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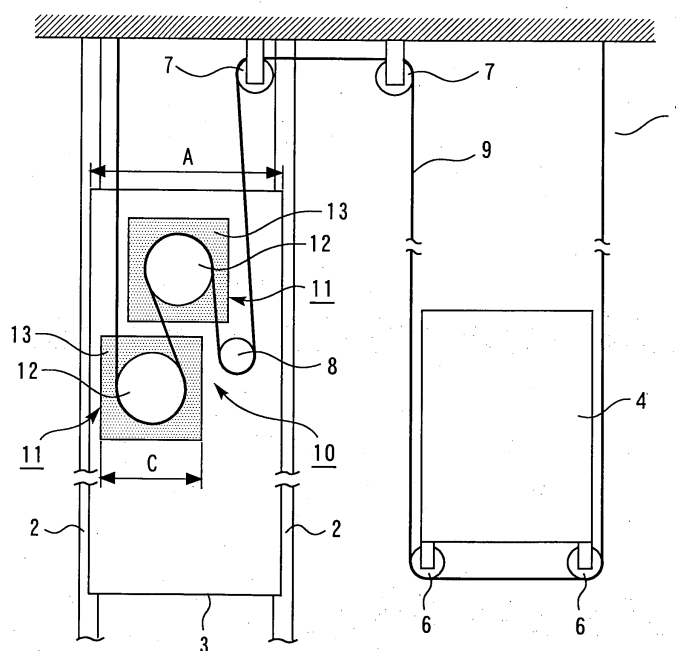
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(54) **ELEVATOR EQUIPMENT**

(57) An elevator system wherein an elevator car (4) and a counterweight (3) travel through the hoistway (1) in the directions opposite to each other comprises a hoisting device (10) around which a main rope (9) is passed and which drives the elevator car (4) and the counterweight (3). The hoisting device (10) has at least two hoisting machines (11) which comprise a drive sheave (12) around which the main rope (9) is passed

and an electric motor (13) to drive the drive sheave (12) to rotate; and at least one of the hoisting machines (11) is mounted on the counterweight (3). Furthermore, both of the hoisting machines (11) used for hoisting device (10) are mounted on the counterweight (3), or, in other cases, at least one of the other hoisting machines (11) of the hoisting device (10) is provided in an upper part of the hoistway.

Fig. 1



Description

Technical Field

[0001] The present invention relates to a traction-type elevator system wherein a hoisting device is used, and particularly to an elevator system wherein the hoisting device is mounted on a counterweight.

Background Art

[0002] With a view to reduce the required space in the hoistway of an elevator as much as possible, there have been suggested elevator systems wherein a thin-shaped hoisting machine that can be housed in the frame body of the counterweight is mounted on the counterweight. Since hoisting machines to be used in elevator systems of this type generally require an electric motor which is small in thickness and comparatively large in capacity, electric motors of the axial gap type or the radial gap type using a permanent magnet having the rotation axis of the rotor provided on the same axis as the rotation axis of the drive sheave of the hoisting machine are used. Here, the electric motor of the axial gap type is provided so that the stator and the rotor face each other in the direction of the rotation axis of the rotor via an air gap; and for example, in Japanese non-examined laid-open patent publication No. Hei 7-137963, an elevator system wherein a hoisting machine using this axial gap type electric motor is mounted on the counterweight, is disclosed. On the other hand, the radial gap type electric motor is mounted so that the stator and the rotor face each other in the direction vertical to the direction of the rotation axis of the rotor via an air gap; and conventionally, also this radial gap type electric motor has been used in hoisting machines.

[0003] In an elevator system wherein the hoisting machine is mounted on the counterweight as above-mentioned, in order to realize an elevator wherein the load of the elevator car is further increased, e.g. to provide an elevator of large capacity, it is necessary to enlarge the hoisting machine. Here, in order to enlarge the torque of the electric motor used in the hoisting machine, as for the axial gap type electric motor, generally the diameter of the air gap between the stator and the rotor is increased; however, as a result, the diameter of the electric motor becomes large, and there is a tendency that also the thickness of the electric motor in the direction of the rotation axis of the rotor becomes large due to the enlargement of the bearing which supports the rotor. Accordingly, the external form of the hoisting machine, i.e. the radial diameter and the thickness of the hoisting machine in the direction of the rotation axis of the drive sheave of the hoisting machine become large. Also, as for the radial gap type electric motor, in the case where the torque of the electric motor used for the hoisting machine is to be increased, generally, the thickness of the rotor and the stator in the direction of the rotation

axis of the rotor are increased. In accordance with this, the thickness of the hoisting machine in the direction of the rotation axis of the drive sheave becomes large.

[0004] According to the aforementioned, even if an electric motor of the axial gap type or the radial gap type is used, in order to increase the torque of the hoisting machine according to the increase in capacity of the elevator, the hoisting machine will not fit inside the frame body of the counterweight unless the dimensions of the frame body of the counterweight are not increased, because of the enlargement of the hoisting machine. As a result of this, there is a problem that the space required inside the hoistway is enlarged according to the increase in the area of the horizontal projection view of the hoistway.

[0005] Furthermore, in the case where one hoisting machine is provided inside the frame body of the counterweight, in order to make the hoisting machine adapt to the increase in the capacity of the elevator, hoisting machines of sizes corresponding to each of the ranges of the capacities of the elevators are needed. Moreover, in order to make one hoisting machine correspond to small ranges to large ranges of the capacities of the elevators, it is necessary to standardize the hoisting machine to a large and costly hoisting machine corresponding to all ranges of capacities, thus making it meaningless.

[0006] The present invention was devised to solve the above-mentioned problems, and has as its intension to provide an elevator system capable to cope with increase to large capacity of the elevator without causing enlargement of the area of the horizontal projection view of the hoistway, i.e. the space required for the hoistway in a building, wherein the hoisting machine is mounted on the counterweight in an elevator.

Disclosure of the Invention

[0007] The elevator system in the present invention comprises an elevator car which ascends and descends through the hoistway, a counterweight which travels in the direction opposite to the elevator car, and a main rope which suspends the elevator car and the counterweight; and the elevator car and the counterweight are driven by a hoisting device around which the main rope is passed. The hoisting machines used in the hoisting device comprises a drive sheave around which the main rope is passed and an electric motor which drives the drive sheave to rotate. The hoisting device comprises at least two of these hoisting machines, and at least one thereof is mounted on the counterweight.

[0008] Also, it is structured so that all the hoisting machines are mounted on the counterweight.

[0009] Furthermore, it is structured so that at least one of the other hoisting machines of the hoisting device is provided in an upper part of the hoistway.

[0010] According to the aforementioned invention, it is possible to construct an elevator capable to corre-

spond to the elevator's increase to large capacity without causing enlargement of the area of the horizontal projection view of the hoistway, i.e. the space required for the hoistway in a building. Also, it is possible to serialize with facility elevators of capacities of small ranges to large ranges by simply adjusting the number of hoisting machines by construction using hoisting machines of the same specifications.

