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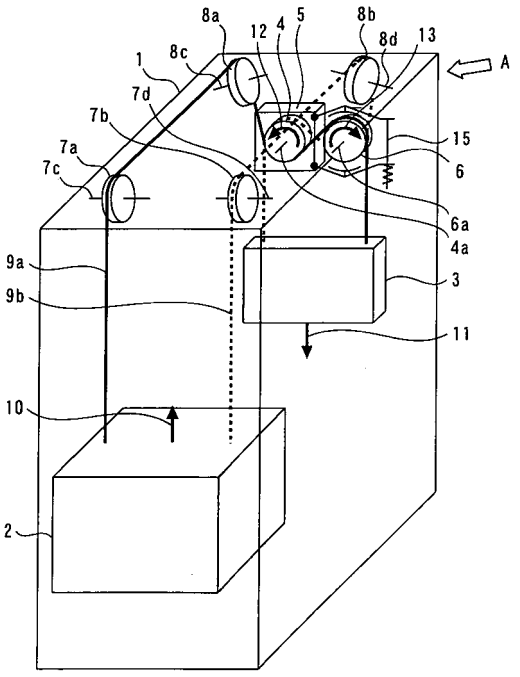
(54) ELEVATOR APPARATUS

(57) An elevator apparatus capable of securing a maintenance space for a traction machine without increasing an installation space even when a diameter of the traction machine becomes large is provided. In the elevator apparatus including an elevator car 2, a counter weight 3, a driving sheave 4 on which a main rope 9 is wound, and a traction machine 5 which rotates the driving sheave, a reversing pulley 6 which is provided by a side of the driving sheave, has a parallel shaft with a shaft of the driving sheave and rotates in a reverse direction from the driving sheave, a first group turning pulley 8a, a second group turning pulley 8b are included, the main rope is constituted of a first group main rope 9a and a second group main rope 9b, the first group main rope is wound on the driving sheave from the first group turning pulley, turned in the reverse direction to be wound on the reversing pulley, the second group main rope is wound on the reversing pulley from the second group turning pulley, turned in the reverse direction to be wound on the driving sheave, a portion of the first group main rope which is passed onto the reversing pulley from the driving sheave and a portion of the second group main rope which is passed onto the driving sheave from the reversing pulley intersect each other on a plane of projection seen in an axial direction of the driving sheave and the reversing pulley.

Fig.1



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Description

Technical Field

[0001] The present invention relates to a traction type elevator apparatus.

Background Art

[0002] In a conventional traction type elevator apparatus with a machine room, a shaft of a traction machine is placed to be horizontal, a main rope which is wound on a driving sheave extends vertically downward from the driving sheave to suspend an elevator car without passing through a turning pulley, and the main rope which extends from an opposite side of the driving sheave is wound on a turning pulley and extends vertically downward from the turning pulley to suspend a counter weight.
In a conventional traction type elevator apparatus without a machine room in which a traction machine is placed at a top portion of an hoistway, there are, for example, an elevator apparatus with a structure in which a traction machine is placed at the highest portion of an hoistway so that the shaft of the driving sheave is horizontal, and an elevator apparatus in which a traction machine is placed at a top portion of an hoistway so that the shaft of a driving sheave is in a vertical direction (for example, see Patent Document 1 and Patent Document 2).
As another prior art, there is a self-propelled elevator apparatus in which at least a pair of driving sheaves with driving motors which rotate in the reverse directions from each other and are mounted to an elevator car are included, and during traveling, the driving sheaves rotate to move the elevator car relatively to a rope, whereby the elevator car vertically moves in an hoistway (see Patent Document 3, for example).

[0003]

Patent Document 1: Japanese Patent Laid-Open No. 2002-80178
Patent Document 2: Japanese Patent Laid-Open No. 2001-48450
Patent Document 3: National Publication of International Patent Application No. 2002-504473

