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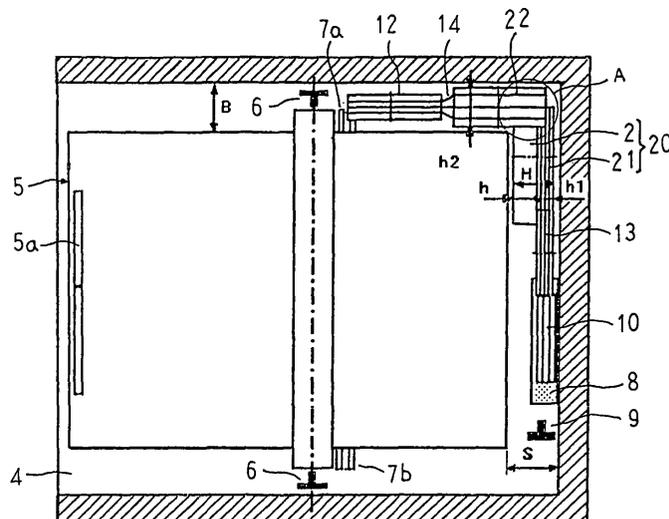
(54) **ELEVATOR DEVICE**

(57) The present invention provides an elevator apparatus enabling construction costs to be reduced by making a rope groove pitch of a return sheave connected to a drive sheave by means of hoisting ropes for changing a rope alignment direction of the hoisting ropes larger than a rope groove pitch of the drive sheave to enable reductions in the thickness of the drive sheave and reduce a gap between a car and a wall surface of a hoistway.

The elevator hoisting machine is provided with a

hoisting machine mounted with a shaft of a motor portion perpendicular to a rear wall surface in a depth direction of the hoistway, and a return sheave connected to a drive sheave of the hoisting machine by means of the hoisting ropes for changing a direction of alignment of the hoisting ropes, disposed in a gap between the car and one side wall surface of the hoistway in a width direction so as to be rotatable around a horizontal axis. A rope groove pitch of the return sheave is formed so as to be greater than a rope groove pitch of the drive sheave.

FIG. 1



Description

Technical Field

[0001] The present invention relates to an elevator apparatus from which a machine room is omitted, and particularly to an elevator apparatus in which a hoisting machine is disposed in a gap between a wall of a hoistway and a car.

Background Art

[0002] Figure 9 is a lateral cross section showing a conventional elevator apparatus, Figure 10 is an enlargement of Portion A in Figure 9, and Figure 11 is a longitudinal section showing the conventional elevator apparatus. Here, to facilitate explanation, a length direction of a hoistway (a direction perpendicular to the surface of the page in Figure 9) shall be referred to as "the vertical direction", a front-back direction of the hoistway (left-right in Figure 9) shall be referred to as "the depth direction", and a width direction of the hoistway (up-down in Figure 9) shall be referred to as "the lateral direction".

[0003] In the figures, a hoisting machine 1 is constituted by a motor portion 2, and a drive sheave 3 fixed to a rotating shaft of the motor portion 2, being constructed into a disk shape that is generally flat in an axial direction of the rotating shaft of the motor portion 2. The hoisting machine 1 is mounted in a gap between a car 5 and a rear wall surface in a lower portion of a drive hoistway 4 with the rotating shaft of the motor portion 2 aligned in the depth direction.

[0004] The car 5 is raisably disposed so as to be guided by a pair of car guide rails 6 disposed so as to extend in the vertical direction on right and left wall surfaces of the hoistway 4. The car 5 is disposed inside the hoistway 4 with car doors 5a facing the front of the hoistway 4. A pair of car suspension sheaves 7a and 7b are mounted to generally central portions in the depth direction of left and right edge portions of the lower end of the car 5 so as to be rotatable around shafts having axes aligned in the depth direction.

[0005] A counterweight 8 is raisably disposed so as to be guided by a pair of counterweight guide rails 9 disposed so as to extend in the vertical direction on a rear wall surface of the hoistway 4. A counterweight deflection pulley 10 is mounted to an upper portion of the counterweight 8 so as to be rotatable around a shaft having an axis aligned in the depth direction.

[0006] First and second return sheaves 11 and 12 are mounted in an upper portion of the hoistway 4 so as to be rotatable around shafts having axes aligned in the lateral direction. The first and second return sheaves 11 and 12 are disposed so as to line up in the depth direction behind the car suspension sheave 7a in a gap B between the car 5 and a left side wall surface of the hoistway 4. A third return sheave 13 is mounted in an

upper portion of the hoistway 4 in a gap S between the car 5 and a rear wall surface of the hoistway 4 so as to be rotatable around a shaft having an axis aligned in the depth direction. The third return sheave 13 is disposed between the counterweight deflection pulley 10 and the drive sheave 3 when viewed from above.

[0007] Ends of hoisting ropes 14 are fixed to a ceiling of the hoistway 4. The hoisting ropes 14 are lowered from the ceiling, are passed through the car suspension sheave 7b, pass under the car 5, are passed through the car suspension sheave 7a, and are then raised to the second return sheave 12. Then the hoisting ropes 14 are passed through the second return sheave 12 and the first return sheave 11, and are then lowered to the drive sheave 3. The hoisting ropes 14 are passed through the drive sheave 3 and then raised to the third return sheave 13. Next, the hoisting ropes 14 are passed through the third return sheave 13, and are lowered to the counterweight deflection pulley 10, are passed through the counterweight deflection pulley 10, and are then raised and the other ends are fixed to the ceiling.

[0008] In an elevator apparatus constructed in this manner, the motor portion 2 of the hoisting machine 1 is activated and controlled by a control apparatus (not shown), driving the drive sheave 3 to rotate. Thus, the hoisting ropes 14 are moved by the drive sheave 3, and the car 5 and the counterweight 8 are guided by the car guide rails 6 and the counterweight guide rails 9 to ascend and descend inside the hoistway 4.