Brief Description of the Drawings

[0011]

Figure 1 is a diagram showing an example of an arrangement of the elevator system in accordance with the first embodiment of the present invention; Figure 2 is a plan view of the elevator system in accordance with Figure 1;

Figure 3 is a diagram showing an example of an arrangement of the elevator system in accordance with the second embodiment of the present invention;

Figure 4 is a diagram showing an example of an arrangement of the elevator system in accordance with the third embodiment of the present invention; Figure 5 is a diagram showing an example of an arrangement of the elevator system in accordance with the fourth embodiment of the present invention; Figure 6 is a diagram showing an example of an arrangement of the elevator system in accordance with the fifth embodiment of the present invention; Figure 7 is a diagram showing an example of an arrangement of the elevator system in accordance with the sixth embodiment of the present invention; and

Figure 8 is a diagram showing an example of an arrangement of the elevator system in accordance with the seventh embodiment of the present invention.

Best Mode for Carrying out the Invention

[0012] To describe the present invention in more detail, the invention will be described by referring to the accompanying drawings. In each of the drawings, the same numerals are given to the same parts or the corresponding parts, and repeated explanation will be appropriately simplified or omitted.

First Embodiment

[0013] Figure 1 is a diagram showing an example of an arrangement of the elevator system in accordance with the first embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the elevator main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the

counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0014] Figure 2 is a plan view of the elevator system in accordance with Figure 1; and in Figure 2, illustration of the deflector sheave and the main rope is omitted because the drawing is used mainly as a drawing to explain the arrangement of the hoisting device mounted on the counterweight and the arrangement of the relation between the elevator car and the counterweight.

[0015] In Figure 1 and Figure 2, in the hoistway 1, there are provided a pair of guiderails 2 for the counterweight, and another pair of guiderails (not shown) for the elevator car respectively. The counterweight 3 ascends and descends the hoistway 1 being guided by the guiderails 2 for the counterweight. The elevator car 4 ascends and descends the hoistway 1 in the direction opposite to the counterweight 3 being guided by the guiderails for the elevator car. Furthermore, on the elevator car 4 there are provided entrance doors 5; and the surface having the entrance doors 5 is treated as the front face of the car 4. The counterweight 3 is provided between the back face of the elevator car 4 which is opposite to the front face of the car 4, and the wall surface 1a of the hoistway 1. The counterweight 3 can also be arranged between either of the side faces of the elevator car 4 which are orthogonal to the front face of the elevator car 4, and the wall surface 1a of the hoistway 1.

[0016] Next: a hoisting device 10 around which a main rope 9 is passed and which drives the elevator car 4 and the counterweight 3 is mounted on the counterweight 3. The hoisting device 10 is comprised of two hoisting machines 11; and the torque required for driving the elevator is shared between the two hoisting machines 11. Each of the hoisting machines 11 has a drive sheave 12 around which the main rope 9 is passed, and an electric motor 13 which drives the drive sheave 12 to rotate; and the thickness D in the direction of the rotation axis of the drive sheave 12 is formed so as to be smaller than the dimension C in the direction of the external diameter.

[0017] Next: the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 which constructs the external form thereof so as to overlap each other not in the horizontal direction, but in the vertical direction. To describe further, as shown in Figure 2, generally, the form of the section of the counterweight 3 in the horizontal direction is short in the direction of the gap between the car 4 and the wall surface 1a; and the counterweight 3 has a long rectangular section in the width direction of the car 4 and also a rectangular parallelepiped external form which is formed long in the vertical direction. That is, the counterweight 3 is arranged so as to take up as little space as possible in the horizontal projection view of the hoistway 1. Also, the external form of the counterweight 3 is constructed of a frame body; and a weight for the counterweight is mounted in a lower part of the frame body. In the counterweight 3 shown in Figure 1 (and in the remaining

drawings), illustration of the weight for the counterweight is omitted; and the external form of the counterweight 3 in the drawings show the external form of the frame body. Accordingly, the hoisting device 10 in the first embodiment has the two hoisting machines 11 mounted so as to overlap each other in the vertical direction so that the dimension A (also referred to as the width A of the counterweight 3 in the present invention) in the longitudinal direction of the counterweight 3 in the horizontal projection view of the hoistway 1 does not widen. Also, the hoisting device 10 is mounted on the counterweight 3 with the direction in the thickness of the hoisting machine 11 matching the short-side direction of the counterweight 3, so that the dimension B (also referred to as the thickness B of the counterweight 3 in the present invention) which crosses the above-mentioned dimension A orthogonally does not widen. In the first embodiment, the hoisting device 10 is constructed of two hoisting machines 11 of the same specifications.

[0018] Next: both ends of the main rope 9 are fixed to an upper part of the hoistway 1; and starting at the upper part of the hoistway 1, one end of the main rope 9 is successively passed around the two hoisting machines 11, then around the deflector sheave 8 for the counterweight which is mounted on the counterweight 3 with the intention of increasing the winding amount of the main rope 9 to the hoisting machines 11, and then rises and is passed around two upper-hoistway deflector sheaves 7 which are provided in an upper part of the hoistway 1. Furthermore, the main rope 9 is successively passed around a pair of suspension sheaves 6 for the car that are provided in a lower part of the elevator car 4 and rises again; and the other end of the main rope 9 is fixed to the upper part of the hoistway 1. In the first embodiment of the present invention, the main rope 9, which is comprised of a plurality of ropes, has only one route, and is successively passed on around the two hoisting machines 11.

[0019] According to the aforementioned first embodiment, because the hoisting device 10 comprises two hoisting machines 11, it is possible to share the torque required for driving the elevator between the two hoisting machines 11. Conventionally, in order to cope with elevators of which the load of the elevator car is further increased, i.e. elevators of large capacity, it has been necessary to enlarge the hoisting machine in order to gain the torque necessary for driving the elevator; however, in contrast, as for the hoisting device 10 in the first embodiment, it is not necessary to enlarge the external form of each of the hoisting machines 11. Moreover, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. In accordance with this, as for hoisting machines 11 using an electric motor 13 of the radial gap type, it is possible to control increase in the thickness D in the direction of the rotation axis of the drive sheave 12, and it is unnecessary to widen the thickness B of the coun-

terweight 3. Also, as for hoisting machines 11 using an electric motor 13 of the axial gap type, it is possible to control increase in dimension C in the direction of the external diameter and the thickness D in the direction of the rotation axis of the drive sheave of the hoisting machine, so it is unnecessary to widen the width A or the thickness B of the counterweight 3. Accordingly, by using either type of electric motor 13, it is possible to cope with elevators with increased capacity without enlarging the horizontal projection area of the hoistway.

[0020] Moreover, by adopting two hoisting machines 11 of the same specifications as hoisting machines 11 of the hoisting device 10, productivity and installability of the hoisting machines 11 are improved. For this reason, in the case where the capacity of the elevator is to be further increased, it is possible to cope by increasing the number of hoisting machines 11 of the same specifications. That is, it is able to serialize with facility elevators of capacities of small ranges to large ranges by simply adjusting the number of hoisting machines.

Second Embodiment

[0021] Figure 3 is a diagram showing an example of an arrangement of the elevator system in accordance with the second embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0022] As shown in Figure 3, in the second embodiment, similarly to the first embodiment, a hoisting device 10 which comprises two hoisting machines 11 is mounted on the counterweight 3; and the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. That is, also in this case, two hoisting machines 11 are provided so that there is no necessity to enlarge the width A or the thickness B of the counterweight 3. The main rope 9 has only one route, and is successively passed on around the two hoisting machines 11.

