterweight guide rails 3 are disposed within the hoistway 1 such that a line connecting the respective car guide rails 2 to each other extends perpendicularly to a line connecting the respective counterweight guide rails 3 to each other when the hoistway 1 is vertically projected.

[0010] A car 4 is disposed between the respective car guide rails 2. A counterweight 5 is disposed between the respective counterweight guide rails 3. The car 4 is guided by the respective car guide rails 2 to be raised/lowered within the hoistway 1. The counterweight 5 is guided by the respective counterweight guide rails 3 to be raised/lowered within the hoistway 1. The car 4 and the

counterweight 5 are disposed side by side in a width direction of the hoistway 1 (a direction extending along the line connecting the respective car guide rails 2 to each other) on a vertical projection plane of the hoistway 1. In other words, the counterweight 5 is disposed beside the car 4.

[0011] A drive device 6 for generating a driving force for raising/lowering the car 4 and the counterweight 5 is provided horizontally in an upper portion within the hoistway 1. The drive device 6 is disposed within a region of the car 4 on the vertical projection plane of the hoistway 1. The drive device 6 has a drive device body 7, and a driving sheave 8 which is rotated around a vertically extending rotational shaft by the drive device body 7. In addition, the drive device 6 is designed as a low-profile hoisting machine having a dimension in an axial direction (a direction extending along the rotational shaft of the driving sheave 8) which is smaller than a dimension in a radial direction (a direction extending perpendicularly to the axial direction). In this example, the drive device 6 is disposed such that the driving sheave 8 is located above the drive device body 7.

[0012] A pair of car suspending pulleys 9 and 10 are provided on a lower portion of the car 4 on both sides thereof respectively. The respective car suspending pulleys 9 and 10 are disposed symmetrically with respect to a center point of a line segment connecting the respective car guide rails 2 to each other on the vertical projection plane of the hoistway 1 (Fig. 2).

[0013] A first car side return pulley 11 and a second car side return pulley 12 are provided in the upper portion within the hoistway 1 and above the car 4. Each of the first car side return pulley 11 and the second car side return pulley 12 is rotated around a horizontally extending rotational shaft. The first car side return pulley 11 is disposed above one of the car suspending pulleys 9. The second car side return pulley 12 is disposed above the other car suspending pulley 10.

[0014] A first counterweight rope connecting portion 13 and a second counterweight rope connecting portion 14, which are disposed side by side in a width direction of the counterweight 5, are provided on an upper portion of the counterweight 5. The first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed on the line connecting the respective counterweight guide rails 3 to each other on the vertical projection plane of the hoistway 1 (Fig. 2). Further, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed symmetrically with respect to a vertical line extending past a center of gravity of the counterweight 5.

[0015] A first counterweight side return pulley 15 and a second counterweight side return pulley 16 are provided in the upper portion within the hoistway 1 and above the counterweight 5. Each of the first counterweight side return pulley 15 and the second counterweight side return pulley 16 is rotated around a horizontally extending ro-

tational shaft. The first counterweight side return pulley 15 is disposed above the first counterweight rope connecting portion 13. The second counterweight side return pulley 16 is disposed above the second counterweight rope connecting portion 14.

[0016] The car 4 and the counterweight 5 are suspended within the hoistway 1 by a plurality of main ropes 17 (only one rope is illustrated in the drawings for the sake of simplicity). Each of the main ropes 17 has a first rope end 17a connected to the first counterweight rope connecting portion 13, and a second rope end 17b connected to the second counterweight rope connecting portion 14. Each of the main ropes 17, which extends from the first rope end 17a to the second rope end 17b, is sequentially wound around the first counterweight side return pulley 15, the driving sheave 8, the first car side return pulley 11, the one of the car suspending pulleys 9, the other car suspending pulley 10, the second car side return pulley 12, and the second counterweight side return pulley 16. That is, as for the respective main ropes 17, there is adopted a 1:1 roping method in which the moving distance of each of the main ropes 17 is equal to the moving distance of the car 4 and the counterweight 5.

[0017] Each of the main ropes 17 is manufactured by twisting a plurality of copper wires. Each of these wires has a wire diameter smaller than a normal wire diameter. Thus, the respective main ropes 17 are increased in flexibility. The respective main ropes 17 may also be designed as synthetic fiber ropes to achieve further enhancement of flexibility.

[0018] Next, an operation will be described. When the driving sheave 8 is rotated by the drive device body 7, the respective main ropes 17 are moved in accordance with rotation of the driving sheave 8. Thus, the car 4 and the counterweight 5 are raised/lowered within the hoistway 1 while being guided by the respective car guide rails 2 and the respective counterweight guide rails 3 respectively.

[0019] Next, an axial load applied to the driving sheave 8 will be described. The car 4 and the counterweight 5 are suspended by the main ropes 17. Therefore, a first rope tension T1 is applied to portions of the main ropes 17 which are located on the first rope end 17a side with respect to the driving sheave 8, and a second rope tension T2 is applied to portions of the main ropes 17 which are located on the second rope end 17b side with respect to the driving sheave 8.

[0020] A weight W1 of the counterweight 5 is balanced with the sum of the first rope tension T1 and the second rope tension T2. Therefore, the following equation is established.

$$T1 + T2 = W1 \quad \dots (1)$$

[0021] An axial load MT applied to the driving sheave 8 is equal to the sum of the first rope tension T1 and the

second rope tension T2. Therefore, the following relationship is established in consideration of the equation (1).

$$MT = T1 + T2 = W1 \dots (2)$$

[0022] That is, the axial load MT is equal to the weight W1 of the counterweight 5.

[0023] A total weight W2 on the car 4 side (i.e., an added weight of a car weight Wa of the car 4 itself and a laden weight Wb of an onboard object within the car 4) is balanced with the sum of the second rope tension T2 on the one of the car suspending pulleys 9 side and the second rope tension T2 on the other car suspending pulley 10 side. Therefore, the second rope tension T2 is expressed by the following equation.

$$T2 = (W2) / 2 \dots (3)$$

[0024] The first rope tension T1 is expressed by the following equation in consideration of the equations (1) and (3).

$$T1 = W1 - (W2) / 2 \dots (4)$$

[0025] In this example, the total weight W2 on the car 4 side is balanced with the weight W1 of the counterweight 5 when the laden weight Wb is half of a maximum laden weight Wbmax.

[0026] As is apparent from the equations (3) and (4), the magnitudes of the first rope tension T1 and the second rope tension T2 may be different from each other. Accordingly, the larger the clearance between the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 becomes, the larger the offset load applied to the counterweight 5 becomes, and the larger the reactive force applied to each of the counterweight guide rails 3 becomes. Thus, when there is a certain clearance between the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14, the level of a noise resulting from contact of the counterweight 5 with the respective counterweight guide rails 3 may be increased, or the life of the counterweight guide rails 3 may be shortened due to abrasion.

[0027] Accordingly, the clearance between the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 is set within a predetermined range where an adverse effect resulting from an offset load applied to the counterweight 5, for example, a noise, abrasion of the counterweight guide rails 3, or the like can be permitted. In this example, the

first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed on the counterweight 5 in close proximity to the vertical line extending past the center of gravity of the counterweight 5.