Disclosure of the Invention

Problem to be Solved by the Invention

[0004] In the case of using, for example, a traction machine using a permanent magnet type synchronous motor in a traction type of elevator, in order to decrease a use amount of the permanent magnet, it is necessary to decrease the dimension in an axial (width) direction of the motor and increase the dimension in a diameter direction of the motor. However, in the conventional traction type elevator apparatus with a machine room constructed as described above, the height dimension of the traction machine becomes larger as the diameter of the motor becomes larger, and it is necessary to increase height dimension of the machine room.
In the conventional traction type elevator apparatus without a machine room in which the traction machine is placed at the highest portion of the hoistway so that the shaft of the driving sheave is horizontal, the traction machine is placed in close vicinity to the hoistway ceiling, and therefore, when the diameter of the motor becomes large, it is necessary to increase the height dimension from the highest floor to the hoistway ceiling. In order to place such a large traction machine above the elevator car, a large installation space for the traction machine is required above the elevator car. Since the traction machine is placed above the elevator car with a maintenance surface facing sideways, when an operator is to perform a maintenance inspection operation of the traction machine on the elevator car, the operator performs the operation as the operator stands besides the traction machine on the elevator car, and therefore, there arises the problem that the operation space cannot be sufficiently secured.
In the conventional traction type elevator apparatus without a machine room in which the traction machine is placed at the top portion of the hoistway so that the shaft of the driving sheave is in the vertical direction, in order that the approach angle of the main rope to the groove on which the main ropes of the driving sheave and the turning pulley are wound does not become too large, it is necessary to secure a distance between the driving sheave and the turning pulley to some extent, the center of the traction machine has to be placed at the position deviated from the center of the elevator car on the horizontal plane of projection, and therefore, there exists the problem that when the diameter of the motor is large, the traction machine and the elevator passage wall interfere with each other or are too close to each other.

[0005] The prevent invention is made to solve the above described problems, and has an object to provide an elevator apparatus which does not need to increase an installation space in a machine room and an hoistway even when the diameter of a motor becomes large to make the motor of the traction machine thin, and is capable of sufficiently securing a maintenance space of the traction machine.

Means for Solving the Problems

[0006] The present invention provides an elevator apparatus including an elevator car which is suspended with a main rope and ascends and descends in an hoistway, a counter weight which is suspended with the main rope and ascends and descends in an opposite direction from said elevator car in the hoistway, a driving sheave on which said main rope is wound, and a traction machine which moves said elevator car and said counter weight to ascend and descend by rotating said driving sheave, characterized by including:

a reversing pulley which is arranged adjacently to said driving sheave, has a parallel shaft to a shaft of said driving sheave and rotates in a reverse direction from a rotating direction of said driving sheave; a first group turning pulley which is provided other than said reversing pulley and is constituted of at least one turning pulley; and a second group turning pulley constituted of at least one turning pulley, and characterized in that

said main rope is constituted of a first group main rope and a second group main rope each of which is constituted of at least one main rope,

said first group main rope is wound on said driving sheave from one of said first group turning pulleys, and is wound on said reversing pulley so as to be turned in a reverse direction from turning with which the first group main rope is wound on said driving sheave,

said second group main rope is wound on said reversing pulley from one of said second group turning pulleys, and is wound on said driving sheave so as to be turned in a reverse direction from turning with which the second group main rope is wound on said reversing pulley, and

a portion of said first group main rope which is passed onto said reversing pulley from said driving sheave, and a portion of said second group main rope which is passed onto said driving sheave from said reversing pulley intersect with each other on a plane of projection seen in an axial direction of said driving sheave and said reversing pulley.

Effect of the Invention

[0007] Since in the elevator apparatus of this invention, the driving sheave of the traction machine having a horizontal rotary shaft is placed above the counter weight, the reversing pulley is provided above the counter weight to be close to the driving sheave of the traction machine, the turning pulley is provided above the elevator car, and the turning pulley is provided above the shafts of the driving sheave of the traction machine and the reversing pulley, a space on the elevator car can be utilized as a maintenance space when an operator performs a maintenance operation from a side of the traction machine while standing on the elevator car.

Brief Description of the Drawings

[0008]

Figure 1 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 1 of this invention;

Figure 2 is a partial detailed view partially showing the elevator apparatus in the embodiment 1 of this invention;

Figure 3 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 2 of this invention;

Figure 4 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 3 of this invention;

Figure 5 is a schematic plane view showing a conceptual structure of an elevator apparatus in embodiment 4 of this invention;

Figure 6 is a partial detailed view partially showing the elevator apparatus in the embodiment 4 of this invention;

Figure 7 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 5 of this invention;

Figure 8 is a front view seen in a direction B in Figure 7; and

Figure 9 is a plane view seen in a direction C in Figure 7.