[0023] Here, the only difference between the first embodiment and the second embodiment is the manner that the main rope 9 is passed around the hoisting machines 11 and the arrangement of the deflector sheave 8 for the counterweight in accordance with the manner of passing of the main rope 9. That is, while in the first embodiment the deflector sheave 8 for the counterweight is provided after the main rope 9, of which one end is fixed at an upper part of the hoistway 1, is successively passed around the two hoisting machines 11, in the second embodiment, the deflector sheave 8 for the counterweight is provided between the two hoisting machines 11 which are on the route of the main rope 9.

In this manner, it is possible to select a suitable arrangement location for the hoisting device 10 according to the situation in setting the hoisting machines 11 on the counterweight 3 by changing the arrangement location of the deflector sheave 8 for the counterweight. The other structures and the motions thereof are the same as the first embodiment, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0024] Also in the aforementioned second embodiment, the hoisting device 10 is comprised of two hoisting machines 11; and the torque required for driving the elevator can be shared between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. Accordingly, with a hoisting device 10 using either the axial gap type or the radial gap type of electric motor 13, it is possible to cope with elevators with increased capacity without enlarging the horizontal projection area of the hoistway, because it is not necessary to enlarge the width A or the thickness B of the counterweight 3.

[0025] In addition to this, the same effects as the first embodiment can be attained.

Third Embodiment

[0026] Figure 4 is a diagram showing an example of an arrangement of the elevator system in accordance with the third embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0027] As shown in Figure 4, in the third embodiment, similarly to the first and second embodiments, a hoisting device 10 which comprises two hoisting machines 11 is mounted on the counterweight 3; and the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. That is, also in this case, two hoisting machines 11 are provided so that there is no necessity to enlarge the width A or the thickness B of the counterweight 3.

[0028] Next: the main rope 9 used in the third embodiment is comprised of two sets of main rope units 9a and 9b, which are both comprised of a plurality of ropes. One end of the main rope unit 9a is fixed to an upper part of the hoistway 1; and the main rope unit 9a is passed around one of the two hoisting machines 11, and stretches to the upper-hoistway deflector sheaves 7. Then, after being passed around the two upper-hoistway deflec-

tor sheaves 7, the main rope unit 9a is passed on around a pair of suspension sheaves 6 for the car which are provided below the elevator car 4, and rises again; and the other end of the main rope unit 9a is fixed to an upper part of the hoistway 1. One end of the other main rope unit 9b is also fixed to an upper part of the hoistway 1; however, next, the main rope unit 9b is passed around the other one of the two hoisting machines 11. The subsequent route is the same as that of the main rope unit 9a, thus explanation will be omitted. Accordingly, the two sets of main rope units 9a and 9b are equipped in parallel with each other, and are passed around separate hoisting machines. The other structures and the motions thereof are the same as the first and second embodiments, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0029] Also in the aforementioned third embodiment, the hoisting device 10 is comprised of two hoisting machines 11; and it is possible to share the torque required for driving the elevator between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. Accordingly, with a hoisting device 10 using either the axial gap type or the radial gap type of electric motor 13, it is possible to cope with elevators with increased capacity without enlarging the horizontal projection area of the hoistway, because it is not necessary to enlarge the width A or the thickness B of the counterweight 3.

[0030] In addition to this, the same effects as the first and the other embodiments can be attained.

Fourth Embodiment

[0031] Figure 5 is a diagram showing an example of an arrangement of the elevator system in accordance with the fourth embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0032] As shown in Figure 5, in the fourth embodiment, similarly to the third embodiment, a hoisting device 10 comprising two hoisting machines 11 is mounted on the counterweight 3; and the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. That is, also in this case, two hoisting machines 11 are provided so that there is no necessity to enlarge the width A or the thickness B of the counterweight 3. The main rope 9 used

also in the fourth embodiment is similar to that used in the third embodiment, and is comprised of two sets of main rope units 9a and 9b which are both comprised of a plurality of ropes.

[0033] Here, the fourth embodiment is different from the third embodiment on the point that a deflector sheave 8 for the counterweight is used on the route of one of the main rope units 9a. By using deflector sheave 8 for the counterweight in this manner, it is possible to raise freedom of the fixing position of the main rope 9 in the upper part of the hoistway 1 in the horizontal direction and the mounting position of the hoisting machines 11 inside the counterweight 3. The other structures and the motions thereof are the same as the first and the other embodiments, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0034] Also in the aforementioned fourth embodiment, the hoisting device 10 is comprised of two hoisting machines 11; and the torque required for driving the elevator can be shared between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. Accordingly, with a hoisting device 10 using either the axial gap type or the radial gap type of electric motor 13, it is possible to cope with elevators with increased capacity without enlarging the horizontal projection area of the hoistway, because it is not necessary to enlarge the width A or the thickness B of the counterweight 3.

[0035] In addition to this, the same effects as the first and the other embodiments can be attained.

Fifth Embodiment

[0036] Figure 6 is a diagram showing an example of an arrangement of the elevator system in accordance with the fifth embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0037] As shown in Figure 6, in the fifth embodiment, similarly to the first to the fourth embodiments, a hoisting device 10 comprising two hoisting machines 11 is mounted on the counterweight 3. However, in the fifth embodiment, unlike in the first to the fourth embodiments, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other in the horizontal direction, but not in the vertical direction. That is, the two hoisting machines 11 are parallelly provided in the horizontal direction.

[0038] Next: similarly to the second embodiment, the main rope 9 has only one route; and a deflector sheave 8 for the counterweight is arranged between the two hoisting machines 11 on the route of the main rope 9. One end of the main rope 9 is fixed to an upper part of the hoistway 1; and the main rope 9 is passed around in the order of: one of the hoisting machines 11, the deflector sheave 8 for the counterweight, and the other hoisting machine 11; and then stretches to the upper-hoistway deflector sheaves 7. After being passed around the two upper-hoistway deflector sheaves 7, the main rope 9 is passed around a pair of suspension sheaves 6 for the car which are provided below the elevator car 4, and rises again; and the other end of the main rope 9 is fixed to an upper part of the hoistway 1. The other structures and the motions thereof are the same as the first and the other embodiments, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0039] According to the aforementioned fifth embodiment, because the hoisting device 10 is comprised of two hoisting machines 11; and it is possible to share the torque required for driving the elevator between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, compared with the first to the fourth embodiments, because the two hoisting machines 11 are arranged parallelly in the horizontal direction, although the width A of the counterweight 3 increases, arrangement wherein the wasted gap inside the frame body of the counterweight 3 is decreased in the horizontal direction can be realized. Accordingly, in the case where the number of hoisting machines are further increased in order to adapt to elevators of large capacity, it is possible to minimize increase in the dimension E of the vertical direction of the counterweight 3, and to improve volumetric efficiency with respect to arrangement of the hoisting machines 11 inside the frame body of the counterweight 3.

[0040] In addition to this, the same effects as the first and the other embodiments can be attained.

Sixth Embodiment

[0041] Figure 7 is a diagram showing an example of an arrangement of the elevator system in accordance with the sixth embodiment of the present invention; and is a conceptual drawing showing the elevator car and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0042] As shown in Figure 7, in the sixth embodiment, similarly to the fifth embodiment, a hoisting device 10 which comprises two hoisting machines 11 is mounted on the counterweight 3; and the two hoisting machines

11 are mounted inside the frame body of the counterweight 3 so as to overlap each other in the horizontal direction, but not in the vertical direction.