[0009] Here, the hoisting ropes 14 are constituted by a first rope 14a, a second rope 14b, and a third rope 14c. At the same time, the drive sheave 3 and the first return sheave 11 have a thickness h_0 , and are each formed with three rope grooves 3a to 3c and 11a to 11c at a pitch p_0 for accommodating each of the first to third ropes 14a, 14b, and 14c. The rope grooves 3b and 11b are positioned in a central portion in a thickness direction of the drive sheave 3 and the first return sheave 11. The drive sheave 3 and the first return sheave 11 are disposed such that the rope grooves are perpendicular to each other, and end portions of the rope grooves 3b and 11b are aligned in the vertical direction. Here, directions of alignment of the rope grooves 3a to 3c and 11a to 11c of the drive sheave 3 and the first return sheave 11 are aligned with the axes of the drive sheave 3 and the first return sheave 11, respectively, and also aligned with the rope alignment directions of the drive sheave 3 and the first return sheave 11.

[0010] Moreover, although not shown in detail, three rope grooves for accommodating the first to third ropes 14a, 14b, and 14c are also formed at a pitch of p_0 on each of the second and third return sheaves 12 and 13, the car suspension sheaves 7a and 7b, and the counterweight deflection pulley 10. The first and second return sheaves 11 and 12 are disposed with their rope grooves aligned with each other. The drive sheave 3, the third return sheave 13, and the counterweight de-

flection pulley 10 are also disposed with their rope grooves aligned with each other. In addition, the car suspension sheaves 7a and 7b are disposed with their rope grooves aligned with each other, and the car suspension sheave 7a and the second return sheave 12 are disposed with their rope grooves perpendicular to each other.

[0011] Thus, as the hoisting ropes 14 transfer from the drive sheave 3 to the first return sheave 11, as shown in Figure 10, the first rope 14a leaves the rope groove 3a of the drive sheave 3, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 11a of the first return sheave 11, the second rope 14b leaves the rope groove 3b of the drive sheave 3, then extends directly upward and transfers to the rope groove 11b of the first return sheave 11, and the third rope 14c leaves the rope groove 3c of the drive sheave 3, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 11c of the first return sheave 11. In other words, as the hoisting ropes 14 transfer from the drive sheave 3 to the first return sheave 11, the direction of alignment of the first to third ropes 14a to 14c of the hoisting ropes 14 is changed by 90 degrees. In this transition portion where the rope alignment direction changes, because the ropes come into contact with each other if a gap $\delta 0$ between the first to third ropes 14a to 14c is less than or equal to zero, giving rise to abrasion and contact noise between the ropes, the pitch $p 0$ of the rope grooves 3a to 3c and 11a to 11c is set such that the gap $\delta 0$ is greater than or equal to 1 mm.

[0012] In a conventional elevator apparatus constructed in this manner, if the number of ropes and the diameters of the ropes constituting the hoisting ropes 14 are constant, the thickness $h 0$ of the drive sheave 3 and the first return sheave 11 is determined by the pitch $p 0$ of the rope grooves 3a to 3c and 11a to 11c. The gap S in the hoistway 4 is defined by the thickness $H (= h + h 0)$ of the hoisting machine 1, where h is the thickness of the motor portion 2. The gap B in the hoistway 4 is defined by the car 5, the car guide rails 6, and mounting members (not shown) such as rail brackets for mounting the car guide rails 6 to hoistway wall surfaces, etc.

[0013] Thus, one disadvantage has been that the thickness H of the hoisting machine 1 is smallest when the pitch $p 0$ is such that the gap $\delta 0$ is 1 mm, and the gap S cannot be reduced any further than this, preventing scaling down of the hoistway cross section, thereby increasing construction costs.

Disclosure of the Invention

[0014] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus enabling construction costs to be reduced by making a rope groove pitch of a return sheave connected to a drive sheave by means of

hoisting ropes for changing a rope alignment direction of the hoisting ropes larger than a rope groove pitch of the drive sheave to enable reductions in the thickness of the drive sheave and reduce a gap between a car and a wall surface of a hoistway.

[0015] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus including:

a car raisably disposed inside a hoistway;
a hoisting machine being constructed such that a drive sheave formed with a plurality of rope grooves each accommodating a hoisting rope for raising and lowering the car is fixed to a rotating shaft of a motor portion, the hoisting machine being mounted to a wall surface of the hoistway such that an axis of the rotating shaft is generally perpendicular to the wall surface of the hoistway; and
a return sheave connected to the drive sheave by means of the hoisting ropes for changing a direction of alignment of the hoisting ropes, the return sheave being formed with a plurality of rope grooves for accommodating each of the hoisting ropes,

wherein a rope groove pitch of the return sheave is formed so as to be greater than a rope groove pitch of the drive sheave.

Brief Description of the Drawings

[0016]

Figure 1 is a horizontal cross section showing an elevator apparatus according to Embodiment 1 of the present invention;

Figure 2 is an enlargement of Portion A in Figure 1; Figure 3 is a schematic diagram explaining a thickness reduction in a drive sheave in the elevator apparatus according to Embodiment 1 of the present invention;

Figure 4 is an enlargement showing part of an elevator apparatus according to Embodiment 2 of the present invention;

Figure 5 is a schematic diagram explaining a thickness reduction in a drive sheave in the elevator apparatus according to Embodiment 2 of the present invention;

Figure 6 is a horizontal cross section showing an elevator apparatus according to Embodiment 3 of the present invention;

Figure 7 is a longitudinal section showing the elevator apparatus according to Embodiment 3 of the present invention;

Figure 8 is a horizontal cross section showing an elevator apparatus according to Embodiment 4 of the present invention;

Figure 9 is a horizontal cross section showing a conventional elevator apparatus;

Figure 10 is an enlargement of Portion A in Figure 9; and
 Figure 11 is a longitudinal section showing the conventional elevator apparatus.