Description of Symbols

[0009]

1	hoistway
2	elevator car
3	counter weight
4	driving sheave (first driving sheave)
4a	shaft of the driving sheave
5	traction machine (first traction machine)
6	reversing pulley
6a	shaft of the reversing pulley
7a	one of the first group turning pulleys placed directly above the elevator car
7b	one of the second group turning pulleys placed directly above the elevator car
7c	shaft of the first group turning pulleys
7d	shaft of the second group turning pulleys
8a	one of the first group turning pulleys
8b	one of the second group turning pulleys
8c	shaft of the first group turning pulleys
8d	shaft of the second group turning pulleys
9a	first group main rope
9b	second group main rope
10	rising direction of the elevator car
11	descend direction of the counter weight
12	rotational direction of the driving sheave
13	rotational direction of the reversing pulley
14a	counter weight turning pulley
14b	counter weight turning pulley
15	brake device of the reversing pulley.
16	second driving sheave
17	second traction machine
18	rotational direction of the first driving sheave
19	rotational direction of the second driving sheave

Best Mode for Carrying Out the Invention

[0010] In the embodiment of the present invention, a

traction type elevator apparatus without a machine room will be described as an example.

Embodiment 1

[0011] Figure 1 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 1 of this invention; Figure 2 is a partial detailed view partially showing the elevator apparatus in the embodiment 1 of this invention.

[0012] In Figure 1, in the traction type elevator apparatus, an elevator car 2 and a counter weight 3 are ascendably and descendably provided in an hoistway 1. A driving sheave 4 on which a main rope 9 for raising and lowering the elevator car 2 and the counter weight 3 is wound, a traction machine 5 for rotating the driving sheave 4, and a reversing pulley 6 arranged adjacently to the driving sheave 4 are provided on the highest portion in the hoistway 1 to be located above the counter weight 3. Turning pulleys 7a and 7b placed directly above the elevator car 2 are provided at the highest part in the hoistway 1 with shafts 7c and 7d being horizontal. At a side of the counter weight 3 at the highest part in the hoistway 1, turning pulleys 8a and 8b are provided above a shaft 4a of the driving sheave 4 and a shaft 6a of the reversing pulley 6. The shaft 4a of the driving sheave 4 and the shaft 6a of the reversing pulley 6 are placed directly above the counter weight 3 so as to be horizontal to each other, and the reversing pulley 6 rotates in the reverse direction from the driving sheave 4.

The main rope 9 with which the elevator car 2 and the counter weight 3 are suspended with one end attached to the elevator car 2 and the other end attached to the counter weight 3 is constructed by a first group main rope 9a and a second group main rope 9b each of which is constituted of at least one main rope. The turning pulleys 7a and 8a are turning pulleys on which the first group main rope is wound and construct first group turning pulleys. The turning pulleys 7b and 8b are turning pulleys on which the second group main rope is wound, and construct second group turning pulleys.

One end of the first group main rope 9a is attached to a left side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the first group main rope 9a is attached to a right side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The first group main rope 9a starts from the left side fixing portion to the portion above the elevator car 2, is wound on the turning pulley 7a which is one of the first group turning pulleys and at the left side of the portion directly above the elevator car 2, and is wound on the turning pulley 8a which is one of the first group turning pulleys placed at a portion above and at a left side of the driving sheave 4 to be directed diagonally downward. Next, the main rope 9a is wound on a lower side of the driving sheave 4 and turned upward, wound on an upper side of the reversing pulley 6 adjacently arranged and turned in a downward direction again. Then, the main rope 9a takes the route leading to a right side fixing portion at the upper portion of the counter weight 3.

Meanwhile, one end of the second group main rope 9b is attached to a right side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the second group main rope 9b is attached to a left side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The second group main rope 9b starts from the right side fixing portion to the portion above the elevator car 2, is wound on the turning pulley 7b which is one of the second group turning pulleys which are at a right side of a portion directly above the elevator car 2, and is wound on the turning pulley 8b which is one of the second group turning pulleys placed at a portion above and at a right side of the reversing pulley 6 to be directed diagonally downward. Next, the main rope 9b is wound on a lower side of the reversing pulley 6 and turned upward, wound on an upper side of the driving sheave 4 adjacently arranged and turned in a downward direction again. Then, the main rope 9b takes the route leading to a left side fixing portion at the upper portion of the counter weight 3.

