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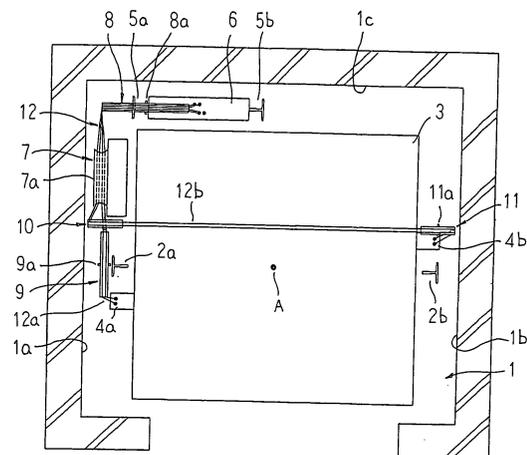
(54) **ELEVATOR APPARATUS**

(57) The present invention aims to provide a machine-roomless elevator apparatus using a one-to-one (1:1) roping method having a simple construction for keeping hoistway dimensions to a minimum, and reducing upper portion space in the hoistway, without aggravating noise from a hoisting machine.

The construction includes: a hoisting machine disposed in a lower portion of a hoistway so as to be positioned in a gap between a wall surface of the hoistway and a first side of a car in a width direction; and first and second rope fastening portions respectively disposed on lower portions of first and second sides of the car in a width direction so as to be in a positional relationship having centrosymmetry relative to a position of a center of gravity of the car, half of the ropes constituting hoisting ropes wound onto a sheave of the hoisting machine being led upward from the sheave, wound over a first car return sheave disposed above the sheave in an upper portion of the hoistway, then lowered and linked to the first rope fastening portion, and a remainder of the ropes constituting the hoisting ropes being led upward from the sheave, wound over a second car return sheave disposed above the sheave in an upper portion of the hoistway, also wound over a third car return sheave disposed above the second rope fastening portion in an upper portion of the hoistway, then lowered and linked to the second rope fastening portion.

Thus, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method for keeping hoistway dimensions to a minimum and reducing upper portion space in the hoistway is achieved.

FIG. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to a machine-roomless elevator apparatus in which a hoisting machine is installed in a lower portion of a hoistway.

BACKGROUND ART

[0002] In recent years, ropes having high flexibility covered with resin, such as synthetic fiber ropes, etc., having superior flexibility, or small diameter high-strength steel ropes, for example, have been developed and produced, making reductions in sizes of sheaves of hoisting machines increasingly possible.

[0003] In conventional machine-roomless elevator apparatuses, reductions in sizes of hoisting machines are mainly achieved by adopting two-to-one (2:1) roping methods. Thus, by applying the newly developed and produced ropes described above to conventional machine-roomless elevator apparatuses adopting these two-to-one (2:1) roping methods, the sheaves can be further reduced in size, enabling hoisting machine torque to be reduced. However, when a car is operated at a given speed, the smaller the sheave, the greater the rotational frequency thereof, and one disadvantage has been that noise increases.

[0004] On the other hand, in conventional machine-roomless elevator apparatuses adopting one-to-one (1:1) roping methods, the rotational frequency of the sheave is reduced by an amount proportionate to the larger sheave compared to elevator apparatus adopting two-to-one (2:1) roping methods, enabling noise to be reduced and making the construction very simple. When a one-to-one (1:1) roping method is adopted, as disclosed in International Patent Publication No. WO 02/16247 A1 (Gazette), for example, a hoisting machine and deflector sheaves are disposed in an upper portion of a hoistway, ropes wound onto the hoisting machine are wound over the deflector sheaves and hung down, and an upper beam of a car is suspended at a position of a center of gravity of the car. Thus, one disadvantage has been that space for installing the hoisting machine and the deflector sheaves is required in the upper portion of the hoistway, making building height proportionately greater.

DISCLOSURE OF INVENTION

[0005] The present invention provides an elevator apparatus having a simple construction achieving a one-to-one (1:1) roping method while keeping hoistway dimensions to a minimum by disposing a sheave in a gap between a hoistway wall in a lower portion of a hoistway and a car to reduce upper portion space in the hoistway without aggravating noise from the hoisting machine.

[0006] 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 and lowerably disposed inside a hoistway; a hoisting machine disposed in a lower portion of the hoistway such that a sheave is positioned in a gap between a wall surface of the hoistway and a first side of the car in a width direction; first and second rope fastening portions respectively disposed on lower portions of first and second sides of the car in a width direction; a counterweight raisably and lowerably disposed in either one of a gap between the first side of the car in a width direction and the wall surface of the hoistway and a gap between a rear side of the car in a depth direction and a wall surface of the hoistway; and hoisting ropes constituted by a plurality of ropes wound onto the sheave, the car and the counterweight being suspended by the hoisting ropes using a one-to-one (1:1) roping method, wherein: half of the ropes constituting the hoisting ropes are led upward from the sheave, wound over a first car return sheave disposed above the sheave in an upper portion of the hoistway, then lowered and linked to the first rope fastening portion, and a remainder of the ropes constituting the hoisting ropes are led upward from the sheave, wound over a second car return sheave disposed above the sheave in an upper portion of the hoistway, also wound over a third car return sheave disposed above the second rope fastening portion in an upper portion of the hoistway, then lowered and linked to the second rope fastening portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention;

Figure 2 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention; Figure 3 is a partially cut away perspective showing a synthetic fiber rope used in a hoisting rope of the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention;

Figure 4 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 2 of the present invention;

Figure 5 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 2 of the present invention; Figure 6 is a cross section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 3 of the present invention; Figure 7 is a cross section showing an elevator apparatus using a one-to-one (1:1) roping method ac-

cording to Embodiment 4 of the present invention; Figure 8 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 5 of the present invention; and

Figure 9 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 5 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

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

Embodiment 1

[0009] Figure 1 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention, and Figure 2 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention.