Best Mode for Carrying Out the Invention

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

Embodiment 1

[0018] Figure 1 is a horizontal cross section showing an elevator apparatus according to Embodiment 1 of the present invention, and Figure 2 is an enlargement of Portion A in Figure 1. Moreover, in the figures, portions identical to or corresponding to those in the conventional elevator apparatus will be given the same numbering, and explanation thereof will be omitted.

[0019] In Figures 1 and 2, a hoisting machine 20 is constituted by a motor portion 2, and a drive sheave 21 fixed to a rotating shaft of the motor portion 2, being constructed into a disk shape that is generally flat in an axial direction of the rotating shaft of the motor portion 2. The hoisting machine 20 is mounted to a rear wall surface in a lower portion of a hoistway 4 with the rotating shaft of the motor portion 2 aligned in the depth direction.

[0020] The drive sheave 21 is formed to a thickness h_1 , and three rope grooves 21a to 21c for accommodating first to third ropes 14a, 14b, and 14c, respectively, are formed at a pitch p_1 . On the other hand, a first return sheave 22 is formed to a thickness h_2 ($> h_0$), and three rope grooves 22a to 22c for accommodating the first to third ropes 14a, 14b, and 14c, respectively, are formed at a pitch p_2 ($p_2 > p_0$). The rope grooves 21b and 22b are positioned in a central portion in a thickness direction of the drive sheave 21 and the first return sheave 22, respectively. The drive sheave 21 and the first return sheave 22 are disposed such that the rope grooves are perpendicular to each other, and end portions of the rope grooves 21b and 22b are aligned in the vertical direction. The first and second return sheaves 22 and 12 are disposed with their rope grooves aligned with each other and the drive sheave 21 and a third return sheave 13 are also disposed with their rope grooves aligned with each other.

[0021] Moreover, the rest of this embodiment is constructed in a similar manner to the conventional elevator apparatus.

[0022] In Embodiment 1, as the hoisting ropes 14 transfer from the drive sheave 21 to the first return sheave 22, as shown in Figure 2, the first rope 14a leaves the rope groove 21a of the drive sheave 21, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 22a of the first return sheave 22, the second rope 14b leaves the rope groove 21b of the drive sheave 21,

then extends directly upward and transfers to the rope groove 22b of the first return sheave 22, and the third rope 14c leaves the rope groove 21c of the drive sheave 21, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 22c of the first return sheave 22. Thus, the rope alignment direction of the hoisting ropes 14 is changed by 90 degrees. In this transition portion where the rope alignment direction changes, the pitches p_1 and p_2 of the rope grooves 21a to 21c and 22a to 22c are set such that the gap δ between the first to third ropes 14a to 14c is greater than or equal to 1 mm.

[0023] In Embodiment 1, because the rope groove pitch p_2 of the first return sheave 22 is greater than the rope groove pitch p_0 of the first return sheave 11 in the conventional device, as shown in Figure 3, the gap δ_1 between the ropes when the rope groove pitch of the drive sheave 21 is p_0 is greater than the gap δ_0 between the ropes in the conventional device. In other words, if the gap δ between the ropes in Embodiment 1 is equal to the gap δ_0 between the ropes in the conventional device, the rope groove pitch p_1 of the drive sheave 21 is less than p_0 . Thus, the thickness h_1 of the drive sheave 21, which is dependent on the rope groove pitch, is thinner than the thickness h_0 of the conventional drive sheave 3.

[0024] Consequently, according to Embodiment 1, because the thickness H of the hoisting machine 1 is ($h + h_1$) and can be made thinner by ($h_0 - h_1$) compared to the conventional device, scaling down of the gap S in the hoistway 4 is made possible. Thus, the hoistway cross section can be reduced, enabling reductions in construction costs.

[0025] Here, the gap B in which the first return sheave 22 is disposed is defined by each of the dimensions of the car 5, the car guide rails 6, and mounting members (not shown) such as rail brackets for mounting the car guide rails 6 to hoistway wall surfaces, etc. Since this gap B is large compared to the thickness h_2 of the first return sheave 22, the thickness h_2 of the first return sheave 22 can be brought close to the gap B . Consequently, if the thickness h_2 of the first return sheave 22 is maximized within a range that does not exceed the gap B (a range that does not hinder the raising and lowering operation of the car 5), the rope groove pitch p_2 of the first return sheave 22 is maximized, enabling the rope groove pitch, and therefore the thickness, of the drive sheave 21, to be minimized. In that case, the thickness of the hoisting machine 20 is minimized, enabling the gap S to be minimized.

Embodiment 2

[0026] Figure 4 is an enlargement showing part of an elevator apparatus according to Embodiment 2 of the present invention.

[0027] In Figure 4, a drive sheave 21A of a hoisting machine 20A is formed to a thickness h_3 , and three rope

grooves 21a to 21c for accommodating first to third ropes 14a, 14b, and 14c, respectively, are formed at a pitch p_3 . The hoisting machine 20A is mounted to a rear wall surface in a lower portion of a hoistway 4 with a rotating shaft of a motor portion 2 aligned in the depth direction. The first return sheave 22 is disposed such that an angle θ formed between the direction of alignment of the rope grooves of the first return sheave 22 and the direction of alignment of the rope grooves of the drive sheave 21 is an acute angle ($\theta < 90$ degrees), and an end portion of the rope groove 22b is aligned with an end portion of the rope groove 21b in the vertical direction.

[0028] Moreover, the rest of the construction is constructed in a similar manner to Embodiment 1 above.

[0029] In Embodiment 2, as the hoisting ropes 14 transfer from the drive sheave 21A to the first return sheave 22, as shown in Figure 2, the first rope 14a leaves the rope groove 21a of the drive sheave 21A, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 22a of the first return sheave 22, the second rope 14b leaves the rope groove 21b of the drive sheave 21A, then extends directly upward and transfers to the rope groove 22b of the first return sheave 22, and the third rope 14c leaves the rope groove 21c of the drive sheave 21A, then extends upward with a predetermined inclination relative to the vertical direction and transfers to the rope groove 22c of the first return sheave 22. Thus, the rope alignment direction of the hoisting ropes 14 is changed by angle θ .