[0043] Next: similarly to the third embodiment, the main rope 9 used in the sixth embodiment is comprised of two sets of main rope units 9a and 9b which are both comprised of a plurality of ropes. One end of the main rope unit 9a is fixed to an upper part of the hoistway 1; and the main rope unit 9a is passed around one of the two hoisting machines 11, and stretches to the upper-hoistway deflector sheaves 7. Then, after being passed around the two upper-hoistway deflector sheaves 7, the main rope unit 9a is passed on around a pair of suspension sheaves 6 for the car which are provided below the elevator car 4, and rises again; and the other end of the main rope unit 9a is fixed to an upper part of the hoistway 1. One end of the other main rope unit 9b is also fixed to an upper part of the hoistway 1; however, next, the main rope unit 9b is passed around the other one of the two hoisting machines 11. The subsequent route is the same as that of the main rope unit 9a, thus explanation will be omitted. Accordingly, the two sets of main rope units 9a and 9b are equipped parallelly with each other, and are passed around separate hoisting machines. The other structures and the motions thereof are the same as the first and the other embodiments, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0044] According to the aforementioned sixth embodiment, the hoisting device 10 is comprised of two hoisting machines 11; and it is possible to share the torque required for driving the elevator between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, compared with the first to the fourth embodiments, because the two hoisting machines 11 are arranged parallelly in the horizontal direction, although the width A of the counterweight 3 increases, arrangement wherein the wasted gap inside the frame body of the counterweight 3 is decreased in the horizontal direction can be realized. Accordingly, in the case where the number of hoisting machines are further increased in order to adapt to elevators of large capacity, it is possible to minimize increase in the dimension E of the vertical direction of the counterweight 3, and to improve volumetric efficiency with respect to arrangement of the hoisting machines 11 inside the frame body of the counterweight 3.

[0045] In addition to this, the same effects as the first and the other embodiments can be attained.

Seventh Embodiment

[0046] Figure 8 is a diagram showing an example of an arrangement of the elevator system in accordance with the seventh embodiment of the present invention; and is a conceptual drawing showing the elevator car

and the counterweight, which are suspended by the main rope, being driven to ascend and descend the hoistway by the hoisting device that is mounted on the counterweight, by expanding the elevation of the elevator system viewed from the horizontal direction of the hoistway.

[0047] As shown in Figure 8, similarly to the other embodiments, the hoisting device 10 comprises two hoisting machines 11. However, in the seventh embodiment, one of the hoisting machines 11 is mounted on the counterweight 3, and the other hoisting machine 11 is provided in an upper part of the hoistway 1 so as to overlap the counterweight 3 when viewed from the vertical direction. That is, this hoisting machine 11 is provided above the travel area of the counterweight 3 which ascends and descends being guided by the guiderails 2 for the counterweight, and between the pair of guiderails 2, which face each other. Accordingly, also in this case, two hoisting machines 11 are provided so that there is no necessity to widen the width A or the thickness B of the counterweight 3.

[0048] Next: the main rope 9 used in the seventh embodiment has only one route. One end of the main rope 9 is fixed to an upper part of the hoistway 1, and the main rope 9 is longitudinally passed on around the two hoisting machines 11, and stretches to the upper-hoistway deflector sheaves 7. After being passed around the two upper-hoistway deflector sheaves 7, the main rope 9 is passed on around a pair of suspension sheaves 6 for the car which are provided below the elevator car, and rises again; and the other end of the main rope 9 is fixed to an upper part of the hoistway 1. The other structures and the motions thereof are the same as the first and the other embodiments, so the same numerals are given to the same parts or the corresponding parts, and repeated explanation is omitted.

[0049] Also in the seventh embodiment, the hoisting device 10 is comprised of two hoisting machines 11; and it is possible to share the torque required for driving the elevator between the two hoisting machines 11. For this reason, there is no necessity to enlarge the external form of each of the hoisting machines 11 to adapt to elevators of large capacity. Furthermore, the two hoisting machines 11 are mounted inside the frame body of the counterweight 3 so as to overlap each other not in the horizontal direction, but in the vertical direction. Accordingly, with a hoisting device 10 using either the axial gap type or the radial gap type of electric motor 13, it is possible to cope with elevators with increased capacity without enlarging the horizontal projection area of the hoistway, because it is not necessary to enlarge the width A or the thickness B of the counterweight 3.

[0050] In addition to this, the same effects as the first and the other embodiments can be attained.

[0051] In the above-mentioned embodiments, examples wherein the hoisting device 10 comprises two hoisting machines 11 are described; however, in the elevator system in the present invention, the number of hoisting

machines 11 does not necessarily have to be two; and it is sufficient to mount at least one hoisting machine 11 on the counterweight 3, and the remaining plurality of hoisting machines 11 can be either mounted on the counterweight 3 or provided in an upper part of the hoistway 1. Accordingly, by constructing the hoisting device 10 using N hoisting machines 11 of the same specifications, it is possible to cope with elevators of the capacity of N times without increasing the width A or the thickness B of the counterweight 3. In accordance with this, by adjusting the number of hoisting machines 11 to be mounted on the hoisting device 10, it is possible to provide an elevator system with an elevator of capacities of small ranges to large ranges without enlarging the horizontal projection area of the hoistway 1.

[0052] Furthermore, in the aforementioned embodiments, examples wherein the hoisting device 10 is comprised of two hoisting machines 11 of the same specifications are described; however, the plurality of hoisting machines can also be of different specifications; for example, a combination of hoisting machines of different capacities.

Industrial Applicability

[0053] As aforementioned, the elevator system in accordance with the present invention enables structure of an elevator which can cope with increase in capacity of the elevator without enlargement in the horizontal projection area of the hoistway, i.e. increase in the space required for the hoistway in a building. Furthermore, by constructing the elevator by using a plurality of hoisting machines of the same specifications, it is able to serialize with facility elevators of capacities of small ranges to large ranges by just adjusting the number of hoisting machines. Accordingly, the present invention is useful as an elevator system which is excellent in productivity and installability and which can cope with increase in capacity of the elevator without eliminating the merits of an elevator of the space-saving type having a hoisting device mounted on counterweight.

Claims

1. An elevator system **characterized in** comprising:

an elevator car which travels through a hoistway;
a counterweight which travels through said hoistway in the direction opposite to said elevator car;
a main rope which suspends said elevator car and said counterweight; and
a hoisting device around which said main rope is passed, and which drives said elevator car and said counterweight;

characterized in that said hoisting device comprises at least two hoisting machines comprising a drive sheave around which said main rope is passed and an electric motor to drive said drive sheave to rotate, and that at least one of said hoisting machines is mounted on said counterweight.

2. The elevator system according to claim 1, **characterized in that** all of said hoisting machines of said hoisting device are mounted on said counterweight.

3. The elevator system according to claim 2, **characterized in that** at least two of said hoisting machines of said hoisting device are mounted inside the frame body of said counterweight so as to overlap each other not in the horizontal direction, but in the vertical direction.

4. The elevator system according to claim 1, **characterized in that** at least one of the rest of said hoisting machines of said hoisting device is provided in an upper part of the hoistway.

5. The elevator system according to claim 4, **characterized in that** at least one of said hoisting machines which are provided in said upper part of the hoistway is installed so as to overlap said counterweight in the vertical direction.

6. The elevator system according to any one of claims 1 through 5, **characterized in that** said main rope is successively passed on around at least two of said hoisting machines.