[0028] In the elevator apparatus constructed as described above, the drive device 6 is horizontally provided in the upper portion within the hoistway 1, and each of the main ropes 17 for suspending the car 4 and the counterweight 5 within the hoistway 1, which extends from the first rope end 17a connected to the counterweight 5 to the second rope end 17b connected to the counterweight 5, is sequentially wound around the first counterweight side return pulley 15, the driving sheave 8 of the drive device 6, the first car side return pulley 11, the one of the car suspending pulleys 9, the other car suspending pulley 10, the second car side return pulley 12, and the second counterweight side return pulley 16. Therefore, the axial load applied to the driving sheave 8 can be made equal to the weight of the counterweight 5, and the moving distance of the main ropes 17 can be made directly equal to the moving distance of the car 4 and the counterweight 5. That is, both the total weight W2 on the car 4 side and the weight W1 of the counterweight 5 can be prevented from being directly applied to the driving sheave 8, and the 1:1 roping method is adopted as to the main ropes 17, so the rotational speed of the driving sheave 8 can be reduced. Accordingly, the drive device 6 can be reduced in size, and the space of the hoistway 1 can be reduced. Further, a noise resulting from rotation of the driving sheave 8 can also be abated.

[0029] The respective car suspending pulleys 11 and 12 are disposed symmetrically with respect to the center point of the line segment connecting the respective car guide rails 2 to each other on the vertical projection plane of the hoistway 1. Therefore, the car 4 can be stably suspended by the main ropes 17.

[0030] The first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed symmetrically with respect to the vertical line extending past the center of gravity of the counterweight 5, and the clearance between the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 is set within the predetermined range. Therefore, the magnitude of an offset load applied to the counterweight 5 can be set within a permissible range. Thus, a noise resulting from, for example, contact of the counterweight 5 on the counterweight guide rails 3 can be abated, and the life of the counterweight guide rails 3 can be restrained from being shortened due to abrasion.

[0031] The drive device 6 is designed as a low-profile hoisting machine having a dimension in an axial direction which is smaller than a dimension in a radial direction, so the dimension of the hoistway 1 in a height direction thereof can further be reduced.

[0032] In the foregoing example, the car suspending pulleys 9 and 10 are provided on the lower portion of the

car 4. However, the car suspending pulleys 9 and 10 may also be provided on an upper portion of the car 4. In this manner as well, the car 4 can be suspended within the hoistway 1 by the main ropes 17.

[0033] In the foregoing example, the present invention is applied to an elevator apparatus of a counter weight-falling-sidewise type in which the counterweight 5 is disposed beside the car 4. However, as shown in Fig. 3, the present invention may also be applied to an elevator apparatus of counterweight-falling-behind type in which the counterweight 5 is disposed behind the car 4. In this case, the line connecting the respective car guide rails 2 to each other is parallel to the line connecting the respective counterweight guide rails 3 to each other on the vertical projection plane of the hoistway 1.

Embodiment 2

[0034] Fig. 4 is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention. Referring to Fig. 4, a first car rope connecting portion 21 and a second car rope connecting portion 22 are provided on the lower portion of the car 4 on both sides thereof. The first car rope connecting portion 21 and the second car rope connecting portion 22 are disposed symmetrically with respect to the line segment connecting the respective car guide rails 2 to each other on the vertical projection plane of the hoistway 1. The first car side return pulley 11 is disposed above the first car rope connecting portion 21. The second car side return pulley 12 is disposed above the second car rope connecting portion 22.

[0035] A counterweight suspending pulley 23 is provided on the upper portion of the counterweight 5. The first counterweight side return pulley 15 and the second counterweight side return pulley 16 are disposed above the counterweight suspending pulley 23.

[0036] The car 4 and the counterweight 5 are suspended within the hoistway 1 by the respective main ropes 17. Each of the main ropes 17 has the first rope end 17a connected to the first car rope connecting portion 21, and the second rope end 17b connected to the second car rope connecting portion 22. Each of the main ropes 17, which extends from the first rope end 17a to the second rope end 17b, is sequentially wound around the first car side return pulley 11, the driving sheave 8, the first counterweight side return pulley 15, the counterweight suspending pulley 23, the second counterweight side return pulley 16, and the second car side return pulley 12. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details and other operational details.

[0037] Next, the axial load applied to the driving sheave 8 will be described. A first rope tension T3 is applied to portions of the main ropes 17 which are located on the first rope end 17b side with respect to the driving sheave 8, and a second rope tension T4 is applied to portions of the main ropes 17 which are located on the second rope

end 17a side with respect to the driving sheave 8.

[0038] The total weight W2 on the car 4 side is balanced with the sum of the first rope tension T3 and the second rope tension T4. Therefore, the following equation is established.

$$T3 + T4 = W2 \dots (5)$$

[0039] The axial load MT applied to the driving sheave 8 is equal to the sum of the first rope tension T3 and the second rope tension T4. Therefore, the following relationship is established in consideration of the equation (5).

$$MT = T3 + T4 = W2 \dots (6)$$

[0040] That is, the axial load MT is equal to the total weight W2 on the car 4 side.

[0041] In the same manner as in Embodiment 1 of the present invention, the first rope tension T3 and the second rope tension T4 are expressed by the following equations respectively.

$$T3 = (W1) / 2 \dots (7)$$

$$T4 = W2 - (W1) / 2 \dots (8)$$

[0042] As described above, the first car rope connecting portion 21 and the second car rope connecting portion 22 are provided on the car 4, and the counterweight suspending pulley 23 is provided on the counterweight 5, and each of the main ropes 17 for suspending the car 4 and the counterweight 5, which extends from the first rope end 17a connected to the first car rope connecting portion 21 to the second rope end 17b connected to the second car rope connecting portion 22, is sequentially wound around the first car side return pulley 11, the driving sheave 8, the first counterweight side return pulley 15, the counterweight suspending pulley 23, the second counterweight side return pulley 16, and the second car side return pulley 12. Therefore, as is the case with Embodiment 1 of the present invention, both the total weight W2 on the car 4 side and the weight W1 of the counterweight 5 can be prevented from being directly applied to the driving sheave 8, and the 1:1 roping method is adopted as to the main ropes 17, so the rotational speed of the driving sheave 8 can be lowered. Thus, the axial load applied to the drive device 6 can be reduced, and a noise can be abated.

[0043] The first rope connecting portion 21 and the sec-

ond rope connecting portion 22 are disposed symmetrically with respect to the center point of the line segment connecting the respective car guide rails 2 to each other on the vertical projection plane of the hoistway 1. Therefore, the car 4 can be stably suspended by the main ropes 17.

Embodiment 3

[0044] Fig. 5 is a lateral view showing an elevator apparatus according to Embodiment 3 of the present invention. Referring to Fig. 5, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14, which are disposed side by side in the width direction of the counterweight 5, are provided on the upper portion of the counterweight 5. The car 4 and the counterweight 5 are suspended within the hoistway 1 by a main rope body 31 having a first main rope 32 and a second main rope 33.

[0045] The first main rope 32 has a first rope end 32a connected to the first car rope connecting portion 21, and a second rope end 32b connected to the first counterweight rope connecting portion 13. The first main rope 32, which extends from the first rope end 32a to the second rope end 32b, is sequentially wound around the first car side return pulley 11, the driving sheave 8, and the first counterweight side return pulley 15.

[0046] The second main rope 33 has a third rope end 33a connected to the second car rope connecting portion 22, and a fourth rope end 33b connected to the second counterweight rope connecting portion 14. The second main rope 33, which extends from the third rope end 33a to the fourth rope end 33b, is sequentially wound around the second car side return pulley 12 and the second counterweight side return pulley 16. That is, the second main rope 33 is wound around the second car side return pulley 12 and the second counterweight side return pulley 16 while bypassing the driving sheave 8. Embodiment 3 of the present invention is identical to Embodiment 2 of the present invention in other constructional details.