[0010] In Figures 1 and 2, a pair of car guide rails 2a and 2b are disposed so as to extend in a vertical direction along wall surfaces 1a and 1b in a width direction (left-to-right in Figure 2) of the hoistway 1 at a generally central position in a depth direction of the hoistway 1 (top-to-bottom in Figure 2) so as to face each other in the width direction of the hoistway 1. A car 3 is raisably and lowerably disposed in the hoistway 1 so as to be guided by the car guide rails 2a and 2b. A first rope fastening portion 4a and a second rope fastening portion 4b are disposed on lower portions of first and second sides of the car 3 in a width direction. The first rope fastening portion 4a is positioned to a side of the car guide rail 2a near a landing, and the second rope fastening portion 4b is positioned to a side of the car guide rail 2b away from the landing, the first rope fastening portion 4a and the second rope fastening portion 4b being in a positional relationship having centrosymmetry relative to a position of a center of gravity A of the car 3. Here, the "width direction" of the hoistway 1 and the car 3 means the direction of opening and closing of a door of the car 3.

[0011] A pair of counterweight guide rails 5a and 5b are disposed so as to extend in a vertical direction along a rear wall surface 1c in a depth direction of the hoistway 1 (a side away from the landing) in a gap between the car 3 and the wall surface 1c so as to face each other in a width direction. A counterweight 6 is raisably and lowerably disposed in the hoistway 1 so as to be guided by the counterweight guide rails 5a and 5b.

[0012] A hoisting machine 7 is a thin hoisting machine having an axial length smaller than its diameter, and is disposed in a lower portion of the hoistway 1 so as to be positioned to a side of the car guide rail 2a away from the landing in a gap between the side wall 1a of the hoist-

way 1 and the car 3. A central axis of a sheave 7a of the hoisting machine 7 is horizontal, and is perpendicular to the side wall 1a.

[0013] A counterweight return pulley 8 is disposed in an upper portion of the hoistway 1 so as to be positioned between the counterweight 6 and the hoisting machine 7 in a gap between the wall surfaces 1a and 1c of the hoistway 1 and the car 3. A rotating shaft 8a of the counterweight return pulley 8 is horizontal, and is perpendicular to the central axis of the sheave 7a.

[0014] A first car return pulley 9 is disposed in an upper portion of the hoistway 1 so as to be positioned between the sheave 7a and the first rope fastening portion 4a in a gap between the side wall 1a and the car 3, and so as to avoid interference with the car guide rail 2a. A rotating shaft 9a of the first car return pulley 9 is parallel to the central axis of the sheave 7a. A second car return pulley 10 is disposed in an upper portion of the hoistway 1 so as to be positioned between the sheave 7a and the first car return pulley 9 in a gap between the side wall 1a and the car 3. A rotating shaft 10a of the second car return pulley 10 is horizontal, and is perpendicular to the rotating shaft 9a. In other words, vertical planes containing the rotating shafts 9a and 10a intersect at a predetermined angle ($\theta = 90$ degrees (90°)). In addition, a third car return pulley 11 is disposed in an upper portion of the hoistway 1 so as to be positioned generally vertically above the second rope fastening portion 4b in a gap between the side wall 1b and the car 3. A rotating shaft 11a of the third car return pulley 11 is parallel to the rotating shaft 10a. Here, the second and third car return pulleys 10 and 11 are positioned at an equal height above the car 3 when it is at an uppermost floor, and the first car return pulley 9 is positioned below the second and third car return pulleys 10 and 11.

[0015] Hoisting ropes 12 are constituted by a plurality of ropes having high flexibility, such as synthetic fiber ropes 20 described below, for example, covered with a resin, first ends being fixed to a counterweight 6, led upward, then wound over the counterweight return pulley 8, and lowered down. The hoisting ropes 12 lowered down from the counterweight return pulley 8 are wound onto the sheave 7a, and led upward. Next, ropes 12a constituting half of the hoisting ropes 12 led upward from the sheave 7a are wound over the first car return pulley 9 and lowered, second ends being fixed to the first rope fastening portion 4a. On the other hand, ropes 12b constituting a remainder of the hoisting ropes 12 led upward from the sheave 7a are wound over the second car return pulley 10 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the ropes 12b are wound over the third car return pulley 11 and lowered, second ends being fixed to the second rope fastening portion 4b. Thus, the car 3 and the counterweight 6 are suspended inside the hoistway 1 by the hoisting ropes 12 using a 1:1 roping method.

[0016] Figure 3 is a partially cut away perspective showing a rope such as a synthetic fiber rope having

high flexibility covered with a resin used in a hoisting rope of the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 1 of the present invention.

[0017] In Figure 3, an inner strand layer 24 made of a plurality of inner strands 22 and filler strands 23 disposed so as to fill gaps between the inner strands 22 is disposed around a core wire 21. Each of the inner strands 22 is constituted by a plurality of aramid fibers and an impregnating material such as a polyurethane or the like. Furthermore, each of the filler strands 23 is composed of a polyamide, for example.

[0018] An outer strand layer 26 having a plurality of outer strands 25 is disposed around an outer periphery of the inner strand layer 24. Each of the outer strands 25 is constituted by a plurality of aramid fibers and an impregnating material such as a polyurethane or the like in a similar manner to the inner strands 22.

[0019] A friction-reducing coating layer 27 for preventing abrasion due to friction among the inner strands 22 and the outer strands 25 is disposed between the inner strand layer 24 and the outer strand layer 26. In addition, a protective coating layer 28 is also disposed on an outer portion of the outer strand layer 26.

[0020] A synthetic fiber rope 20 constructed in this manner has a high coefficient of friction compared to conventional steel ropes, and is superior in flexibility. In hoisting ropes 12 constituted by a plurality of these synthetic fiber ropes 20, load is transferred only to the inner and outer strands 22 and 26.

[0021] Thus, according to Embodiment 1, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method enabling noise to be reduced is achieved by a simpler construction than a conventional machine-room elevator apparatus using a two-to-one (2:1) roping method.

[0022] Because the first and second rope fastening portions 4a and 4b are in a positional relationship having centrosymmetry relative to a position of a center of gravity A of the car 3, the car 3 can be suspended at a position of its center of gravity, enabling a stable raising and lowering operation to be achieved.

[0023] Because the hoisting machine 7 is disposed in the lower portion of the hoistway 1, and second and third car return pulleys 10 and 11 are disposed in gaps between the side walls 1a and 1b and the car 3, space in the upper portion of the hoistway 1 can be reduced, enabling building height to be lowered.