The first group main rope and the second group main rope intersect each other on a plane of projection seen in the axial direction at a portion where they are passed onto the reversing pulley from the driving sheave. Reference numeral 15 denotes a brake device which is not provided at the traction machine 5 but at the reversing pulley 6.

[0013] Figure 2 is a partial detailed view of Figure 1 seen from the direction A, and as shown in Figure 2, the first group main rope 9a and the second group main rope 9b are orderly wound on the driving sheave 4 and the reversing pulley 6 without interfering with each other.

[0014] When the elevator car 2 rises in the direction of a rising direction 10, the counter weight 3 lowers in the direction of a lowering direction 11, and at this time, the driving sheave 4 rotates in the direction of the arrow 12 while the reversing pulley 6 rotates in the direction of the arrow 13.

[0015] Since in Figure 1, the traction machine 5 and the reversing pulley 6 are placed above the counter weight 3, and the turning pulleys 7a and 7b are only placed above the elevator car 2, a space on the car 2 can be utilized as a maintenance space when an operator performs a maintenance operation from a lateral side of the traction machine 5 while standing on the elevator car 2. In order to decrease a use amount of a permanent magnet of the motor of the traction machine, it is necessary to decrease the dimension in the axial (width) direction of the motor and to increase the dimension in the diameter direction thereof, but since in this case, the traction machine is not located above the elevator car, a large installation space is not required above the elevator car, and since the dimension of the traction machine in the axial direction is small, the hoistway area can be made small.

[0016] In Figure 1, the traction machine 5 does not have the brake device, but has the structure in which the main rope groove of the reversing pulley 6 is made the main rope groove which causes the equivalent frictional drive force to the driving sheave 4, and the brake device 15 is provided at the reversing pulley 6. Accordingly, the traction machine 5 does not have the brake device, and therefore, it is not given the dimensional limitation of the brake device and is able to be downsized. The brake device 15 is not given the dimensional limitation of the traction machine 5 and is able to be downsized.

The traction machine 5, the reversing pulley 6 and the brake device 15 are placed to be in close vicinity to each other, and therefore, it is sufficiently possible to integrally construct them.

[0017] In the embodiment 1, the turning pulleys 7a, 7b, 8a and 8b, the driving sheave 4, the traction machine 5, the reversing pulley 6 and the brake device 15 are all placed inside the hoistway 1, but it is possible to place all or a part of them in a machine room (not shown) which is provided adjacently to the hoistway.

[0018] In the embodiment 1, the end portion of the first group main rope 9a and the end portion of the second group main rope 9b are directly attached to the elevator car 2 and the counter weight 3, but it is possible to provide suspension sheave (not shown) at suspension portions of the elevator car and the counter weight, the main ropes are wound on the suspension sheave and turned, and the end portion of each main rope is fixed to the top portion of the hoistway and the machine room.

[0019] In the elevator apparatus which is thus constructed, the driving sheave of the traction machine having the horizontal shaft is placed above the counter weight, the reversing pulley is provided above the counter weight adjacently to the driving sheave of the traction machine, the turning pulley is provided above the elevator car, and the turning pulleys are provided at the sides of the portions above the traction machine and the reversing pulley, and therefore, when an operator performs a maintenance operation from a side of the traction machine while standing on the elevator car, the space on the car can be widely utilized as the maintenance space.

Embodiment 2

[0020] Figure 3 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 2 of this invention.

[0021] In Figure 3, the components given the same reference numerals as in Figure 1 show the corresponding components. While the two turning pulleys 7a and 7b are placed at the portions above the elevator car 2 in the embodiment 1, one turning pulley 7b is placed at a portion above the elevator car 2 in this embodiment. In the other respects, the embodiment 2 is the same as the embodiment 1.

The turning pulley 8a is the turning pulley on which the first group main rope is wound, and constructs the first group turning pulley. The turning pulleys 7b and 8b are the turning pulleys on which the second main rope is wound, and construct the second group turning pulleys.

One end of the first group main rope 9a is attached to a left back side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the first group main rope 9a is attached to a right side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The first group main rope 9a starts from the left back side fixing portion to the portion above the elevator car 2, and is wound on the turning pulley 8a which is placed at a portion above and at a left side of the driving sheave 4 to be directed diagonally downward. Next, the main rope 9a is wound on a lower side of the driving sheave 4 and turned upward, wound on an upper side of the reversing pulley 6 adjacently arranged and turned in a downward direction again. Then, the main rope 9a takes the route leading to a right side fixing portion at the upper portion of the counter weight 3.