[0047] The main rope body 31 suspends the car 4 and the counterweight 5 such that the sum of the weight W1 of the counterweight 5 and the total weight W2 on the car 4 side is distributed to the first main rope 32 and the second main rope 33. The axial load applied to the driving sheave 8 results only from a tension in the first main rope 32. That is, the axial load applied to the driving sheave 8 is equal to that part of the sum of the weight W1 of the counterweight 5 and the total weight W2 on the car 4 side which is borne by the first main rope 32.

[0048] As described above, the first car rope connecting portion 21 and the second car rope connecting portion 22 are provided on the car 4, and the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are provided on the counterweight 5. Also, the main rope body 31 for suspending the car 4 and the counterweight 5 has the first main rope 32, which is wound around the driving sheave

8 and connected to the first car rope connecting portion 21 and the first counterweight rope connecting portion 13, and the second main rope 33, which is connected to the second car rope connecting portion 22 and the second counterweight rope connecting portion 14 while bypassing the driving sheave 8. Therefore, the car 4 and the counterweight 5 can be suspended by the first main rope 32 and the second main rope 33 in a distributed manner, so both the total weight W2 on the car 4 side and the weight W1 of the counterweight 5 can be prevented from being directly applied to the driving sheave 8. The 1:1 roping method is adopted as to the main ropes 17, so the rotational speed of the driving sheave 8 can be reduced. Thus, the axial load applied to the drive device 6 can be reduced, and a noise can be abated.

[0049] In Embodiments 1 and 2 of the present invention, the present invention is applied to the elevator apparatus of counterweight-falling-sidewise type in which the counterweight 5 is disposed beside the car 4. However, the present invention is also applicable to an elevator apparatus of counterweight-falling-behind type in which the counterweight 5 is disposed behind the car 4.

[0050] In Embodiments 1 and 3 of the present invention, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed side by side in the width direction of the counterweight 5. However, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 may be disposed side by side in a thickness direction of the counterweight 5. In this case, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed symmetrically with respect to the vertical line extending past the center of gravity of the counterweight 5. The clearance between the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 is set within a predetermined range. In this manner as well, the magnitude of an offset load applied to the counterweight 5 can be confined within a permissible range.

[0051] In Embodiments 1 and 3 of the present invention, the first counterweight rope connecting portion 13 and the second counterweight rope connecting portion 14 are disposed side by side in the width direction of the counterweight 5. However, it is also appropriate that a plurality of (an even number of) first counterweight rope connecting portions 13 are disposed symmetrically with respect to the vertical line extending past the center of gravity of the counterweight 5, and that a plurality of (an even number of) second counterweight rope connecting portions 14 are disposed symmetrically with respect to the vertical line extending past the center of gravity of the counterweight 5. In this manner, the occurrence of an offset load applied to the counterweight 5 can be prevented even when the first rope tension T1 and the second rope tension T2 are different in magnitude from each other.

Claims

1. An elevator apparatus comprising:

a drive device (6) having a drive device body (7) 5
and a driving sheave (8) rotated around a vertically extending rotational shaft by the drive device body (7), and disposed in an upper portion within a hoistway (1);
a car (4) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6); 10
a counterweight (5) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6); 15
characterized in that the counterweight (5) is provided with a first counterweight rope connecting portion (13) and a second counterweight rope connecting portion (14); and
that the elevator apparatus further comprises: 20

a car suspending pulley (9, 10) provided on the car (4);
a first car side return pulley (11) and a second car side return pulley (12) that are disposed in the upper portion within the hoistway (1) and above the car (4); 25
a first counterweight side return pulley (15) and a second counterweight side return pulley (16) that are disposed in the upper portion within the hoistway (1) and above the counterweight (5); and 30
a main rope (17) having a first rope end (17a) connected to the first counterweight rope connecting portion (13) and a second rope end (17b) connected to the second counterweight rope connecting portion (14), and sequentially wound around the first counterweight side return pulley (15), the driving sheave (8), the first car side return pulley (11), the car suspending pulley (9, 10), the second car side return pulley (12), and the second counterweight side return pulley (16) while extending from the first rope end (17a) to the second rope end (17b), for suspending the car (4) and the counterweight (5) within the hoistway (1). 35 40 45

2. An elevator apparatus comprising:

a drive device (6) having a drive device body (7) 50
and a driving sheave (8) rotated around a vertically extending rotational shaft by the drive device body (7), and disposed in an upper portion within a hoistway (1); 55
a car (4) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6);

a counterweight (5) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6);

characterized in that:

the car (4) is provided with a first car rope connecting portion (21) and a second car rope connecting portion (22); and

that the elevator apparatus further comprises:

a counterweight suspending pulley (23) provided on the counterweight (5);
a first car side return pulley (11) and a second car side return pulley (12) that are disposed in the upper portion within the hoistway (1) and above the car (4);
a first counterweight side return pulley (15) and a second counterweight side return pulley (16) that are disposed in the upper portion within the hoistway (1) and above the counterweight (5); and
a main rope (17) having a first rope end (17a) connected to the first car rope connecting portion (21) and a second rope end (17b) connected to the second car rope connecting portion (22), and sequentially wound around the first car side return pulley (11), the driving sheave (8), the first counterweight side return pulley (15), the counterweight suspending pulley (23), the second counterweight side return pulley (16), and the second car side return pulley (12) while extending from the first rope end (17a) to the second rope end (17b), for suspending the car (4) and the counterweight (5) within the hoistway (1).

3. An elevator apparatus comprising:

a drive device (6) having a drive device body (7) and a driving sheave (8) rotated around a vertically extending rotational shaft by the drive device body (7), and disposed in an upper portion within a hoistway (1);
a car (4) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6);

a counterweight (5) for being raised/lowered within the hoistway (1) due to a driving force of the drive device (6);

characterized in that:

the car (4) is provided with a first car rope connecting portion (21) and a second car rope connecting portion (22);
the counterweight (5) is provided with a first counterweight rope connecting portion (13)

and a second counterweight rope connecting portion (14); and

that the elevator apparatus further comprises:

a first car side return pulley (11) and a second car side return pulley (12) that are disposed in the upper portion within the hoistway (1) and above the car (4);

a first counterweight side return pulley (15) and a second counterweight side return pulley (16) that are disposed in the upper portion within the hoistway (1) and above the counterweight (5); and

a main rope body (31) having a first main rope (32), which includes a first rope end (32a) connected to the first car rope connecting portion (21) and a second rope end (32b) connected to the first counterweight rope connecting portion (13) and is sequentially wound around the first car side return pulley (11), the driving sheave (8), and the first counterweight side return pulley (15) while extending from the first rope end (32a) to the second rope end (32b), and a second main rope (32), which includes a third rope end (33a) connected to the second car rope connecting portion (22) and a fourth rope end (33b) connected to the second counterweight rope connecting portion (14) and is sequentially wound around the second car side return pulley (12) and the second counterweight side return pulley (16) and bypasses the driving sheave (8) while extending from the third rope end (33a) to the fourth rope end (33b), for suspending the car (4) and the counterweight (5) within the hoistway (1).

4. The elevator apparatus according to Claim 1, **characterized in that:**

the hoistway (1) has provided therein a pair of car guide rails (2) for guiding the car (4); the car (4) is provided with a pair of car suspending pulleys (9, 10) as mentioned above; and the respective car suspending pulleys (9, 10) are disposed symmetrically with respect to a center point of a line segment connecting the respective car guide rails (2) to each other on a vertical projection plane of the hoistway (1).