[0024] Because synthetic fiber ropes 20 having superior flexibility are used for the hoisting ropes 12, the sheave 7a and the return pulleys can be reduced in diameter. In particular, by using return pulleys having a reduced diameter for the second and third car return pulleys 10 and 11, it is possible to dispose the second and third car return pulleys 10 and 11 at right angles to the wall surfaces 1a and 1b in gaps between the wall surfaces 1a and 1b of the hoistway 1 and the car 3 without increasing cross sectional dimensions of the hoistway

1. Thus, the cross sectional dimensions of the hoistway 1 can be kept to a minimum.

Embodiment 2

[0025] Figure 4 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 2 of the present invention, and Figure 5 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 2 of the present invention.

[0026] In Figures 4 and 5, first and second rope fastening portions 4a and 4b are disposed on lower portions of first and second sides of a car 3 in a width direction in close proximity to car guide rails 2a and 2b to a side of the car guide rails 2a and 2b away from a landing. A first car return pulley 9 is disposed in an upper portion of a hoistway 1 so as to be positioned generally vertically above the first rope fastening portion 4a in a gap between a side wall 1a and the car 3. A rotating shaft 9a of the first car return pulley 9 is horizontal, and is perpendicular to a central axis of a sheave 7a. A second car return pulley 10 is disposed in an upper portion of the hoistway 1 so as to be positioned generally vertically above the first car return pulley 9 in a gap between the side wall 1a and the car 3. A rotating shaft 10a of the second car return pulley 10 is parallel to the rotating shaft 9a. In addition, a third car return pulley 11 is disposed in an upper portion of the hoistway 1 so as to be positioned generally vertically above the second rope fastening portion 4b in a gap between a side wall 1b and the car 3. A rotating shaft 11a of the third car return pulley 11 is parallel to the rotating shaft 10a. Here, the second and third car return pulleys 10 and 11 are positioned at an equal height above the car 3 when it is at an uppermost floor, and the first car return pulley 9 is positioned below the second and third car return pulleys 10 and 11.

[0027] First ends of hoisting ropes 12 are fixed to a counterweight 6, led upward, then wound over a counterweight return pulley 8, and lowered down. The hoisting ropes 12 lowered down from the counterweight return pulley 8 are wound onto the sheave 7a, and led upward. Next, ropes 12a constituting half of the hoisting ropes 12 led upward from the sheave 7a are wound over the first car return pulley 9 and lowered, second ends being fixed to the first rope fastening portion 4a. On the other hand, ropes 12b constituting a remainder of the hoisting ropes 12 led upward from the sheave 7a are wound over the second car return pulley 10 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the ropes 12b are wound over the third car return pulley 11 and lowered, second ends being fixed to the second rope fastening portion 4b. Thus, the car 3 and the counterweight 6 are suspended inside the hoistway 1 by the hoisting ropes 12 using a 1:1 roping method.

[0028] Moreover, the rest of this construction is con-

structed in a similar manner to Embodiment 1 above.

[0029] In Embodiment 2, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method enabling a car 3 to be suspended generally at a position of its center of gravity can also be achieved, enabling similar effects to those in Embodiment 1 above to be achieved.

Embodiment 3

[0030] Figure 6 is a cross section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 3 of the present invention.

[0031] In Figure 6, a first rope fastening portion 4a and a second rope fastening portion 4b are disposed on lower portions of first and second sides of a car 3 in a width direction so as to be in a positional relationship having centrosymmetry relative to a position of a center of gravity A of the car 3. The first rope fastening portion 4a is positioned to a side of a car guide rail 2a away from a landing, and the second rope fastening portion 4b is positioned to a side of a car guide rail 2b near the landing. A first car return pulley 9 is disposed in an upper portion of a hoistway 1 so as to be positioned vertically above a sheave 7a and the first rope fastening portion 4a in a gap between a side wall 1a and the car 3. A rotating shaft 9a of the first car return pulley 9 is parallel to a central axis of the sheave 7a. A second car return pulley 10 is disposed in an upper portion of the hoistway 1 so as to be positioned vertically above the first car return pulley 9 in a gap between the side wall 1a and the car 3. A rotating shaft 10a of the second car return pulley 10 is horizontal, and is inclined relative to the rotating shaft 9a. In other words, vertical planes containing the rotating shafts 9a and 10a of the first and second car return pulleys 9 and 10 intersect at a predetermined angle ($\theta \neq 0$ degrees (0°) or 90 degrees (90°)). In addition, a third car return pulley 11 is disposed in an upper portion of the hoistway 1 so as to be positioned generally vertically above the second rope fastening portion 4b in a gap between a side wall 1b and the car 3. A rotating shaft 11a of the third car return pulley 11 is parallel to the rotating shaft 10a. Here, the second and third car return pulleys 10 and 11 are positioned at an equal height above the car 3 when it is at an uppermost floor, and the first car return pulley 9 is positioned below the second and third car return pulleys 10 and 11.

[0032] First ends of hoisting ropes 12 are fixed to a counterweight 6, led upward, then wound over a counterweight return pulley 8, and lowered down. The hoisting ropes 12 lowered down from the counterweight return pulley 8 are wound onto the sheave 7a, and led upward. Next, ropes 12a constituting half of the hoisting ropes 12 led upward from the sheave 7a are wound over the first car return pulley 9 and lowered, second ends being fixed to the first rope fastening portion 4a. On the other hand, ropes 12b constituting a remainder of the hoisting ropes 12 led upward from the sheave 7a are

wound over the second car return pulley 10 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the ropes 12b are wound over the third car return pulley 11 and lowered, second ends being fixed to the second rope fastening portion 4b. Thus, the car 3 and the counterweight 6 are suspended inside the hoistway 1 by the hoisting ropes 12 using a 1:1 roping method.

[0033] Moreover, the rest of this construction is constructed in a similar manner to Embodiment 1 above.

[0034] In Embodiment 3, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method enabling a car 3 to be suspended at a position of its center of gravity can also be achieved, enabling similar effects to those in Embodiment 1 above to be achieved.

Embodiment 4

[0035] Figure 7 is a cross section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 4 of the present invention.

[0036] In Figure 7, a pair of counterweight guide rails 5a and 5b are disposed so as to extend in a vertical direction along a wall surface 1a to a side of a car guide rail 2a away from a landing in a gap between the wall surface 1a and a car 3 so as to face each other in a depth direction. A counterweight 6 is raisably and lowerably disposed in a hoistway 1 so as to be guided by the counterweight guide rails 5a and 5b.