Meanwhile, one end of the second group main rope 9b is attached to a right front side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the second group main rope 9b is attached to a left side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The second group main rope 9b starts from the right front side fixing portion to the portion above the elevator car 2, is wound on the turning pulley 7b which is one of the second group turning pulleys which are at the right side of a portion directly above the elevator car 2, and is wound on the turning pulley 8b which is one of the second group turning pulleys placed at a portion above and at a right side of the reversing pulley 6 to be directed diagonally downward. Next, the main rope 9b is wound on a lower side of the reversing pulley 6 and turned upward, wound on an upper side of the driving sheave 4 adjacently arranged and turned in a downward direction again. Then, the main rope 9b takes the route leading to a left side fixing portion at the upper portion of the counter weight 3.

The first group main rope and the second group main rope intersect each other on a plane of projection seen in the axial direction at the portion where they are passed onto the reversing pulley from the driving sheave.

With such a construction, the same effect can be provided with the smaller number of turning pulleys than in the embodiment 1.

Embodiment 3

[0022] Figure 4 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 3 of this invention.

[0023] In Figure 4, in the traction type elevator apparatus, an elevator car 2 and a counter weight 3 are ascendably and descendably provided in an hoistway 1. A driving sheave 4 on which a main rope 9 for raising and

lowering the elevator car 2 and the counter weight 3 is wound, a traction machine 5 for rotating the driving sheave 4, and a reversing pulley 6 arranged adjacently to the driving sheave 4 are provided to be located above the counter weight 3. Turning pulleys 8a and 8b are provided above a shaft 4a of the driving sheave 4 and a shaft 6a of the reversing pulley 6 with shafts 8c and 8d being horizontal. The shaft 4a of the driving sheave 4 and the shaft 6a of the reversing pulley 6 are placed at portions directly above the counter weight 3 so as to be horizontal to each other, and the reversing pulley 6 rotates in the reverse direction from the driving sheave 4. The main rope 9 with which the elevator car 2 and the counter weight 3 are suspended with one end attached to the elevator car 2 and the other end attached to the counter weight 3 is constructed by a first group main rope 9a and a second group main rope 9b each of which is constituted of at least one main rope. The turning pulley 8a is a turning pulley on which the first group main rope is wound and constructs a first group turning pulley. The turning pulley 8b is a turning pulley on which the second group main rope is wound, and constructs a second group turning pulley.

One end of the first group main rope 9a is attached to a left side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the first group main rope 9a is attached to a right side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The first group main rope 9a starts from the left side fixing portion to the portion above the elevator car 2, and is wound on the turning pulley 8a which is placed at a portion above and at a left side of the driving sheave 4 to be directed downward. Next, the main rope 9a is wound on a lower side of the driving sheave 4 and turned upward, wound on an upper side of the reversing pulley 6 adjacently arranged and turned in a downward direction again. Then, the main rope 9a takes the route leading to a right side fixing portion at the upper portion of the counter weight 3.

Meanwhile, one end of the second group main rope 9b is attached to a right side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the second group main rope 9b is attached to a left side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The second group main rope 9b starts from the right side fixing portion to the portion above the elevator car 2, and is wound on the turning pulley 8b which is placed at a portion above and at a right side of the reversing pulley 6 to be directed downward. Next, the main rope 9b is wound on a lower side of the reversing pulley 6 and turned upward, wound on an upper side of the driving sheave 4 adjacently arranged and turned in a downward direction again. Then, the main rope 9b takes the route leading to a left side fixing portion at the upper portion of the counter weight 3.

The first group main rope and the second group main rope intersect each other on the plane of projection seen in the axial direction at a portion where they are passed onto the reversing pulley from the driving sheave. A brake device is incorporated in the traction machine 5.

When the elevator car 2 rises in the direction of a rising direction 10, the counter weight 3 lowers in the direction of a lowering direction 11, and at this time, the driving sheave 4 rotates in the direction of the arrow 12 while the reversing pulley 6 rotates in the direction of the arrow 13.