7. The elevator system according to any one of claims 1 through 5, **characterized in that** said main rope comprises at least two parallelly equipped sets of main rope units, and that each of main rope units is passed around different said hoisting machine.

8. The elevator system according to any one of claims 1 through 7, **characterized in that** hoisting machines of same specifications are used as at least two of said hoisting machines of said hoisting device.

Fig. 1

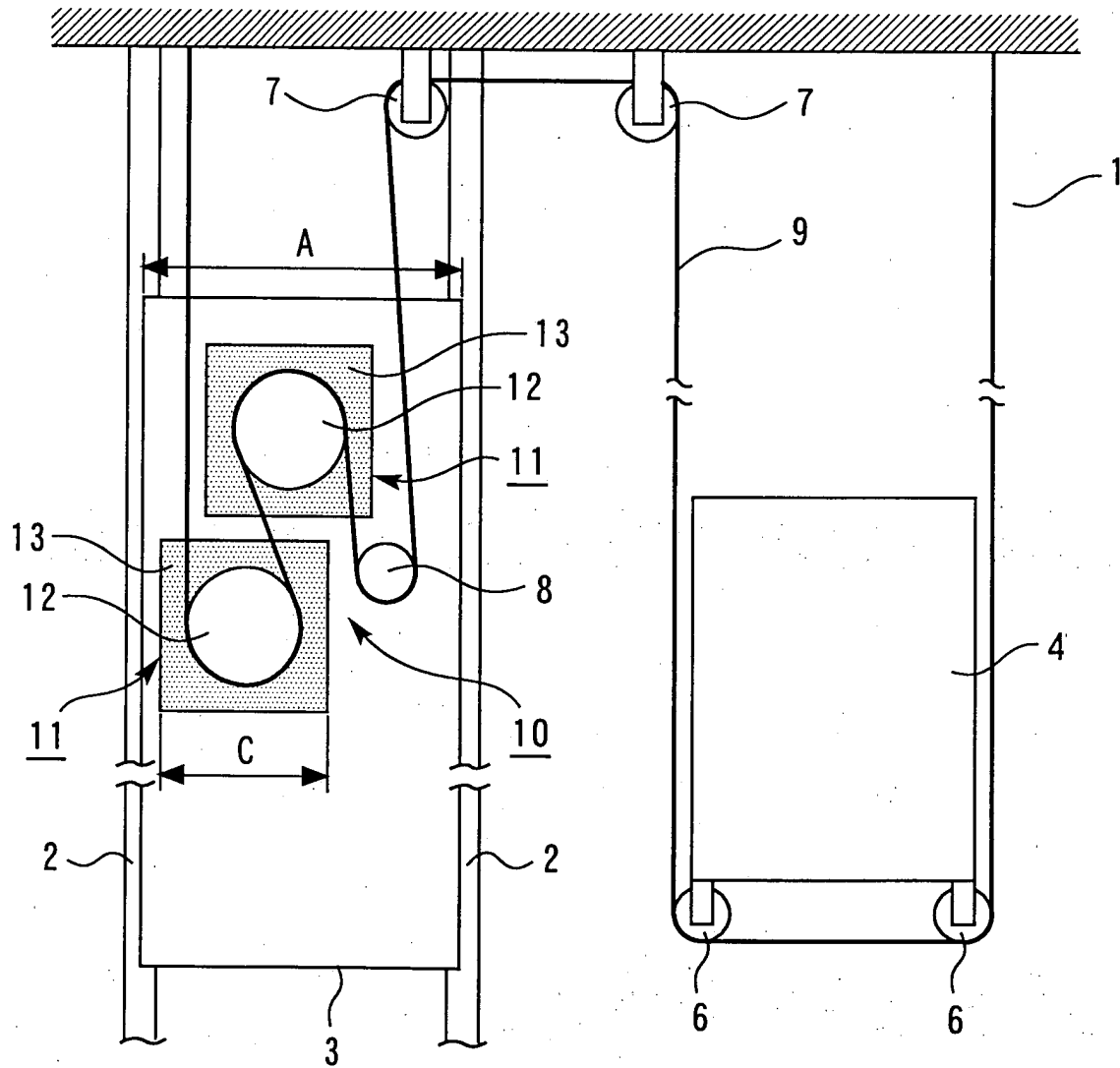