[0030] In Embodiment 2, because the first return sheave 22 is disposed such that the angle θ formed between the direction of alignment of the rope grooves of the first return sheave 22 and the direction of alignment of the rope grooves of the drive sheave 21A is an acute angle, as shown in Figure 5, the gap δ_2 between the ropes in the transition portion where the rope alignment direction changes when the rope groove pitch of the drive sheave 21A is p_1 is greater than the gap δ_0 between the ropes in Embodiment 1 above. In other words, if the gap δ between the ropes in Embodiment 2 is equal to the gap δ_0 between the ropes in Embodiment 1 above, the rope groove pitch p_3 of the drive sheave 21A is less than p_1 . Thus, the thickness h_3 of the drive sheave 21A, which is dependent on the rope groove pitch, is thinner than the thickness h_1 of the drive sheave 21 in Embodiment 1 above.

[0031] Consequently, according to Embodiment 2, because the thickness H of the hoisting machine 20A is $(h + h_3)$ and can be made thinner by $(h_1 - h_3)$ compared to Embodiment 1 above, further scaling down of the gap S in the hoistway 4 is made possible. Thus, the hoistway cross section can be reduced, further enabling reductions in construction costs.

[0032] Here, since the gap B in which the first return sheave 22 is disposed is large compared to the thickness of the first return sheave 22, the rope grooves of

the first return sheave 22 can be inclined relative to the depth direction of the hoistway 4 within a range that does not exceed the gap B (a range that does not hinder the raising and lowering operation of the car 5). Thus, if the rope grooves of the first return sheave 22 are inclined to a maximum relative to the depth direction of the hoistway 4, the rope groove pitch, and therefore the thickness, of the drive sheave 21A can be minimized.

10 Embodiment 3

[0033] Figure 6 is a horizontal cross section showing an elevator apparatus according to Embodiment 3 of the present invention, and Figure 7 is a longitudinal section showing the elevator apparatus according to Embodiment 3 of the present invention.

[0034] In Figures 6 and 7, a car deflection pulley 23 is mounted to a generally central portion of an upper portion of a car 5 so as to be rotatable around a shaft having an axis aligned in the depth direction. First and second return sheaves 22 and 12 are mounted in an upper portion of the hoistway 4 so as to be rotatable around shafts having axes aligned in the lateral direction. The first and second return sheaves 22 and 12 are disposed so as to line up in the depth direction behind the car deflection pulley 23.

[0035] The drive sheave 21 and the first return sheave 22 are disposed such that the rope grooves are perpendicular to each other, and end portions of the rope grooves 21b and 22b are aligned in the vertical direction. The rope grooves 21b and 22b are positioned in a central portion in a thickness direction of the drive sheave 21 and the first return sheave 22.

[0036] Ends of hoisting ropes 14 are fixed to a ceiling of the hoistway 4. The hoisting ropes 14 are lowered from the ceiling, are passed through the car pulley 23, and are then raised to the second return sheave 12. Then, the hoisting ropes 14 are passed through the second return sheave 12 and the first return sheave 22, and are then lowered to the drive sheave 21. The hoisting ropes 14 are passed through the drive sheave 21 and then raised to the third return sheave 13. Next, the hoisting ropes 14 are passed through the third return sheave 13, and are lowered to the counterweight deflection pulley 10, are passed through the counterweight deflection pulley 10, and are then raised, and the other ends are fixed to the ceiling. Thus, as the hoisting ropes 14 transfer from the drive sheave 21 to the first return sheave 22, the direction of alignment of the first to third ropes 14a to 14c of the hoisting ropes 14 is changed by 90 degrees.

[0037] Moreover, the rest of the construction is constructed in a similar manner to Embodiment 1 above.

[0038] In an elevator apparatus constructed in this manner, the motor portion 2 of the hoisting machine 1 is activated and controlled by a control apparatus (not shown), driving the drive sheave 21 to rotate. Thus, the hoisting ropes 14 are moved by the drive sheave 21,

and the car 5 and the counterweight 8 are guided by the car guide rails 6 and the counterweight guide rails 9 to ascend and descend inside the hoistway 4.

[0039] In Embodiment 3, because the rope groove pitch p_2 of the first return sheave 22 is greater than the rope groove pitch p_1 of the drive sheave 21, the gap δ between the ropes is maintained at δ_0 in the transition portion where the rope alignment direction changes when the hoisting ropes 14 transfer from the drive sheave 21 to the first return sheave 22, also enabling the thickness of the drive sheave 21 to be made thinner than that of the conventional drive sheave 3.

[0040] Furthermore, the thickness of the hoisting machine 20 can be minimized by making the gap δ 1 mm.

Embodiment 4

[0041] Figure 8 is a horizontal cross section showing an elevator apparatus according to Embodiment 4 of the present invention.

[0042] In Figure 8, a hoisting machine 20 is mounted in an upper portion of a hoistway 4 with the rotating shaft of a motor portion 2 aligned in the vertical direction. A first return sheave 22 is mounted in an upper portion of the hoistway 4 so as to be rotatable around a shaft having an axis aligned horizontally. The first return sheave 22 is disposed between the hoisting machine 20 and a car suspension sheave 7a. A second return sheave 24 is formed to a thickness h_2 , and is mounted in an upper portion of the hoistway 4 so as to be rotatable around a shaft having an axis aligned horizontally. The second return sheave 24 is disposed between the hoisting machine 20 and a counterweight deflection pulley 10. The second return sheave 24 has three rope grooves for accommodating first to third ropes 14a, 14b, and 14c, respectively, formed at a pitch of p_2 .