[0037] A hoisting machine 7 is disposed in a lower portion of the hoistway 1 so as to be positioned to a side of the car guide rail 2a near the landing in a gap between the wall surface 1a and the car 3. A central axis of a sheave 7a of this hoisting machine 7 is horizontal, and is perpendicular to the side wall 1a. A first counterweight return pulley 13 is disposed in an upper portion of the hoistway 1 so as to be positioned vertically above the counterweight 6 in a gap between the wall surface 1a and the car 3. A rotating shaft 13a of the first counterweight return pulley 13 is parallel to a central axis of the sheave 7a. A second counterweight return pulley 14 is disposed in an upper portion of the hoistway 1 in a gap between the wall surface 1a and the hoisting machine 7 such that a rotating shaft 14a is parallel to the rotating shaft 13a.

[0038] A first car return pulley 9 is disposed in an upper portion of a hoistway 1 so as to be positioned vertically above a sheave 7a and the first rope fastening portion 4a in a gap between a side wall 1a and the car 3. A rotating shaft 9a of the first car return pulley 9 is parallel to a central axis of the sheave 7a. A second car return pulley 10 is disposed in an upper portion of the hoistway 1 so as to be positioned vertically above the first car return pulley 9 in a gap between the side wall 1a and the car 3. A rotating shaft 10a of the second car return pulley 10 is horizontal, and is inclined relative to the rotating shaft 9a. In other words, vertical planes containing the rotating shafts 9a and 10a of the first and second car

return pulleys 9 and 10 intersect at a predetermined angle ($\theta \neq 0$ degrees (0°) or 90 degrees (90°)). In addition, a third car return pulley 11 is disposed in an upper portion of the hoistway 1 so as to be positioned generally vertically above the second rope fastening portion 4b in a gap between a side wall 1b and the car 3. A rotating shaft 11a of the third car return pulley 11 is parallel to the rotating shaft 10a. Here, the second and third car return pulleys 10 and 11 are positioned at an equal height above the car 3 when it is at an uppermost floor, and the first car return pulley 9 is positioned below the second and third car return pulleys 10 and 11.

[0039] First ends of hoisting ropes 12 are fixed to a counterweight 6, led upward, then wound over the first counterweight return pulley 13 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the hoisting ropes 12 are wound over the second counterweight return pulley 14, and lowered down. The hoisting ropes 12 lowered down from the second counterweight return pulley 13 are wound onto the sheave 7a, and led upward. Next, ropes 12a constituting half of the hoisting ropes 12 led upward from the sheave 7a are wound over the first car return pulley 9 and lowered, second ends being fixed to the first rope fastening portion 4a. On the other hand, ropes 12b constituting a remainder of the hoisting ropes 12 led upward from the sheave 7a are wound over the second car return pulley 10 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the ropes 12b are wound over the third car return pulley 11 and lowered, second ends being fixed to the second rope fastening portion 4b. Thus, the car 3 and the counterweight 6 are suspended inside the hoistway 1 by the hoisting ropes 12 using a 1:1 roping method.

[0040] Moreover, the rest of this construction is constructed in a similar manner to Embodiment 1 above.

[0041] In Embodiment 4, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method enabling a car 3 to be suspended at a position of its center of gravity can also be achieved, enabling similar effects to those in Embodiment 1 above to be achieved.

[0042] In Embodiment 4, because the first and second counterweight return pulleys 13 and 14 are positioned in the gap between the wall surface 1a and the hoisting machine 7 to avoid interference between the hoisting ropes 12 running between the first and second counterweight return pulleys 13 and 14 and the second car return sheave 10, a width dimension of the hoistway 1 is increased. However, because the counterweight 6 is disposed in the gap between the wall surface 1a and the car 3, depth dimensions of the hoistway 1 are reduced. As a result, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method can be achieved without increasing the cross sectional dimensions of the hoistway 1.

Embodiment 5

[0043] Figure 8 is a longitudinal section showing an elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 5 of the present invention, and Figure 9 is a cross section showing the elevator apparatus using a one-to-one (1:1) roping method according to Embodiment 5 of the present invention.

[0044] In Figures 8 and 9, a hoisting machine 15 is a cylindrical hoisting machine, and is disposed in a pit portion 1d of a hoistway 1 such that a sheave 15a is positioned to a side of a car guide rail 2a away from a landing in a gap between a wall surface 1a of the hoistway 1 and a car 3. A central axis of the sheave 15a is horizontal, and is perpendicular to the wall surface 1a.

[0045] First ends of hoisting ropes 12 are fixed to a counterweight 6, led upward, then wound over a counterweight return pulley 8, and lowered down. The hoisting ropes 12 lowered down from the counterweight return pulley 8 are wound onto the sheave 15a, and led upward. Next, ropes 12a constituting half of the hoisting ropes 12 led upward from the sheave 15a are wound over the first car return pulley 9 and lowered, second ends being fixed to the first rope fastening portion 4a. On the other hand, ropes 12b constituting a remainder of the hoisting ropes 12 led upward from the sheave 15a are wound over the second car return pulley 10 so as to change a rope traveling direction by approximately 90 degrees (90°). Thereafter, the ropes 12b are wound over the third car return pulley 11 and lowered, second ends being fixed to the second rope fastening portion 4b. Thus, the car 3 and the counterweight 6 are suspended inside the hoistway 1 by the hoisting ropes 12 using a 1:1 roping method.

[0046] Moreover, the rest of this construction is constructed in a similar manner to Embodiment 1 above except for the fact that the cylindrical hoisting machine 15 is used instead of the thin hoisting machine 7.

[0047] In Embodiment 5, a machine-roomless elevator apparatus using a one-to-one (1:1) roping method enabling a car 3 to be suspended at a position of its center of gravity can also be achieved, enabling similar effects to those in Embodiment 1 above to be achieved.

[0048] Moreover, in each of the above embodiments, hoisting ropes 12 constituted by a plurality of synthetic fiber ropes 20 are used, but similar effects can also be achieved using hoisting ropes constituted by a plurality of small diameter, high-strength steel ropes.

INDUSTRIAL APPLICABILITY

[0049] As explained above, an elevator apparatus according to the present invention can be used as a machine-roomless elevator apparatus using a one-to-one (1:1) roping method having a simple construction for keeping hoistway dimensions to a minimum, and reducing upper portion space in the hoistway, without aggravating noise from a hoisting machine.