5. The elevator apparatus according to Claim 2 or 3, **characterized in that:**

the hoistway (1) has provided therein a pair of car guide rails (2) for guiding the car (4); and the first car rope connecting portion (21) and the

second car rope connecting portion (22) are disposed symmetrically with respect to a center point of a line segment connecting the respective car guide rails (2) to each other on a vertical projection plane of the hoistway (1).

6. The elevator apparatus according to Claim 1 or 3, **characterized in that:**

the first counterweight rope connecting portion (13) and the second counterweight rope connecting portion (14) are disposed symmetrically with respect to a vertical line extending past a center of gravity of the counterweight (5); and the first counterweight rope connecting portion (13) and the second counterweight rope connecting portion (14) are spaced apart from each other by a clearance that is set within a predetermined range.

7. The elevator apparatus according to Claim 1 or 3, **characterized in that:**

the counterweight (5) is provided with an even number of first counterweight rope connecting portions (13) as mentioned above and an even number of second counterweight rope connecting portions (14) as mentioned above; and the respective first counterweight connecting portions (13) are disposed symmetrically with respect to a vertical line extending past a center of gravity of the counterweight (5); and the respective second counterweight connecting portions (14) are disposed symmetrically with respect to the vertical line.

8. The elevator apparatus according to any one of Claims 1 to 7, **characterized in that** the drive device (6) is a low-profile hoisting machine having a dimension in an axial direction along the rotational shaft which is smaller than a dimension in a radial direction perpendicular to the rotational shaft.

Patentansprüche

1. Aufzugsvorrichtung mit:

einer Antriebseinrichtung (6) mit einem Antriebseinrichtungskörper (7) und einer Antriebs-scheibe (8), die durch den Antriebseinrichtungskörper (7) um eine sich vertikal erstreckende Drehwelle gedreht wird, und die in einem oberen Abschnitt in einem Aufzugsschacht (1) angeordnet ist;
einer Kabine (4) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6);

einem Gegengewicht (5) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6); **dadurch gekennzeichnet, dass** das Gegengewicht (5) mit einem ersten Gegengewichtsseilverbindungsabschnitt (13) und einem zweiten Gegengewichtsseilverbindungsabschnitt (14) versehen ist; und

dass die Aufzugsvorrichtung ferner aufweist:

eine Kabinenaufhängerrolle (9, 10), die an der Kabine (4) vorgesehen ist;

eine erste Kabinenseitenumlenkrolle (11) und eine zweite Kabinenseitenumlenkrolle (12), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb der Kabine (4) angeordnet sind;

eine erste Gegengewichtsseitenumlenkrolle (15) und eine zweite Gegengewichtsseitenumlenkrolle (16), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb des Gegengewichts (5) angeordnet sind; und

ein Hauptseil (17), das ein mit dem ersten Gegengewichtsseilverbindungsabschnitt (13) verbundenes erstes Seilende (17a) und ein mit dem zweiten Gegengewichtsseilverbindungsabschnitt (14) verbundenes zweites Seilende (17b) aufweist und sequentiell um die erste Gegengewichtsseitenumlenkrolle (15), die Antriebsscheibe (8), die erste Kabinenseitenumlenkrolle (11), die Kabinenaufhängerrolle (9, 10), die zweite Kabinenseitenumlenkrolle (12), und die zweite Gegengewichtsseitenumlenkrolle (16) gewickelt ist, während es sich von dem ersten Seilende (17a) zu dem zweiten Seilende (17b) erstreckt, zum Aufhängen der Kabine (4) und des Gegengewichts (5) innerhalb des Aufzugsschachts (1).

2. Aufzugsvorrichtung mit:

einer Antriebseinrichtung (6) mit einem Antriebseinrichtungskörper (7) und einer Antriebsscheibe (8), die durch den Antriebseinrichtungskörper (7) um eine sich vertikal erstreckende Drehwelle gedreht wird, und die in einem oberen Abschnitt in einem Aufzugsschacht (1) angeordnet ist;

einer Kabine (4) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6); einem Gegengewicht (5) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6); **dadurch gekennzeichnet, dass:**

die Kabine (4) mit einem ersten Kabinenseilverbindungsabschnitt (21) und einem zweiten Kabinenseilverbindungsabschnitt (22) versehen ist; und

dass die Aufzugsvorrichtung ferner aufweist:

eine Gegengewichtsaufhängerrolle (23), die an dem Gegengewicht (5) vorgesehen ist; eine erste Kabinenseitenumlenkrolle (11) und eine zweite Kabinenseitenumlenkrolle (12), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb der Kabine (4) angeordnet sind;

eine erste Gegengewichtsseitenumlenkrolle (15) und eine zweite Gegengewichtsseitenumlenkrolle (16), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb des Gegengewichts (5) angeordnet sind; und

ein Hauptseil (17), das ein mit dem ersten Kabinenseilverbindungsabschnitt (21) verbundenes erstes Seilende (17a) und ein mit dem zweiten Kabinenseilverbindungsabschnitt (22) verbundenes zweites Seilende (17b) aufweist und sequentiell um die erste Kabinenseitenumlenkrolle (11), die Antriebsscheibe (8), die erste Gegengewichtsseitenumlenkrolle (15), die Gegengewichtsaufhängerrolle (23), die zweite Gegengewichtsseitenumlenkrolle (16), und die zweite Kabinenseitenumlenkrolle (12), gewickelt ist, während es sich von dem ersten Seilende (17a) zu dem zweiten Seilende (17b) erstreckt, zum Aufhängen der Kabine (4) und des Gegengewichts (5) innerhalb des Aufzugsschachts (1).

3. Aufzugsvorrichtung mit:

einer Antriebseinrichtung (6) mit einem Antriebseinrichtungskörper (7) und einer Antriebsscheibe (8), die durch den Antriebseinrichtungskörper (7) um eine sich vertikal erstreckende Drehwelle gedreht wird, und die in einem oberen Abschnitt in einem Aufzugsschacht (1) angeordnet ist;

einer Kabine (4) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6); einem Gegengewicht (5) zum Anheben/Absenken innerhalb des Aufzugsschachts (1) infolge einer Antriebskraft der Antriebseinrichtung (6); **dadurch gekennzeichnet, dass:**

die Kabine (4) mit einem ersten Kabinenseilverbindungsabschnitt (21) und einem zweiten Kabinenseilverbindungsabschnitt

(22) versehen ist;
wobei das Gegengewicht (5) mit einem ersten Gegengewichtsseilverbindungsabschnitt (13) und einem zweiten Gegengewichtsseilverbindungsabschnitt (14) versehen ist; und

dass die Aufzugsvorrichtung ferner aufweist:

eine erste Kabinenseitenumlenkrolle (11) und einer zweite Kabinenseitenumlenkrolle (12), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb der Kabine (4) angeordnet sind;
eine erste Gegengewichtsseitenumlenkrolle (15) und eine zweite Gegengewichtsseitenumlenkrolle (16), die in dem oberen Abschnitt innerhalb des Aufzugsschachts (1) und oberhalb des Gegengewichts (5) angeordnet sind; und
einen Hauptseilkörper (31) mit einem ersten Hauptseil (32), das ein mit dem ersten Kabinenseilverbindungsabschnitt (21) verbundenes erstes Seilende (32a) und ein mit dem ersten Gegengewichtsseilverbindungsabschnitt (13) verbundenes zweites Seilende (32b) aufweist und sequentiell um die erste Kabinenseitenumlenkrolle (11), die Antriebsscheibe (8), und die erste Gegengewichtsseitenumlenkrolle (15) gewickelt ist, während es sich von dem ersten Seilende (32a) zu dem zweiten Seilende (32b) erstreckt, und mit einem zweiten Hauptseil (32), das ein mit dem zweiten Kabinenseilverbindungsabschnitt (22) verbundenes drittes Seilende (33a) und ein mit dem zweiten Gegengewichtsseilverbindungsabschnitt (14) verbundenes viertes Seilende (33b) aufweist und sequentiell um die zweite Kabinenseitenumlenkrolle (12) und die zweite Gegengewichtsseitenumlenkrolle (16) gewickelt ist und die Antriebsscheibe (8) umgeht, während es sich von dem dritten Seilende (33a) zu dem vierten Seilende (33b) erstreckt, zum Aufhängen der Kabine (4) und des Gegengewichts (5) innerhalb des Aufzugsschachts (1).