[0043] The drive sheave 21 and the first return sheave 22 are disposed such that the directions of alignment of the rope grooves are perpendicular to each other. The drive sheave 21 and the second return sheave 24 are similarly disposed such that the directions of alignment of the rope grooves are perpendicular to each other.

[0044] Ends of hoisting ropes 14 are fixed to a ceiling of the hoistway 4. The hoisting ropes 14 are lowered from the ceiling, are passed through the counterweight deflection pulley 10, and are then raised to the second return sheave 24. Then, the hoisting ropes 14 are passed through the second return sheave 24, changed in direction, and are then extended to the drive sheave 21. Next, the hoisting ropes 14 are passed through the drive sheave 21, changed in direction, and then extended to the first return sheave 22. The hoisting ropes 14 are passed through the first return sheave 22, and are then lowered to the car suspension sheave 7a. Finally, the hoisting ropes 14 are passed through the car suspension sheaves 7a and 7b, and are then raised, and the other ends are fixed to the ceiling.

[0045] Moreover, the rest of the construction is con-

structed in a similar manner to Embodiment 1 above.

[0046] In an elevator apparatus constructed in this manner, the direction of alignment of the first to third ropes 14a to 14c of the hoisting ropes 14 is changed by 90 degrees as the hoisting ropes 14 transfer from the second return sheave 24 to the drive sheave 21, and as the hoisting ropes 14 transfer from the drive sheave 21 to the first return sheave 22.

[0047] Because the rope groove pitch of the first return sheave 22 and the second return sheave 24 is formed to p_2 ($> p_0$), the rope groove pitch of the drive sheave 21 can be made p_1 ($< p_0$) in a similar manner to Embodiment 1 above. In other words, the gap δ between the ropes is maintained at δ_0 in the transition portion where the rope alignment direction changes when the hoisting ropes 14 transfer from the drive sheave 21 to the first return sheave 22, and the gap δ between the ropes is maintained at δ_0 in the transition portion where the rope alignment direction changes when the hoisting ropes 14 transfer from the second return sheave 24 to the drive sheave 21, enabling the thickness of the drive sheave 21 to be made thinner than that of the conventional drive sheave 3. Consequently, according to Embodiment 4, the thickness of the hoisting machine 20 can be reduced, enabling a gap between the car 5 and the ceiling of the hoistway 4 can be reduced, thereby enabling reductions in construction costs.

[0048] Furthermore, in Embodiment 4, the thickness of the hoisting machine 20 can also be minimized by making the gap δ 1 mm.

[0049] Moreover, the first return sheave and the drive sheave are not limited to the arrangements in each of the above embodiments provided that they are disposed such that the rope alignment direction of the hoisting ropes can be changed.

[0050] Furthermore, it goes without saying that the present invention is not limited to the roping methods in each of the above embodiments and may also be applied to other roping methods.

[0051] In each of the above embodiments, the hoisting ropes 14 explained as being constituted by three ropes, but the number of ropes constituting the hoisting ropes is not limited to three, provided that it is a plural number, and may also be four, for example.

[0052] As explained above, according to one aspect of the present invention, there is provided an elevator apparatus including:

a car raisably disposed inside a hoistway;
 a hoisting machine being constructed such that a drive sheave formed with a plurality of rope grooves each accommodating a hoisting rope for raising and lowering the car is fixed to a rotating shaft of a motor portion, the hoisting machine being mounted to a wall surface of the hoistway such that an axis of the rotating shaft is perpendicular to the wall surface of the hoistway; and
 a return sheave connected to the drive sheave by

means of the hoisting ropes for changing a direction of alignment of the hoisting ropes, the return sheave being formed with a plurality of rope grooves for accommodating each of the hoisting ropes,

wherein a rope groove pitch of the return sheave is formed so as to be greater than a rope groove pitch of the drive sheave,

thereby providing an elevator apparatus enabling construction costs to be reduced by enabling reductions in the thickness of the drive sheave and reducing the gap between the car and the wall surface of the hoistway.

[0053] The hoisting machine may be mounted to a rear wall surface in a depth direction of the hoistway,

enabling a gap between the car and the rear wall surface of the hoistway to be reduced, thereby making scaling down of the hoistway cross section possible.

[0054] The car may be raisably disposed so as to be guided by guide rails extending in a vertical direction mounted by mounting members to both side wall surfaces in a width direction of the hoistway,

gaps between the car and the side wall surfaces of the hoistway being formed to minimum dimensions determined by the car, the guide rails, and the mounting members, and

the return sheave being disposed in a gap between the car and one side wall surface of the hoistway so as to be rotatable around a horizontal axis,

enabling the thickness of the return sheave to be brought close to the dimensions of the gap between the car and one side wall surface of the hoistway within a range that does not hinder the raising and lowering operation of the car, thereby making further scaling down of the hoistway cross section possible.

[0055] The hoisting machine may be mounted to a ceiling of the hoistway,

enabling a gap between the car and the ceiling of the hoistway to be reduced, making reductions in the height of the hoistway possible, and thereby enabling construction costs to be reduced.

Claims

1. An elevator apparatus comprising:

a car raisably disposed inside a hoistway;
 a hoisting machine being constructed such that a drive sheave formed with a plurality of rope grooves each accommodating a hoisting rope for raising and lowering said car is fixed to a rotating shaft of a motor portion, said hoisting machine being mounted to a wall surface of said hoistway such that an axis of said rotating shaft is substantially perpendicular to said wall surface of said hoistway; and
 a return sheave connected to said drive sheave

by means of said hoisting ropes for changing a direction of alignment of said hoisting ropes, said return sheave being formed with a plurality of rope grooves for accommodating each of said hoisting ropes,

wherein a rope groove pitch of said return sheave is formed so as to be greater than a rope groove pitch of said drive sheave.

2. The elevator apparatus according to Claim 1, wherein said hoisting machine is mounted to a rear wall surface in a depth direction of said hoistway.