Claims

1. An elevator apparatus comprising:

a car raisably and lowerably disposed inside a hoistway;
 a hoisting machine disposed in a lower portion of said hoistway such that a sheave is positioned in a gap between a wall surface of said hoistway and a first side of said car in a width direction;
 first and second rope fastening portions respectively disposed on lower portions of first and second sides of said car in a width direction;
 a counterweight raisably and lowerably disposed in either one of a gap between said first side of said car in a width direction and said wall surface of said hoistway and a gap between a rear side of said car in a depth direction and a wall surface of said hoistway; and
 hoisting ropes constituted by a plurality of ropes wound onto said sheave,

said car and said counterweight being suspended by said hoisting ropes using a one-to-one (1:1) roping method,
 wherein:

half of said ropes constituting said hoisting ropes are led upward from said sheave, wound over a first car return sheave disposed above said sheave in an upper portion of said hoistway, then lowered and linked to said first rope fastening portion, and a remainder of said ropes constituting said hoisting ropes are led upward from said sheave, wound over a second car return sheave disposed above said sheave in an upper portion of said hoistway, also wound over a third car return sheave disposed above said second rope fastening portion in an upper portion of said hoistway, then lowered and linked to said second rope fastening portion.

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

said first car return sheave and said second car return sheave are disposed such that vertical planes respectively containing a rotating shaft of each intersect at a predetermined angle.

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

said first rope fastening portion and said second rope fastening portion are disposed in a po-

sitional relationship having centrosymmetry relative to a position of a center of gravity of said car.

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

said first to third car return sheaves are disposed in a gap between said wall surface of said hoistway and said car.

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

said hoisting machine is a thin hoisting machine having an axial length smaller than its diameter, and is disposed in a gap between a wall surface of said hoistway and one side of said car in a width direction.

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

said hoisting machine is a cylindrical hoisting machine, and is disposed in a pit portion of said hoistway.

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

said plurality of ropes are each constituted by a rope having high flexibility covered with a resin.