4. Aufzugsvorrichtung nach Anspruch 1, dadurch gekennzeichnet, dass:

der Aufzugsschacht (1) darin mit einem Paar an Kabinenführungsschienen (2) zum Führen der Kabine (4) versehen ist;
die Kabine (4) mit einem Paar an Kabinenaufhängerrollen (9, 10), wie vorstehend erwähnt, versehen ist; und
die jeweiligen Kabinenaufhängerrollen (9, 10) in

Bezug auf einen Mittelpunkt eines Liniensegments, das die jeweiligen Kabinenführungsschienen (2) auf einer vertikalen Projektionsebene des Aufzugsschachts (1) miteinander verbindet, symmetrisch angeordnet sind.

5. Aufzugsvorrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, dass:

der Aufzugsschacht (1) darin mit einem Paar an Kabinenführungsschienen (2) zum Führen der Kabine (4) versehen ist; und
der erste Kabinenseilverbindungsabschnitt (21) und der zweite Kabinenseilverbindungsabschnitt (22) in Bezug auf einen Mittelpunkt eines Liniensegments, das die jeweiligen Kabinenführungsschienen (2) auf einer vertikalen Projektionsebene des Aufzugsschachts (1) miteinander verbindet, symmetrisch angeordnet sind.

6. Aufzugsvorrichtung nach Anspruch 1 oder 3, dadurch gekennzeichnet, dass:

der erste Gegengewichtsseilverbindungsabschnitt (13) und der zweite Gegengewichtsseilverbindungsabschnitt (14) in Bezug auf eine vertikale Linie, die sich an einem Schwerpunkt des Gegengewichts (5) vorbei erstreckt, symmetrisch angeordnet sind; und
wobei der erste Gegengewichtsseilverbindungsabschnitt (13) und der zweite Gegengewichtsseilverbindungsabschnitt (14) zueinander um einen Zwischenraum beabstandet sind, der innerhalb eines vorgegebenen Bereichs festgelegt ist.

7. Aufzugsvorrichtung nach Anspruch 1 oder 3, dadurch gekennzeichnet, dass:

das Gegengewicht (5) mit einer geraden Anzahl an ersten Gegengewichtsseilverbindungsabschnitten (13), wie vorstehend erwähnt, und einer geraden Anzahl an zweiten Gegengewichtsseilverbindungsabschnitten (14), wie vorstehend erwähnt, versehen ist;
die jeweiligen ersten Gegengewichtsverbindungsabschnitte (13) in Bezug auf eine vertikale Linie, die sich an einem Schwerpunkt des Gegengewichts (5) vorbei erstreckt, symmetrisch angeordnet sind; und
die jeweiligen zweiten Gegengewichtsverbindungsabschnitte (14) in Bezug auf die vertikale Linie symmetrisch angeordnet sind.

8. Aufzugsvorrichtung nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass die Antriebseinrichtung (6) eine Low-Profile-Fördermaschine ist, mit einer Abmessung in einer Axialrichtung entlang der

Drehwelle, die kleiner ist als eine Abmessung in einer Radialrichtung, senkrecht zu der Drehwelle.

Revendications

1. Appareil d'ascenseur comprenant :

un dispositif d'entraînement (6) ayant un corps de dispositif d'entraînement (7) et une poulie d'entraînement (8) mise en rotation autour d'un arbre rotatif s'étendant verticalement par le corps de dispositif d'entraînement (7), et étant disposé dans une partie supérieure à l'intérieur d'une cage (1) ;

une cabine (4) destinée à être soulevée/abaissée à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

un contrepoids (5) destiné à être soulevé/abaissé à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

caractérisé en ce que le contrepoids (5) est pourvu d'une première partie de raccordement de câble de contrepoids (13) et d'une deuxième partie de raccordement de câble de contrepoids (14) ; et

en ce que l'appareil d'ascenseur comprend en outre :

une poulie de suspension de cabine (9, 10) prévue sur la cabine (4) ;

une première poulie de retour côté cabine (11) et une deuxième poulie de retour côté cabine (12) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus de la cabine (4) ;

une première poulie de retour côté contrepoids (15) et une deuxième poulie de retour côté contrepoids (16) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus du contrepoids (5) ; et

un câble principal (17) ayant une première extrémité de câble (17a) raccordée à la première partie de raccordement de câble de contrepoids (13) et une deuxième extrémité de câble (17b) raccordée à la deuxième partie de raccordement de câble de contrepoids (14), et étant enroulé de manière sé-

quentielle autour de la première poulie de retour côté contrepoids (15), de la poulie d'entraînement (8), de la première poulie de retour côté cabine (11), de la poulie de suspension de cabine (9, 10), de la deuxième poulie de retour côté cabine (12), et de la deuxième poulie de retour côté contrepoids (16) tout en s'étendant depuis la première

extrémité de câble (17a) jusqu'à la deuxième extrémité de câble (17b), pour suspendre la cabine (4) et le contrepoids (5) à l'intérieur de la cage (1).

2. Appareil d'ascenseur comprenant :

un dispositif d'entraînement (6) ayant un corps de dispositif d'entraînement (7) et une poulie d'entraînement (8) mise en rotation autour d'un arbre rotatif s'étendant verticalement par le corps de dispositif d'entraînement (7), et étant disposé dans une partie supérieure à l'intérieur d'une cage (1) ;

une cabine (4) destinée à être soulevée/abaissée à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

un contrepoids (5) destiné à être soulevé/abaissé à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

caractérisé en ce que :

la cabine (4) est pourvue d'une première partie de raccordement de câble de cabine (21) et d'une deuxième partie de raccordement de câble de cabine (22) ; et

en ce que l'appareil d'ascenseur comprend en outre :

une poulie de suspension de contrepoids (23) prévue sur le contrepoids (5) ;

une première poulie de retour côté cabine (11) et une deuxième poulie de retour côté cabine (12) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus de la cabine (4) ;

une première poulie de retour côté contrepoids (15) et une deuxième poulie de retour côté contrepoids (16) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus du contrepoids (5) ; et

un câble principal (17) ayant une première extrémité de câble (17a) raccordée à la première partie de raccordement de câble de cabine (21) et une deuxième extrémité de câble (17b) raccordée à la deuxième partie de raccordement de câble de cabine (22),

et étant enroulé de manière séquentielle autour de la première poulie de retour côté cabine (11), de la poulie d'entraînement (8), de la première poulie de retour côté contrepoids (15), de la poulie de suspension de contrepoids (23), de la deuxième poulie de retour côté contrepoids (16), et de la deuxième poulie de retour côté cabine (12) tout en

s'étendant depuis la première extrémité de câble (17a) jusqu'à la deuxième extrémité de câble (17b), pour suspendre la cabine (4) et le contrepoids (5) à l'intérieur de la cage (1).