3. The elevator apparatus according to Claim 2, wherein said car is raisably disposed so as to be guided by guide rails extending in a vertical direction mounted by mounting members to both side wall surfaces in a width direction of said hoistway, gaps between said car and said side wall surfaces of said hoistway are formed to minimum dimensions determined by said car, said guide rails, and said mounting members, and

said return sheave is disposed in a gap between said car and one side wall surface of said hoistway so as to be rotatable around a horizontal axis.

4. The elevator apparatus according to Claim 1, wherein said hoisting machine is mounted to a ceiling of said hoistway.

FIG. 1

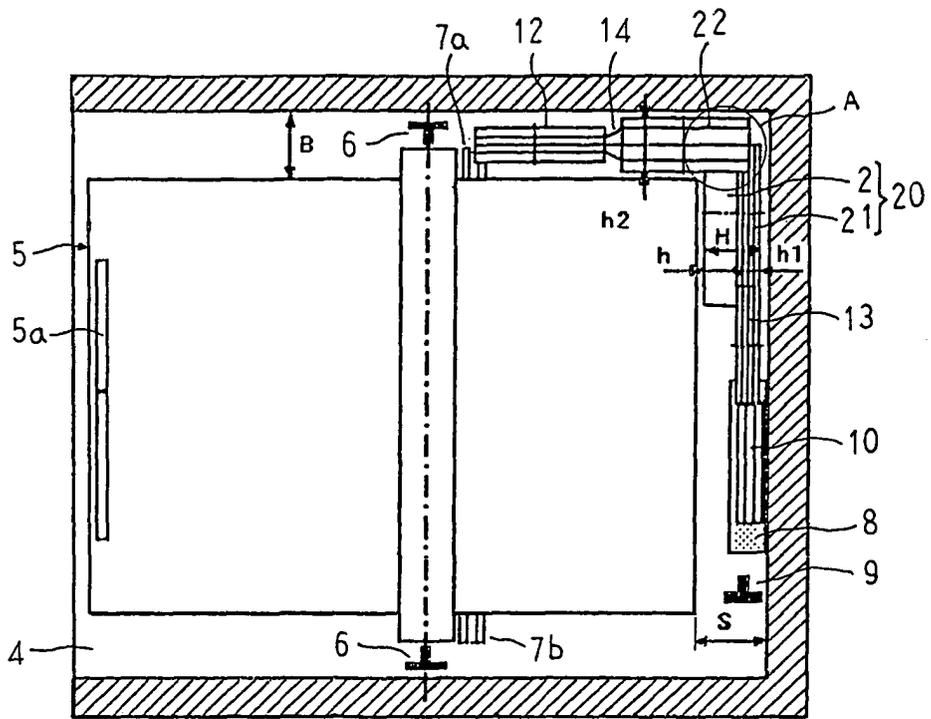


FIG. 2

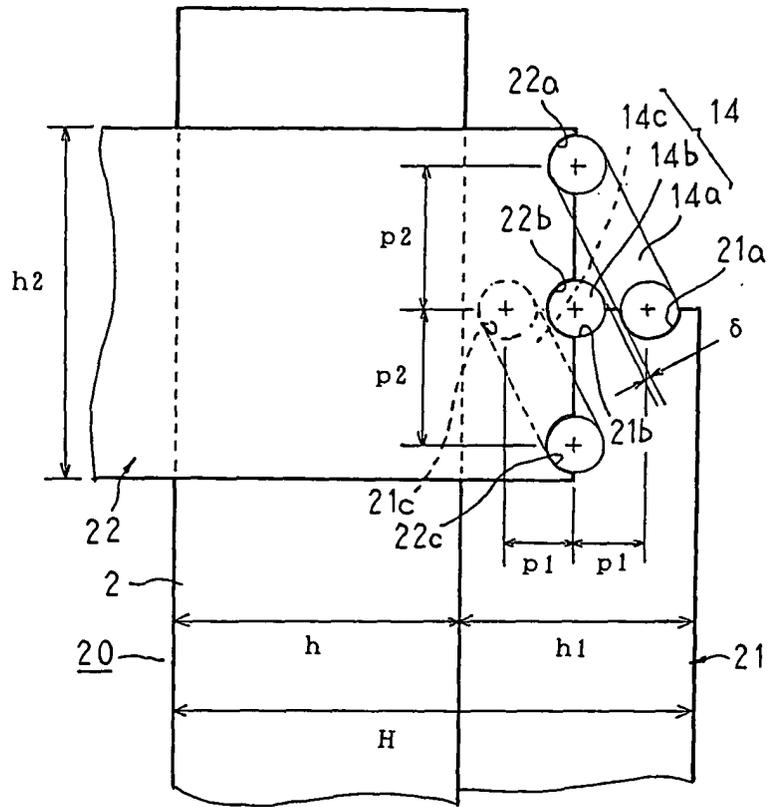


FIG. 3

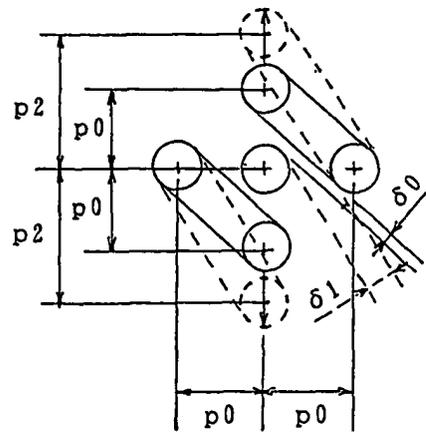


FIG. 4

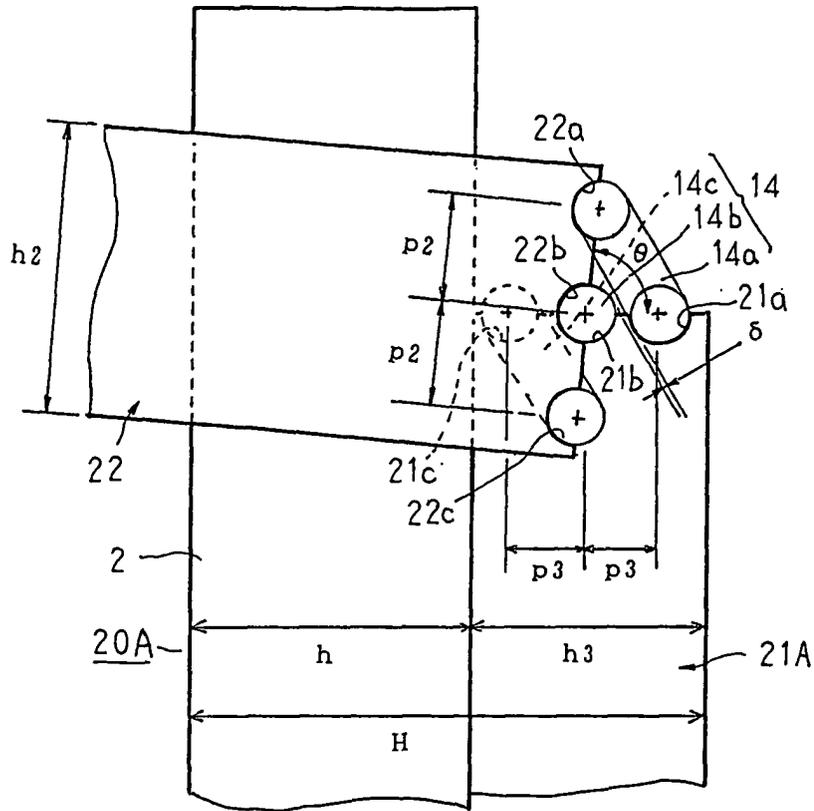


FIG. 5

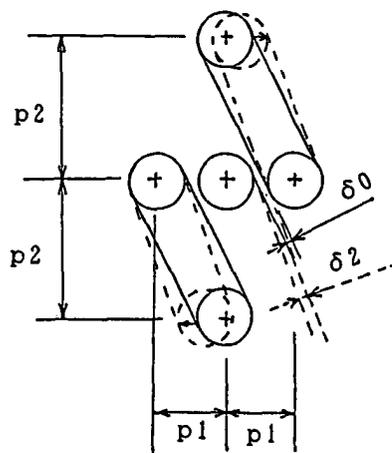


FIG. 7

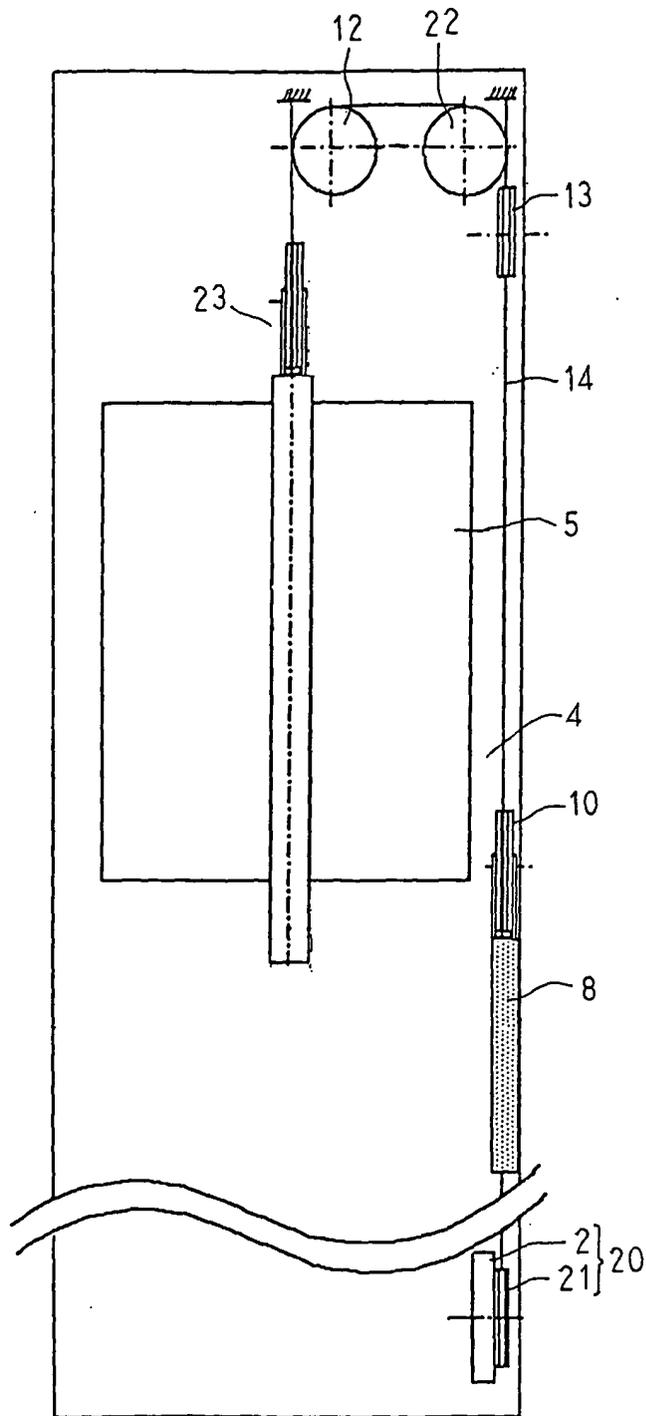