Fig. 2

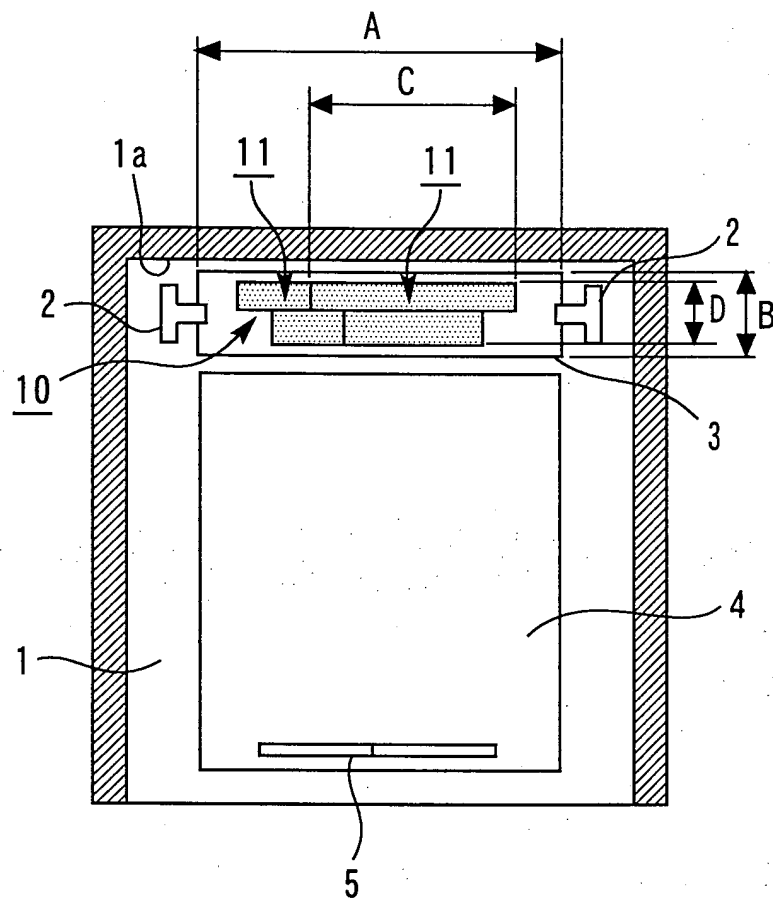


Fig. 3

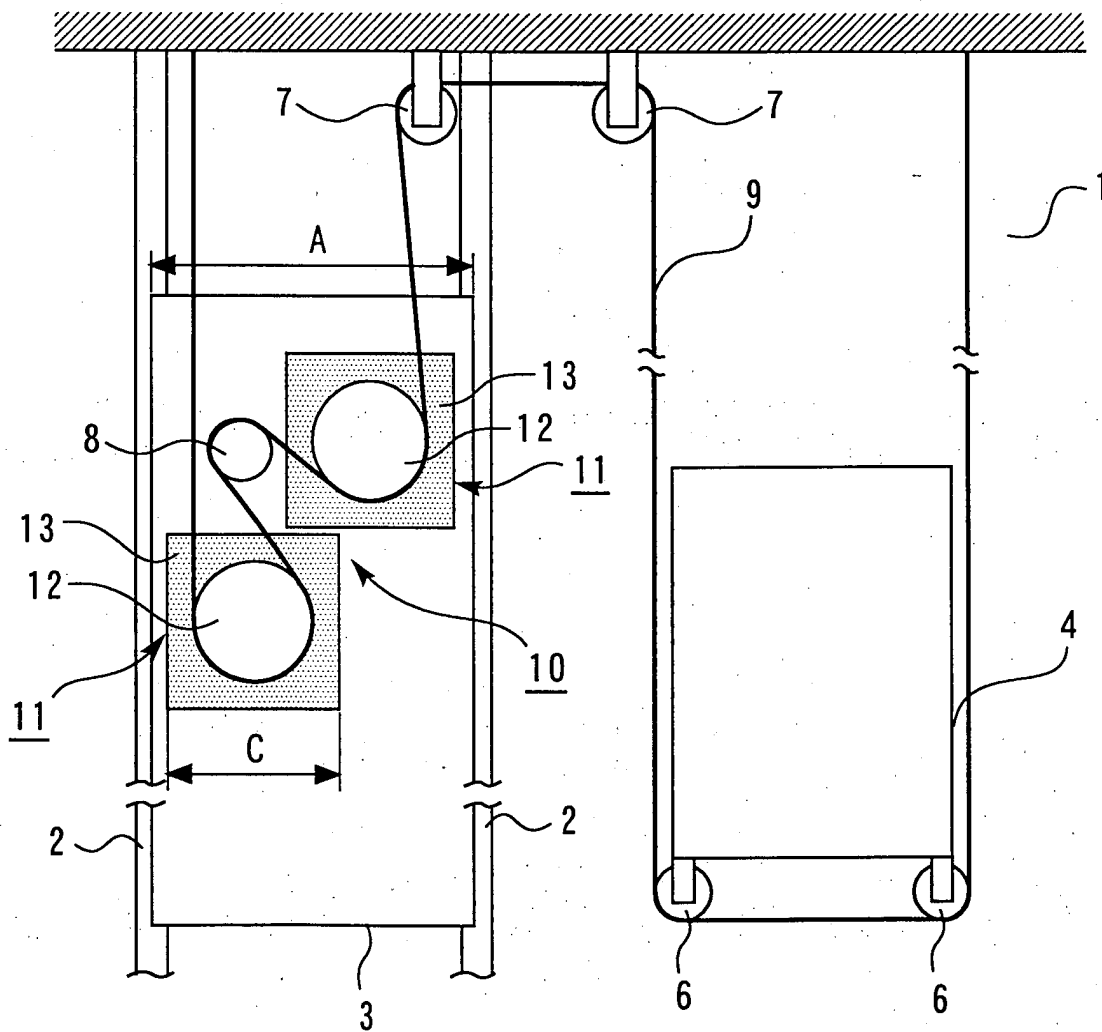


Fig. 4

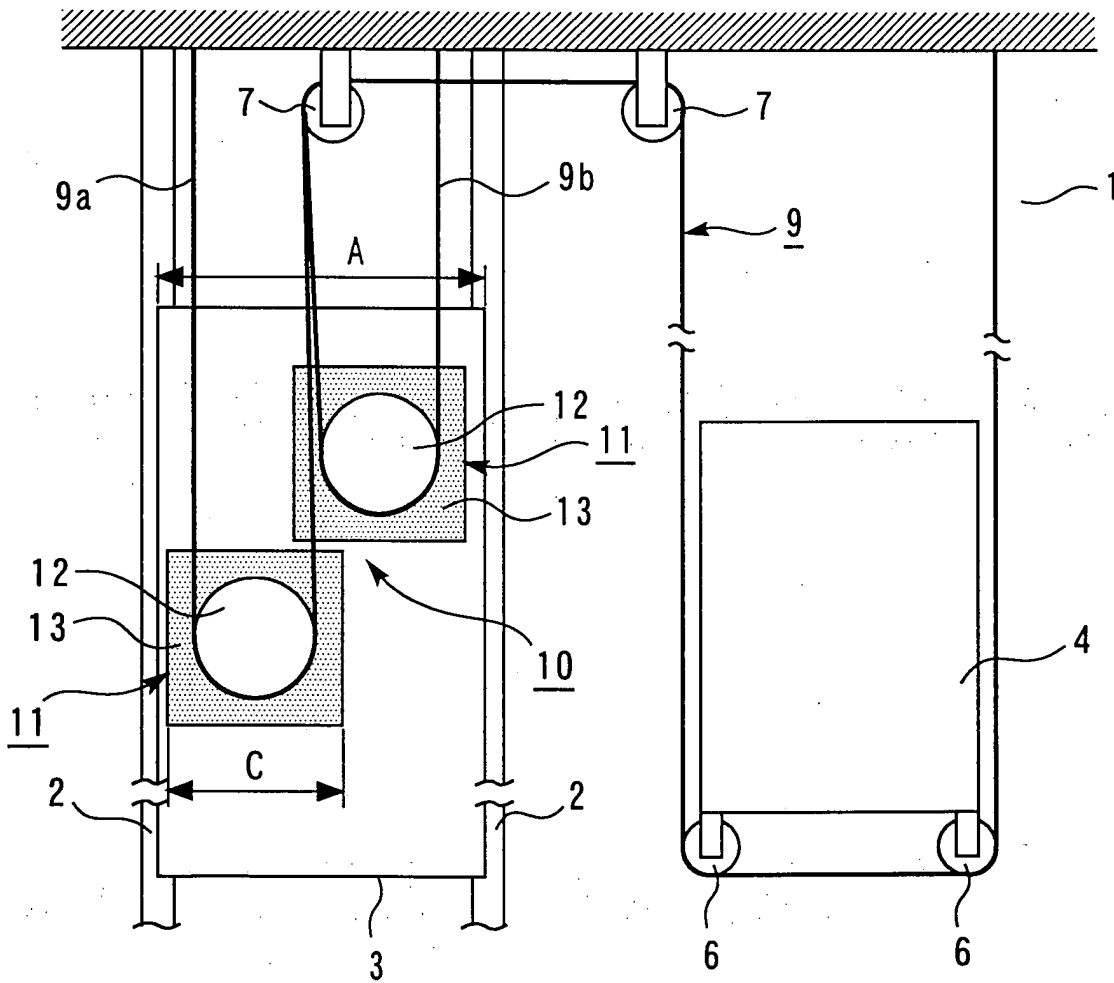


Fig. 5

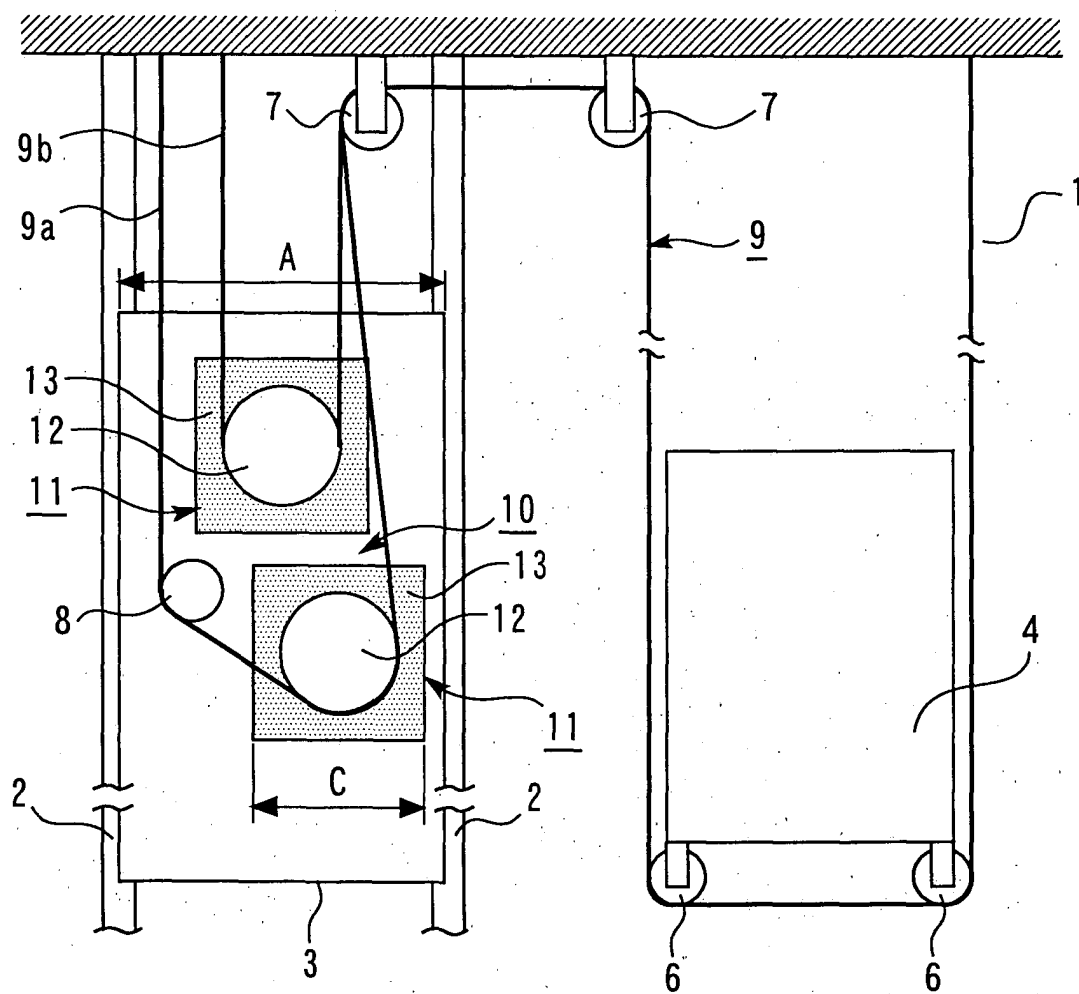


Fig. 6

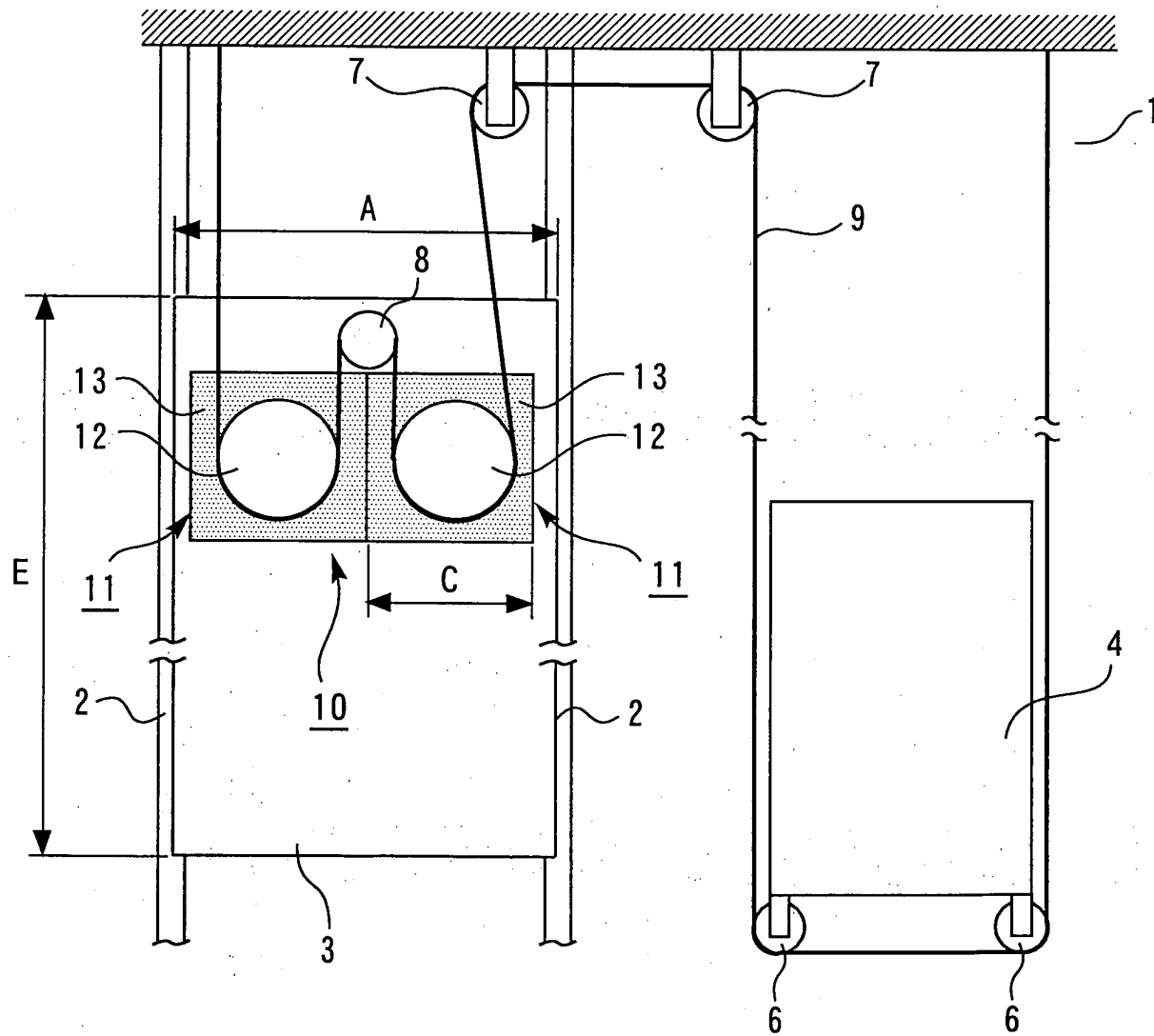


Fig. 7

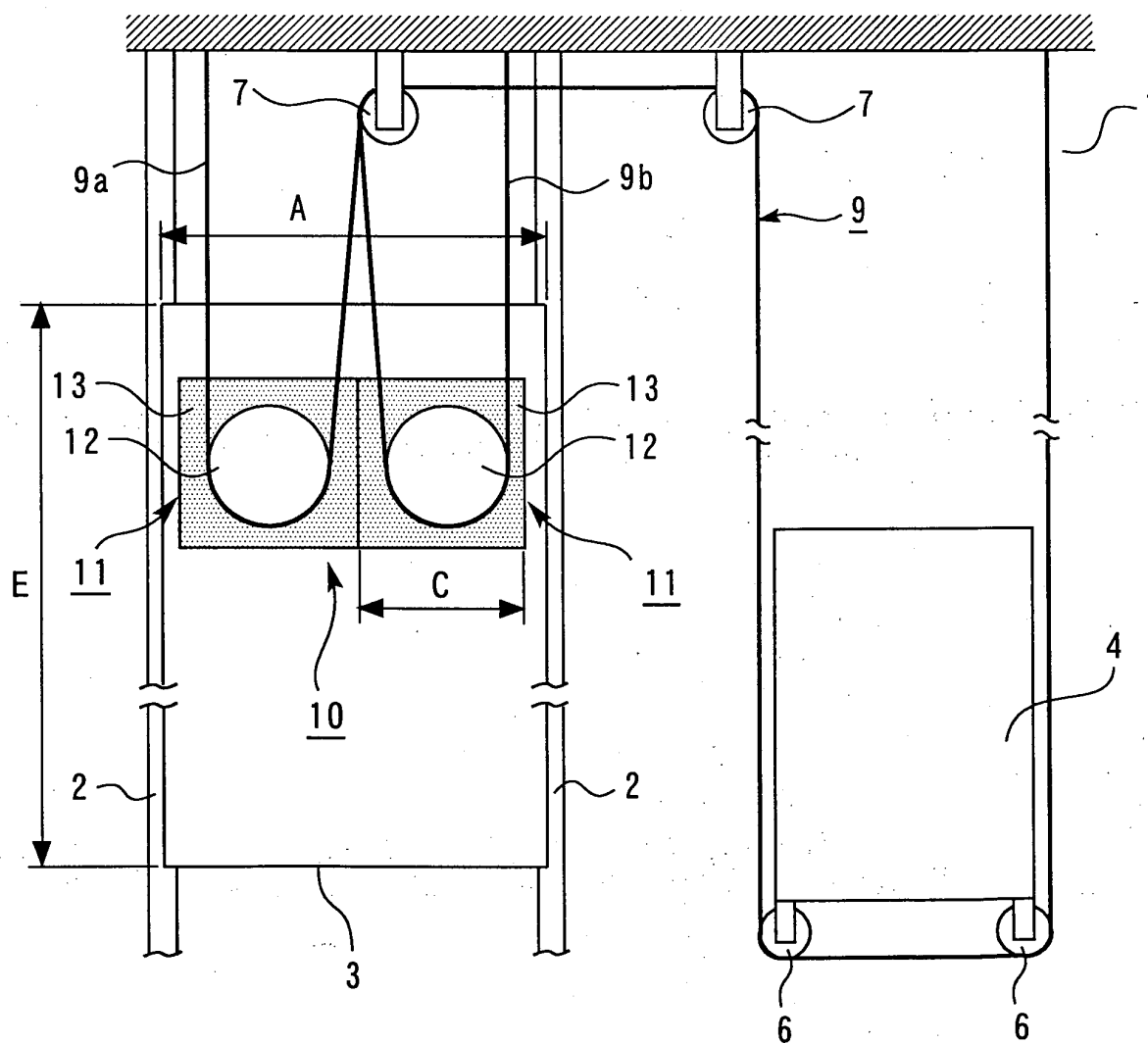
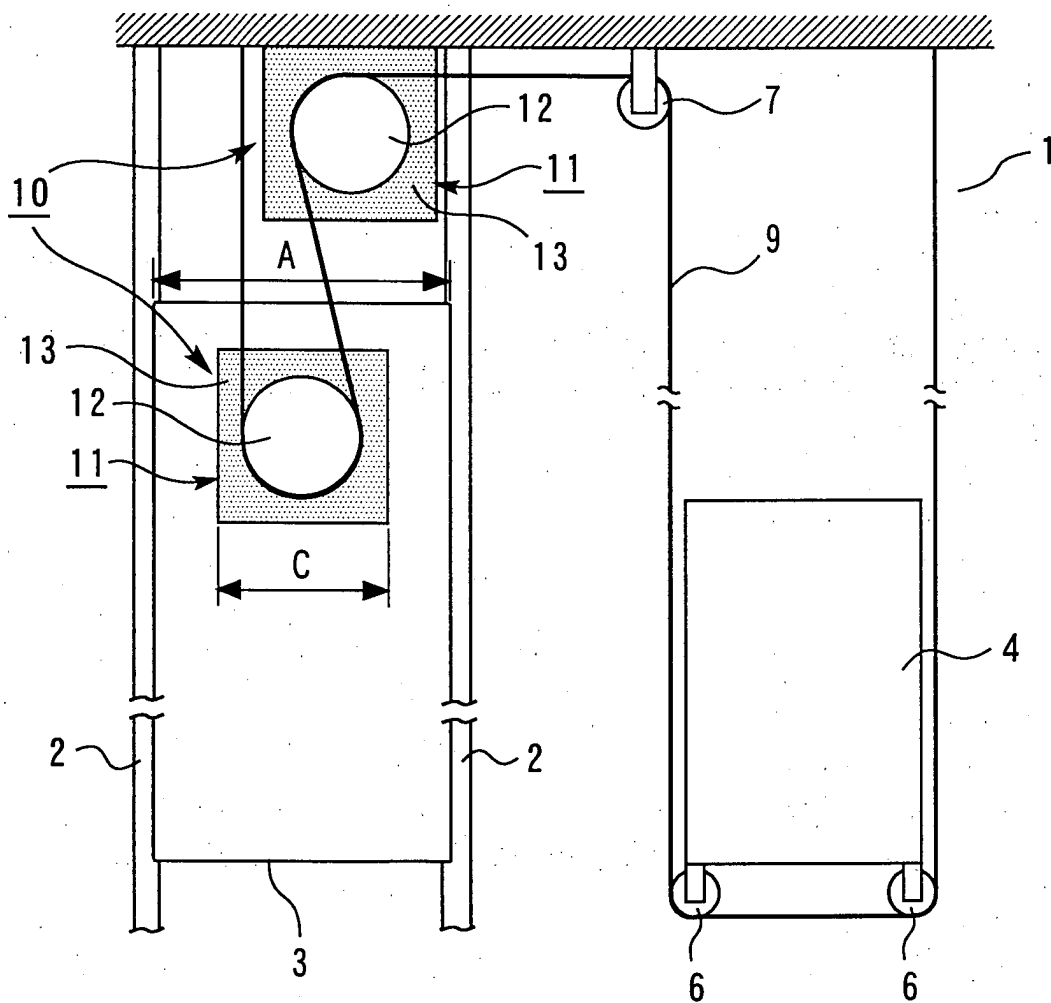


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/01470

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl⁷ B66B11/04

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.Cl⁷ 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 2000-255932 A (Toshiba Corp.), 19 September, 2000 (19.09.00), (Family: none)	1-2, 6, 8
A	JP 6-9178 A (Werner Hagel), 18 January, 1994 (18.01.94), & EP 0565516 A1	1-8
A	WO 02/094701 A1 (Mitsubishi Electric Corp.), 28 November, 2002 (28.11.02), Description, page 8, lines 6 to 9 (Family: none)	1-8
A	JP 5-70057 A (Hitachi Building System Eng. & Service Co., Ltd.), 23 March, 1993 (23.03.93), (Family: none)	7

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"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	

Date of the actual completion of the international search
05 November, 2003 (05.11.03)Date of mailing of the international search report
25 November, 2003 (25.11.03)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP03/01470

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-504473 A (Otis Elevator Co.), 12 February, 2002 (12.02.02), & WO 99/43601 A2	7

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