The embodiment 3 provides the same effect as the embodiment 1, but unless the turning pulleys 8a and 8b with extremely large diameters are used, the elevator car cannot be suspended at the center of gravity with the main rope 9, and the elevator car 2 is suspended at the rear end with the main rope 9. Therefore, the embodiment 3 is more suitable for an elevator with a small floor area (small load capacity) than an elevator with a large floor area, and can be constructed by a smaller number of turning pulleys than in the embodiment 1.

Embodiment 4

[0024] Figure 5 is a schematic plane view showing a conceptual structure of an elevator apparatus in embodiment 4 of this invention; Figure 6 is a partial detailed view partially showing the elevator apparatus in the embodiment 4 of this invention.

[0025] In Figure 5, in the traction type elevator apparatus, an elevator car 2 and a counter weight 3 are ascendably and descendably provided in an hoistway 1. A first driving sheave 4 on which a main rope 9 for raising and lowering the elevator car 2 and the counter weight 3 is wound, a second driving sheave 16 which is arranged adjacently to the driving sheave 4 and on which the main rope 9 for raising and lowering the elevator car 2 and the counter weight 3 is wound, a first traction machine 5 for rotating the first driving sheave 4, and a second traction machine 17 which is arranged adjacently to the first traction machine 5 and for rotating the second driving sheave 16 are provided to be located above the elevator car 2 at the highest part in the hoistway 1. A pair of left and right turning pulleys 7a and 7b placed at portions directly above the elevator car 2 are provided at the highest part in the hoistway 1. A pair of left and right counter weight turning pulleys 14a and 14b which are placed at portions directly above the counter weight 3 are provided at the highest part in the hoistway 1. The first traction machine 5 and the second traction machine 17 are placed substantially horizontally above the elevator car 2 in the hoistway 1 so that the shaft of the first driving sheave 4 and the shaft of the second driving sheave 16 are in the vertical direction, and the second driving sheave 16 rotates in the reverse direction from the first driving sheave 4.

The main rope 9 with which the elevator car 2 and the counter weight 3 are suspended with one end attached to the elevator car 2 and the other end attached to the counter weight 3 is constructed by a first group main rope 9a and a second group main rope 9b each of which is

constituted of at least one main rope.

The turning pulleys 7a and 14a are turning pulleys on which the first group main rope is wound and construct first group turning pulleys. The turning pulleys 7b and 14b are turning pulleys on which the second group main rope is wound, and construct second group turning pulleys.

One end of the first group main rope 9a is attached to a left side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the first group main rope 9a is attached to a right side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The first group main rope 9a starts from the left side fixing portion to the portion above the elevator car 2, is wound on the turning pulley 7a for the elevator car at the left side of the portion directly above the elevator car 2, and is directed horizontally to the first driving sheave 4. Next, the main rope 9a is horizontally wound on the first driving sheave 4 and turned, horizontally wound on the second driving sheave 16 adjacently arranged and turned in an opposite direction from the turning direction on the driving sheave 4 again. Then, the main rope 9a is wound on the turning pulley 14a for the counter weight at the right side of the portion directly above the counter weight 3 and droops, and takes the route leading to a right side fixing portion of the upper portion of the counter weight 3.

Meanwhile, one end of the second group main rope 9b is attached to a right side portion of an upper portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the second group main rope 9b is attached to a left side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The second group main rope 9b starts from the right side fixing portion to the portion above the elevator car 2, is wound on the elevator car turning pulley 7b which is at the right side of a portion directly above the elevator car 2, and is directed horizontally to the second driving sheave 16. Next, the main rope 9b is horizontally wound on the second driving sheave 16 and turned, horizontally wound on the first driving sheave 4 adjacently arranged and turned in an opposite direction from the turning direction on the second driving sheave 16 again. Then, the main rope 9b is wound on the counter weight turning pulley 14b at the left side of the portion directly above the counter weight 3 and droops, and takes the route leading to a left side fixing portion at the upper portion of the counter weight 3. The first group main rope and the second group main rope intersect each other on the plane of projection seen in the axial direction at a portion where they are passed onto the reversing pulleys from the driving sheaves.

[0026] Figure 6 is a partial detailed view of Figure 5, and as shown in Figure 6, the first group main rope 9a and the second group main rope 9b are orderly wound on the first driving sheave 4 and the second driving sheave 16 without interfering with each other.

[0027] When the elevator car 2 rises, the counter weight 3 lowers, and at this time, the first driving sheave 4 rotates in the direction of the arrow 18 while the second driving sheave 16 rotates in the direction of the arrow 19.