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3. Appareil d'ascenseur comprenant :

un dispositif d'entraînement (6) ayant un corps de dispositif d'entraînement (7) et une poulie d'entraînement (8) mise en rotation autour d'un arbre rotatif s'étendant verticalement par le corps de dispositif d'entraînement (7), et étant disposé dans une partie supérieure à l'intérieur d'une cage (1) ;

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une cabine (4) destinée à être soulevée/abaissée à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

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un contrepoids (5) destiné à être soulevé/abaissé à l'intérieur de la cage (1) sous l'effet d'une force d'entraînement du dispositif d'entraînement (6) ;

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caractérisé en ce que :

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la cabine (4) est pourvue d'une première partie de raccordement de câble de cabine (21) et d'une deuxième partie de raccordement de câble de cabine (22) ;

le contrepoids (5) est pourvu d'une première partie de raccordement de câble de contrepoids (13) et d'une deuxième partie de raccordement de câble de contrepoids (14) ; et

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en ce que l'appareil d'ascenseur comprend en outre :

une première poulie de retour côté cabine (11) et une deuxième poulie de retour côté cabine (12) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus de la cabine (4) ;

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une première poulie de retour côté contrepoids (15) et une deuxième poulie de retour côté contrepoids (16) qui sont disposées dans la partie supérieure à l'intérieur de la cage (1) et au-dessus du contrepoids (5) ; et un corps de câble principal (31) ayant un premier câble principal (32), qui comporte une première extrémité de câble (32a) raccordée à la première partie de raccordement de câble de cabine (21) et une deuxième extrémité de câble (32b) raccordée à la première partie de raccordement de câble de contrepoids (13) et est enroulé de manière séquentielle autour de la première poulie de retour côté cabine (11), de la pou-

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lie d'entraînement (8), et de la première poulie de retour côté contrepoids (15) tout en s'étendant depuis la première extrémité de câble (32a) jusqu'à la deuxième extrémité de câble (32b), et un deuxième câble principal (33), qui comporte une troisième extrémité de câble (33a) raccordée à la deuxième partie de raccordement de câble de cabine (22) et une quatrième extrémité de câble (33b) raccordée à la deuxième partie de raccordement de câble de contrepoids (14) et est enroulé de manière séquentielle autour de la deuxième poulie de retour côté cabine (12) et de la deuxième poulie de retour côté contrepoids (16) et contourne la poulie d'entraînement (8) tout en s'étendant depuis la troisième extrémité de câble (33a) jusqu'à la quatrième extrémité de câble (33b), pour suspendre la cabine (4) et le contrepoids (5) à l'intérieur de la cage (1).

4. Appareil d'ascenseur selon la revendication 1, caractérisé en ce que :

une paire de rails de guidage de cabine (2) destinés à guider la cabine (4) sont prévus dans la cage (1) ;

la cabine (4) est pourvue d'une paire de poulies de suspension de cabine (9, 10) comme mentionné ci-dessus ; et

les poulies de suspension de cabine respectives (9, 10) sont disposées symétriquement par rapport à un point central d'un segment de droite reliant les rails de guidage de cabine respectifs (2) l'un à l'autre sur un plan de projection vertical de la cage (1).

5. Appareil d'ascenseur selon la revendication 2 ou 3, caractérisé en ce que :

une paire de rails de guidage de cabine (2) destinés à guider la cabine (4) sont prévus dans la cage (1) ; et

la première partie de raccordement de câble de cabine (21) et la deuxième partie de raccordement de câble de cabine (22) sont disposées symétriquement par rapport à un point central d'un segment de droite reliant les rails de guidage de cabine respectifs (2) l'un à l'autre sur un plan de projection vertical de la cage (1).

6. Appareil d'ascenseur selon la revendication 1 ou 3, caractérisé en ce que :

la première partie de raccordement de câble de contrepoids (13) et la deuxième partie de raccordement de câble de contrepoids (14) sont

disposées symétriquement par rapport à une ligne verticale s'étendant au-delà d'un centre de gravité du contrepoids (5) ; et la première partie de raccordement de câble de contrepoids (13) et la deuxième partie de raccordement de câble de contrepoids (14) sont espacées l'une de l'autre par un jeu qui est réglé dans une plage prédéterminée.

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7. Appareil d'ascenseur selon la revendication 1 ou 3, **caractérisé en ce que :**

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le contrepoids (5) est pourvu d'un nombre pair de premières parties de raccordement de câble de contrepoids (13) comme mentionné ci-dessus et d'un nombre pair de deuxièmes parties de raccordement de câble de contrepoids (14) comme mentionné ci-dessus ; et les premières parties de raccordement de contrepoids respectives (13) sont disposées symétriquement par rapport à une ligne verticale s'étendant au-delà d'un centre de gravité du contrepoids (5) ; et les deuxièmes parties de raccordement de contrepoids respectives (14) sont disposées symétriquement par rapport à la ligne verticale.

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8. Appareil d'ascenseur selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** le dispositif d'entraînement (6) est une machine de levage à profil bas ayant une dimension dans une direction axiale le long de l'arbre rotatif qui est inférieure à une dimension dans une direction radiale perpendiculaire à l'arbre rotatif.