FIG. 1

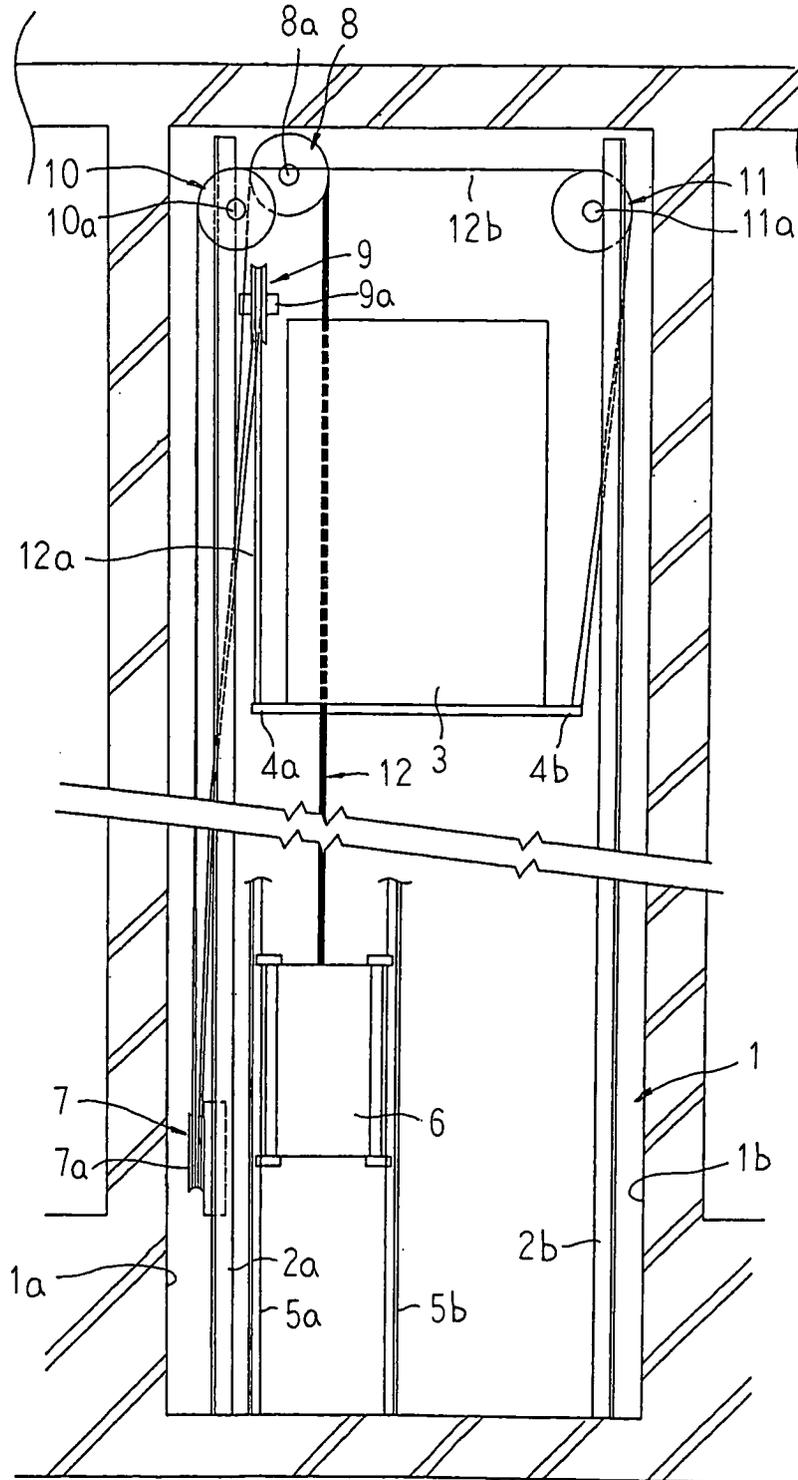


FIG. 2

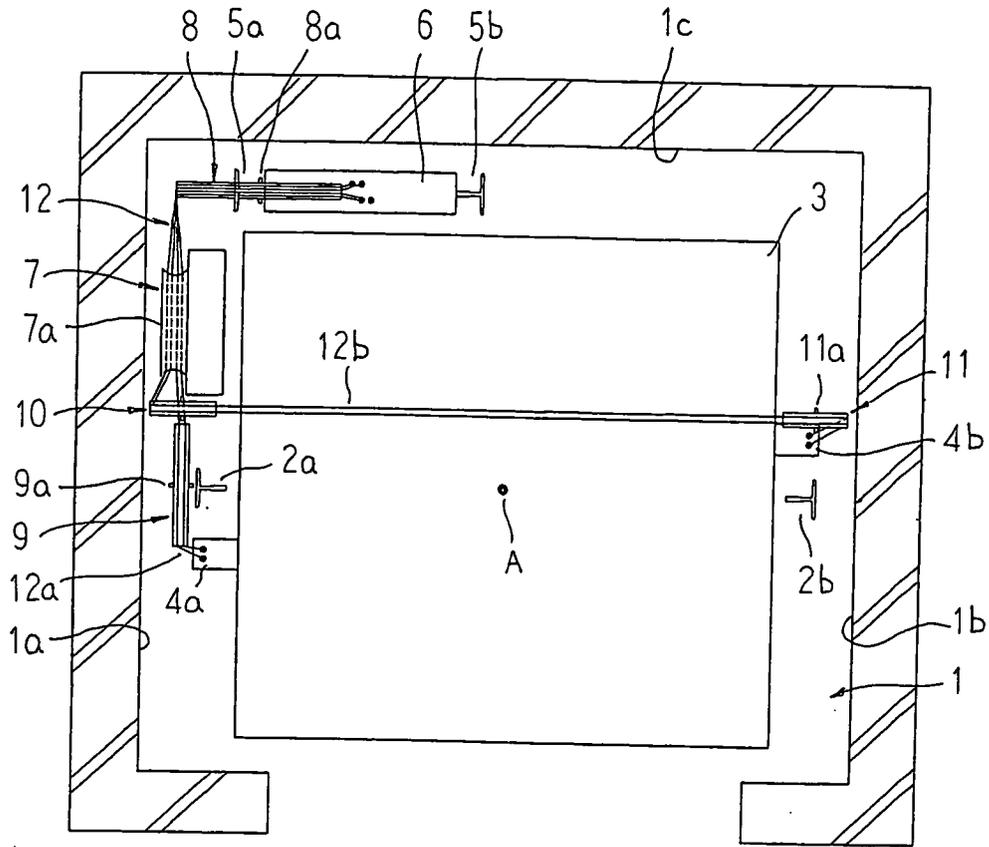


FIG. 3

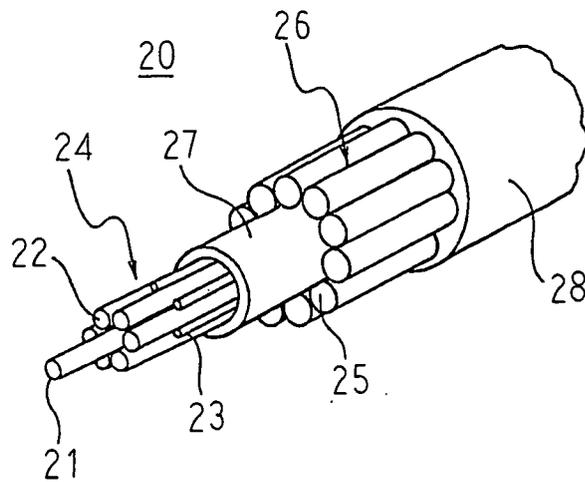


FIG. 5

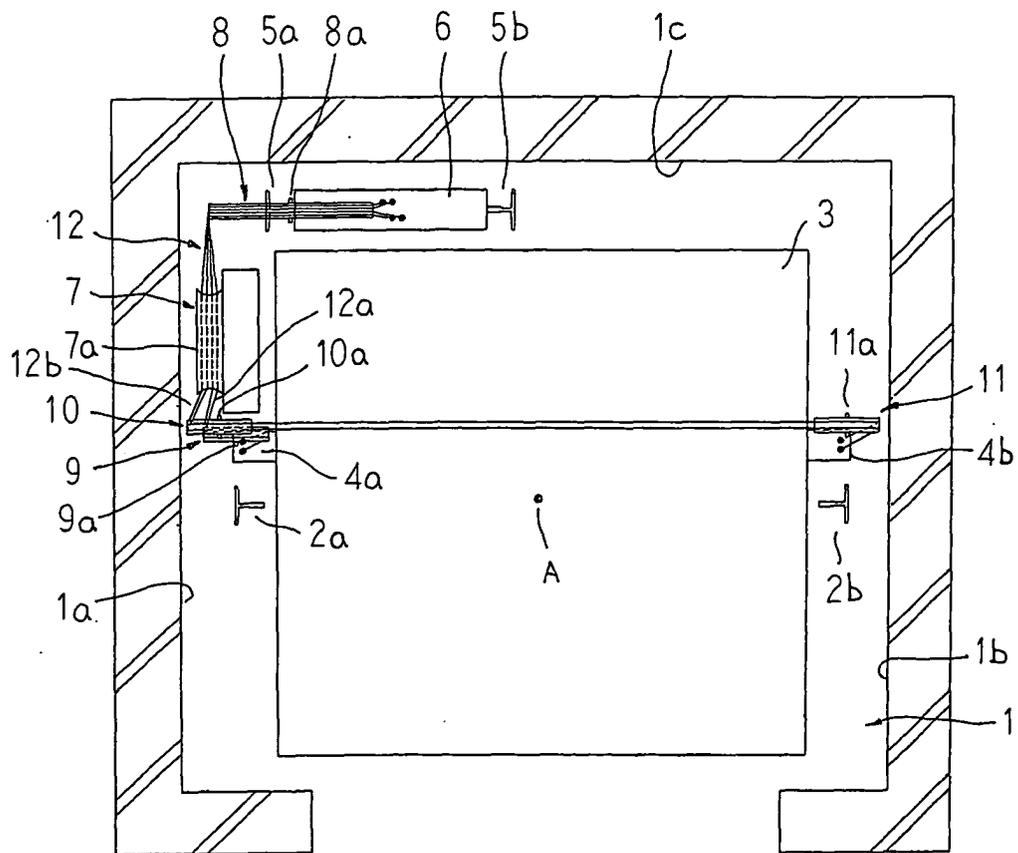


FIG. 6

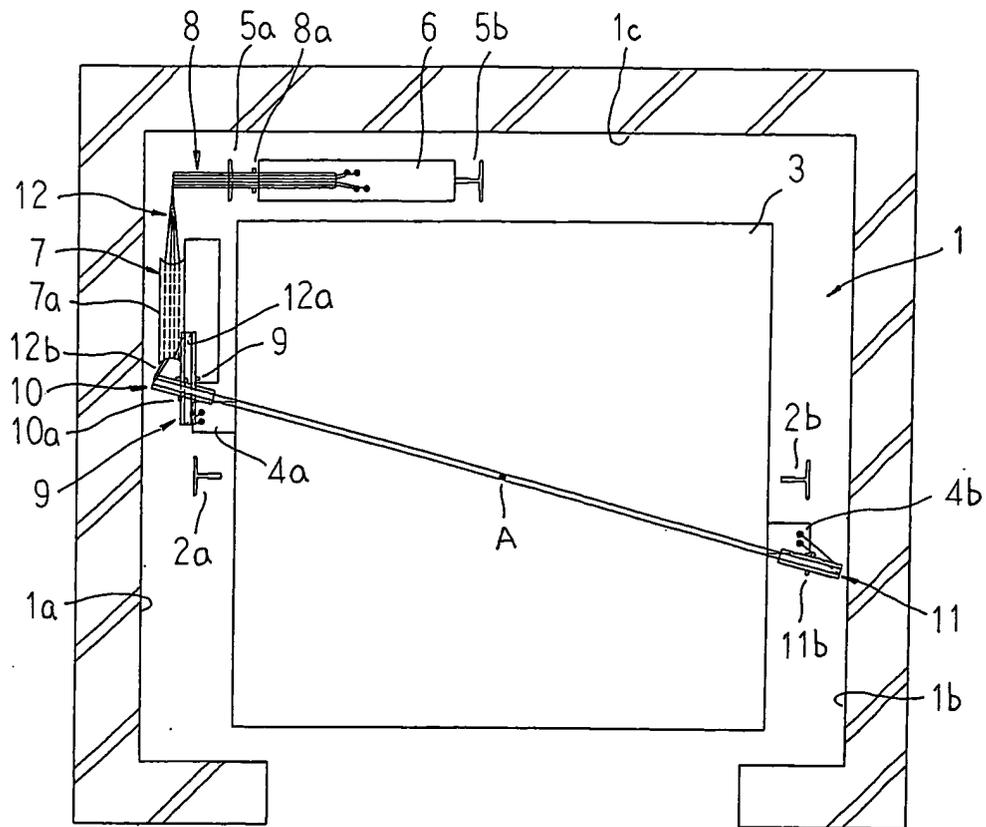


FIG. 7

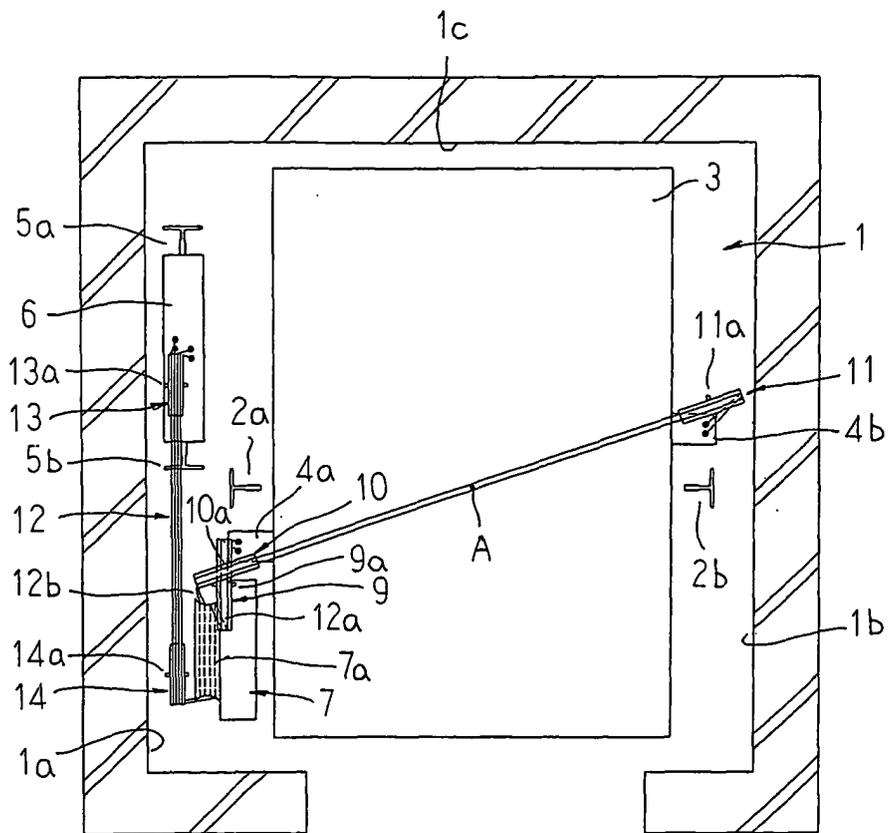


FIG. 8

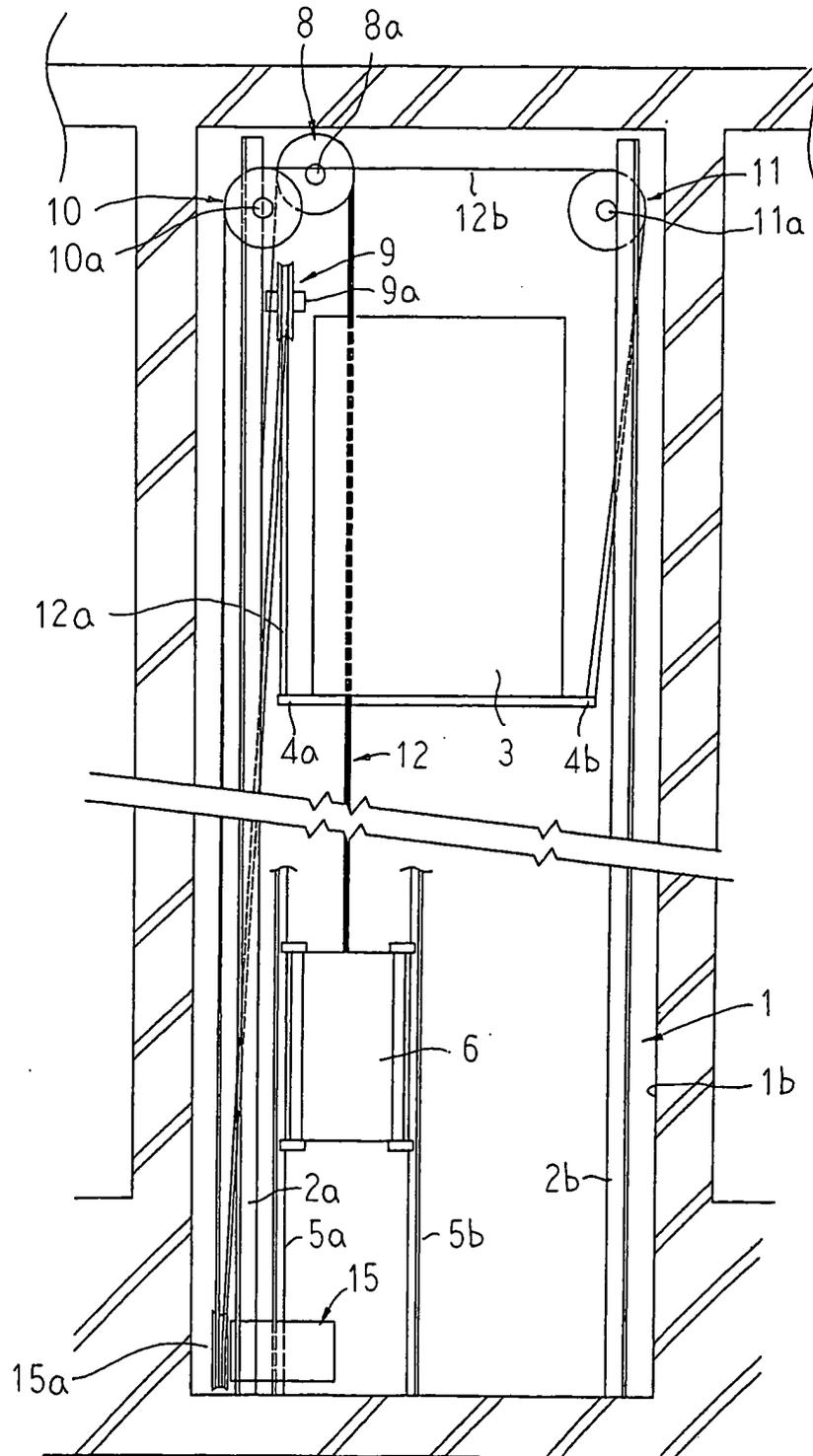
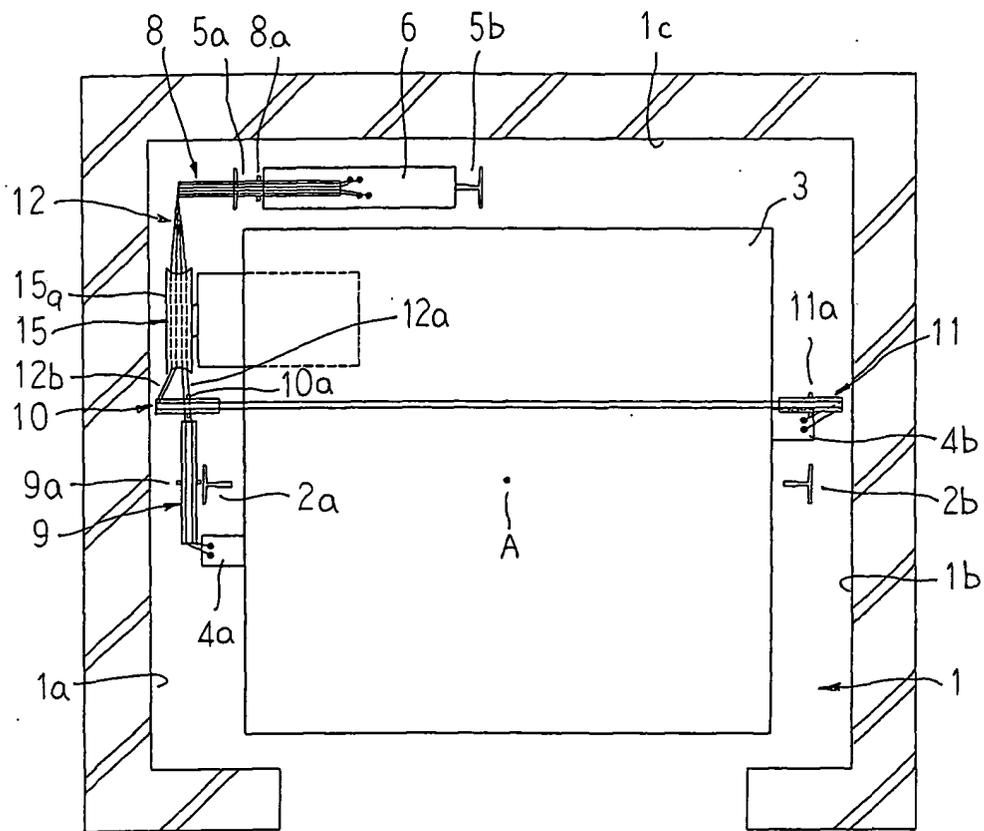


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/02793

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ B66B7/06		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ B66B7/00-B66B11/08		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2003 Kokai Jitsuyo Shinan Koho 1971-2003 Toroku Jitsuyo Shinan Koho 1994-2003		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11-310372 A (Toshiba Elevator and Building Systems Corp., Toshiba Corp.), 09 November, 1999 (09.11.99), Claims 1, 7 to 8; Par. Nos. [0055] to [0063], [0077] to [0080] & EP 0953538 A2 & CN 1233583 A & US 6247557 B1	1-7
A	JP 11-21045 A (Hitachi, Ltd., Hitachi Elevator Engineering Kabushiki Kaisha), 26 January, 1999 (26.01.99), (Family: none)	1-7
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 03 December, 2003 (03.12.03)		Date of mailing of the international search report 24 December, 2003 (24.12.03)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)