FIG. 8

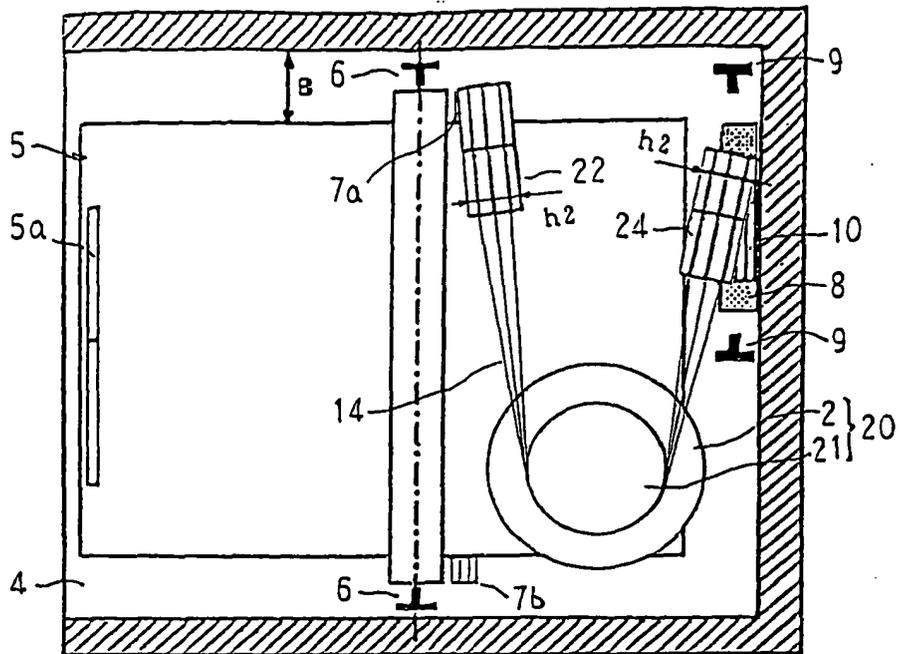
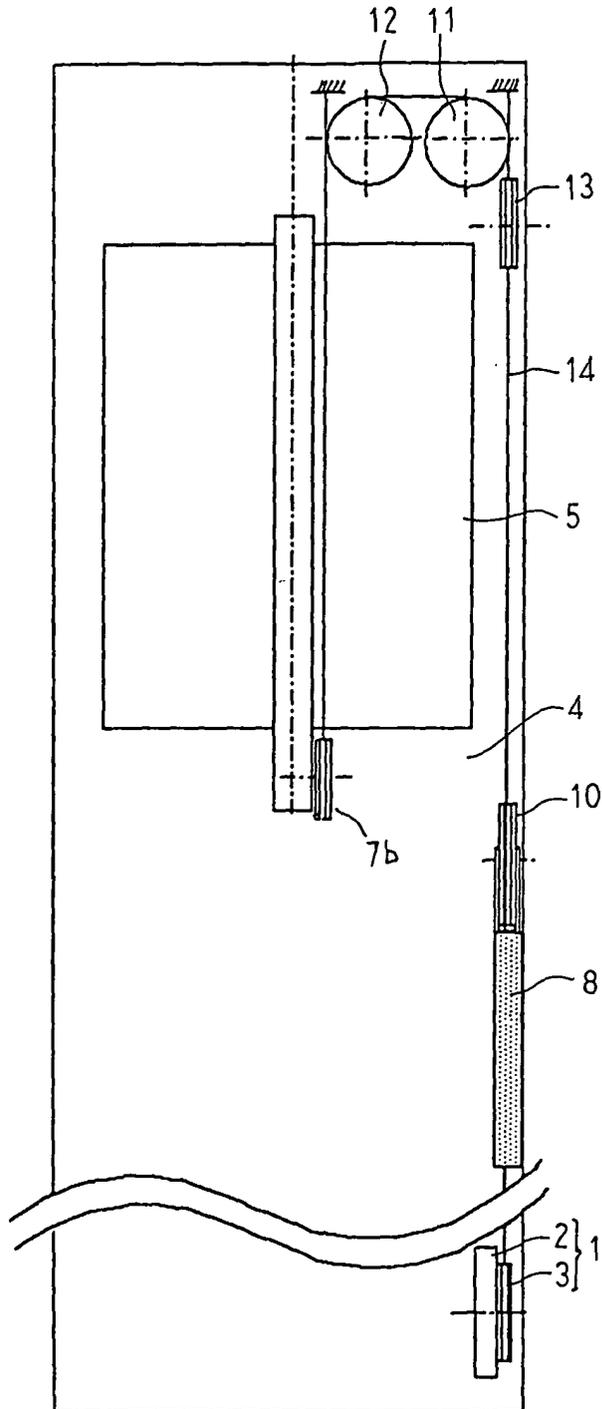


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/06902

<p>A. CLASSIFICATION OF SUBJECT MATTER Int.Cl⁷ B66B7/06, B66B11/08</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>											
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) Int.Cl⁷ B66B7/00-B66B11/08</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2003 Kokai Jitsuyo Shinan Koho 1971-2003 Toroku Jitsuyo Shinan Koho 1994-2003</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>											
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>JP 2000-255933 A (Mitsubishi Electric Corp.), 19 September, 2000 (19.09.00), & EP 1018480 A2 & CN 1260319 A</td> <td>1-4</td> </tr> <tr> <td>A</td> <td>JP 7-61745 A (Otis Elevator Co.), 07 March, 1995 (07.03.95), & EP 0639526 A2 & US 5533595 A</td> <td>1-4</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	JP 2000-255933 A (Mitsubishi Electric Corp.), 19 September, 2000 (19.09.00), & EP 1018480 A2 & CN 1260319 A	1-4	A	JP 7-61745 A (Otis Elevator Co.), 07 March, 1995 (07.03.95), & EP 0639526 A2 & US 5533595 A	1-4
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<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p>											
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td style="vertical-align: top;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="vertical-align: top;"> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p> </td> </tr> </table>			<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>							
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<p>Date of the actual completion of the international search 03 April, 2003 (03.04.03)</p>		<p>Date of mailing of the international search report 22 April, 2003 (22.04.03)</p>									
<p>Name and mailing address of the ISA/ Japanese Patent Office</p>		<p>Authorized officer</p>									
<p>Facsimile No.</p>		<p>Telephone No.</p>									