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FIG. 1

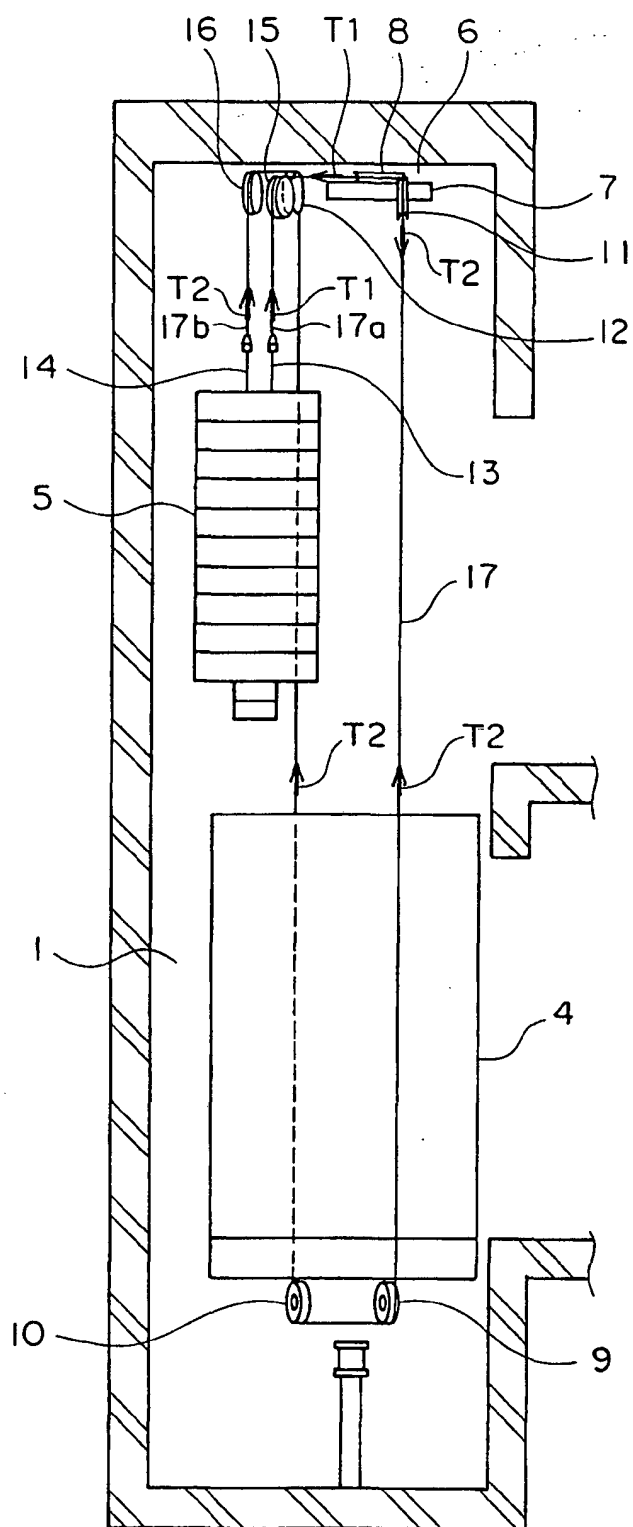


FIG. 2

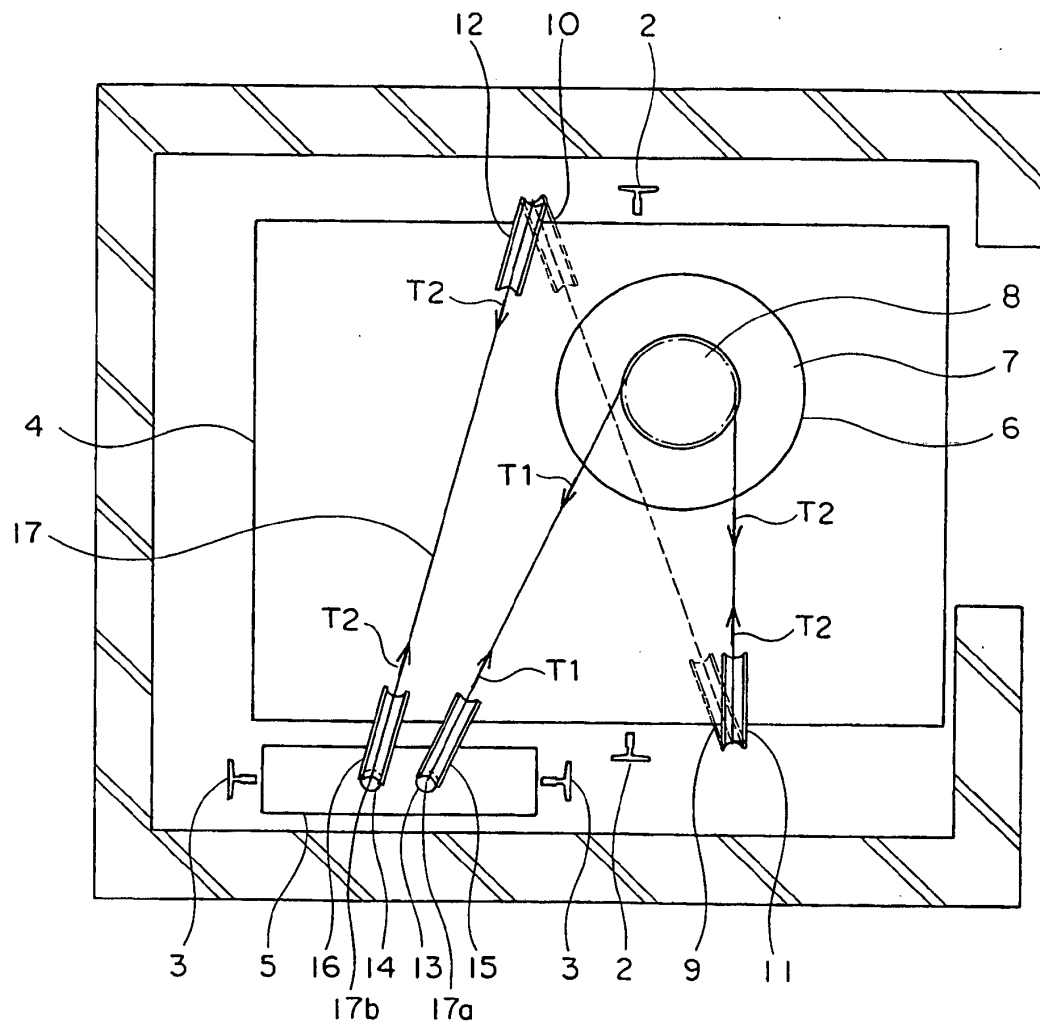


FIG. 3

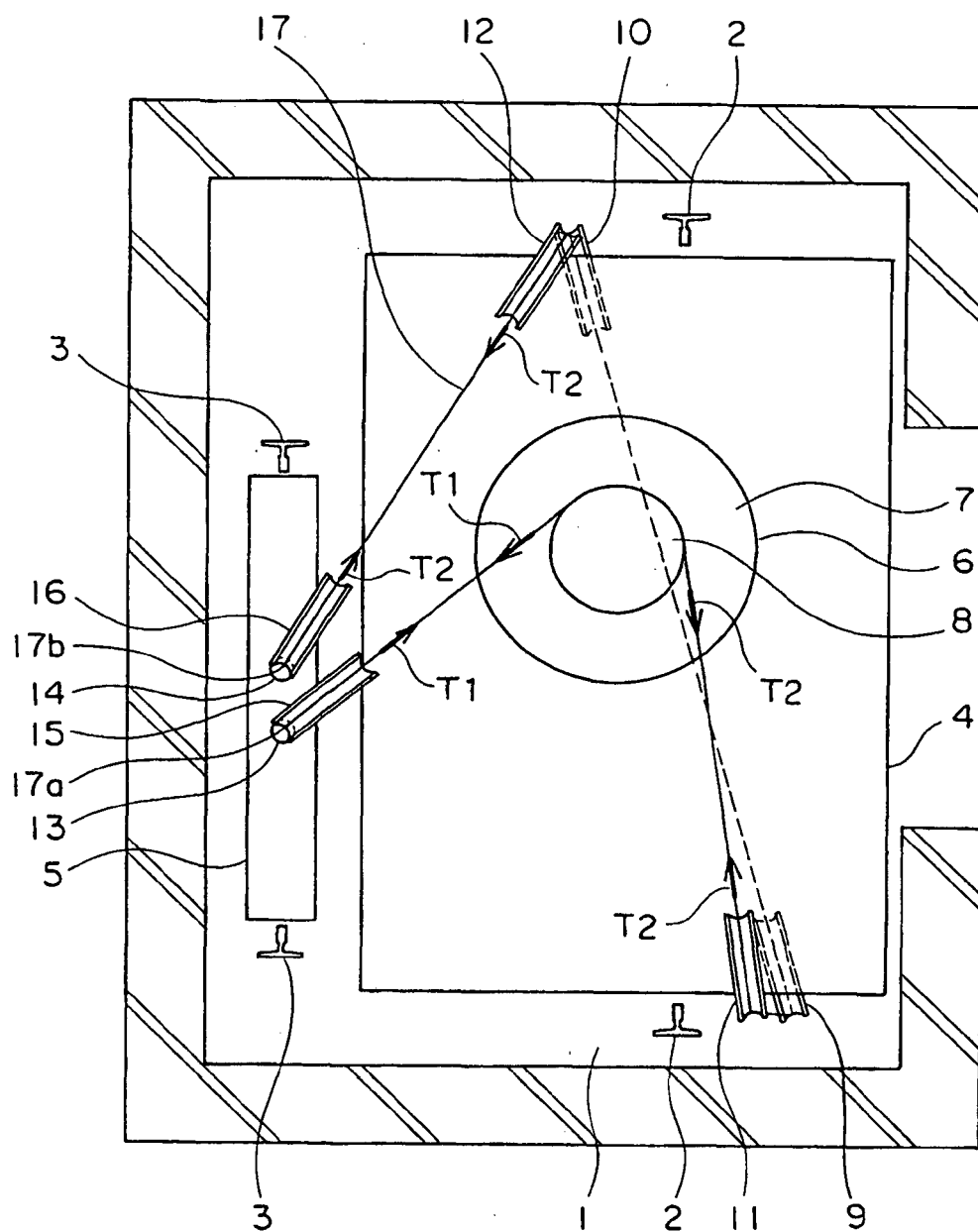


FIG. 4

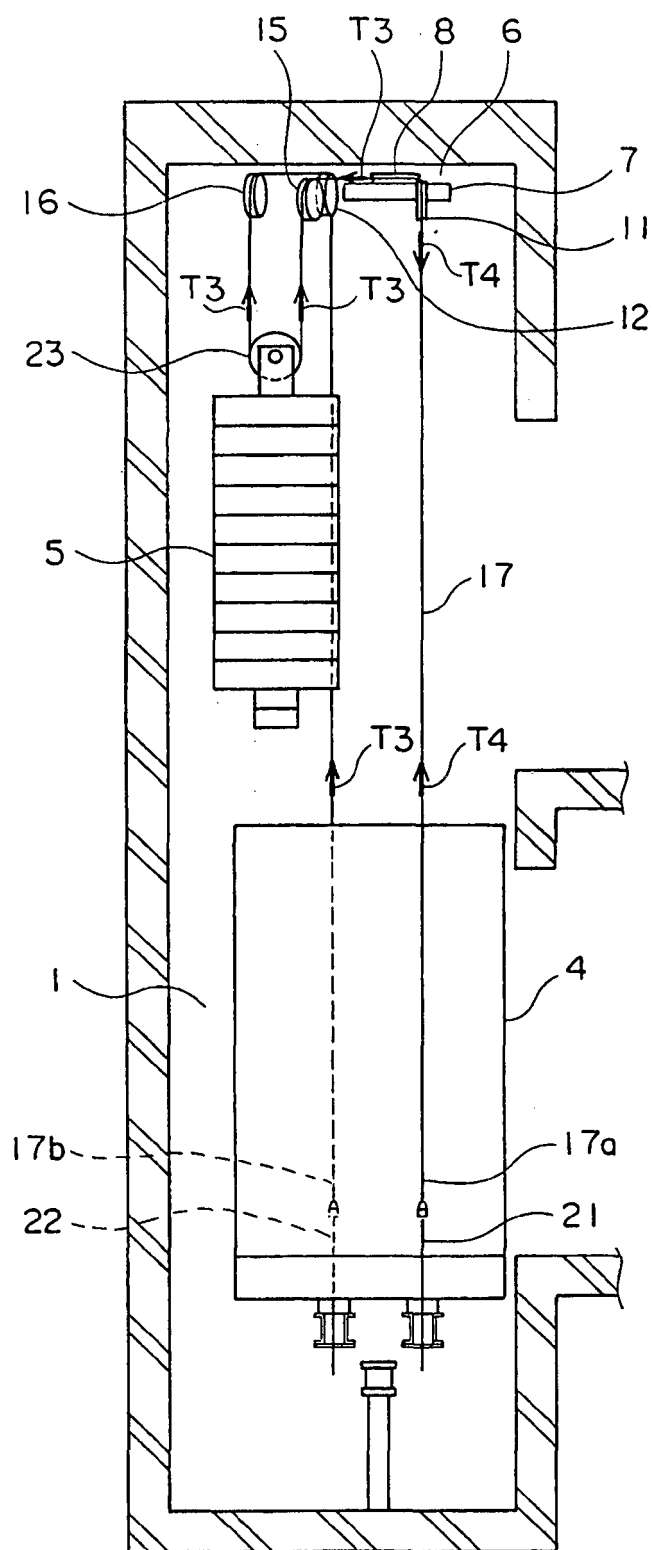
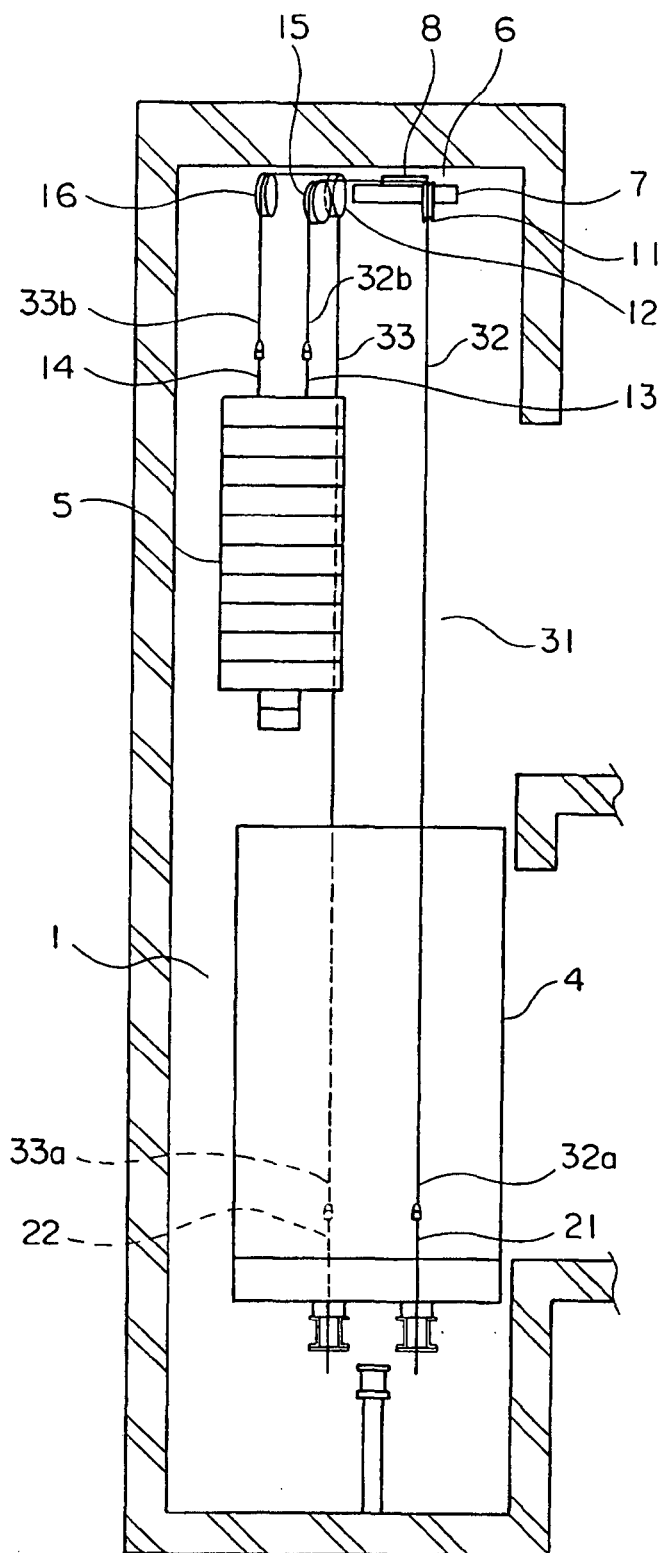


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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- JP 10139321 A [0003]