[0028] In Figure 5, the first traction machine 5 and the second traction machine 17 are placed above the elevator cage 2 in the hoistway, but since the two traction machines are provided, it is possible to reduce the sizes of the individual traction machines respectively, and therefore, it is not necessary to take a large installation space. Even if the traction machine is placed in a center of the hoistway plane area, it is possible to wind the main rope without laboring.

[0029] In the embodiment 4, the second traction machine 17 is provided in addition to the first traction machine 5, but it is possible to make the construction provided with the reversing pulley as in the embodiment 1 instead of the second traction machine 17.

[0030] The turning pulleys 7a and 7b, the weight turning pulleys 14a and 14b, the first driving sheave 4 and the first traction machine 5, the second driving sheave 16 and the second traction machine 17 are placed inside the hoistway 1, but it is possible to place all or a part of them in the machine room (not shown) which is provided adjacently to the hoistway.

[0031] In the embodiment 4, the end portion of the first group main rope 9a and the end portion of the second group main rope 9b are directly attached to the elevator car 2 and the counter weight 3, but it is also possible to provide suspension sheave (not shown) at the suspension portions of the elevator car and the counter weight, and wind the main rope on the suspension sheave and turn it, and fix the end portion of each main ropes to a top portion of the hoistway and the machine room.

[0032] Since in the elevator apparatus thus constructed, the shaft of the driving sheave of the traction machine is placed above the elevator car with the shaft thereof in the vertical direction, the reversing pulley is provided in close vicinity to the driving sheave of the traction machine, the turning pulley is provided above the elevator car, and the turning pulley is provided above the counter weight, it is possible to wind the main rope without laboring even if the traction machine is placed in the center of the hoistway plane, and the traction machine does not interfere with or are not too close to the hoistway and the wall of the machine room.

Embodiment 5

[0033] Figure 7 is a schematic perspective view showing a conceptual structure of an elevator apparatus in embodiment 5 of this invention; Figure 8 is a front view seen in a direction B in Figure 7; and Figure 9 is a plane view seen in a direction C in Figure 7.

[0034] In Figure 7, in the traction type elevator apparatus, an elevator car 2 and a counter weight 3 are ascendably and descendably provided in an hoistway 1. A driving sheave 4 on which a main rope 9 for raising and lowering the elevator car 2 and the counter weight 3 is

wound, a traction machine 5 for rotating the driving sheave 4, and a reversing pulley 6 arranged adjacently to the driving sheave 4 are provided on the highest portion in the hoistway 1 to be located above the counter weight 3. Turning pulleys 7a and 7b, which are placed in a space between the elevator car 2 and the hoistway 1 at a top part of the hoistway 1 when the elevator car 2 is located at the highest part of the travel, are provided at the highest part in the hoistway 1 with shafts 7c and 7d being horizontal. At a side of the counter weight 3 at the highest part in the hoistway 1, turning pulleys 8a and 8b are provided above a shaft 4a of the driving sheave 4 and a shaft 6a of the reversing pulley 6. The shaft 4a of the driving sheave 4 and the shaft 6a of the reversing pulley 6 are placed at portions directly above the counter weight 3 so as to be horizontal, and the reversing pulley 6 rotates in the reverse direction from the driving sheave 4.

The main rope 9 with which the elevator car 2 and the counter weight 3 are suspended with one end attached to the elevator car 2 and the other end attached to the counter weight 3 is constructed by a first group main rope 9a and a second group main rope 9b each of which is constituted of at least one main rope. The turning pulleys 7a and 8a are turning pulleys on which the first group main rope is wound and construct first group turning pulleys. The turning pulleys 7b and 8b are turning pulleys on which the second group main rope is wound, and construct second group turning pulleys.

One end of the first group main rope 9a is attached to a right side portion of a lower portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the first group main rope 9a is attached to a right side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The first group main rope 9a starts from the right side fixing portion to the lower portion of the elevator car 2, is wound on the turning pulley 7a which is one of the first group turning pulleys at the right side of the elevator car 2 at the highest part of the hoistway 1, and is wound on the turning pulley 8a which is one of the first group turning pulleys placed at a portion above and at a right side of the reversing pulley 6 to be directed diagonally downward. Next, the main rope 9a is wound on a lower side of the driving sheave 4 and turned upward, wound on an upper side of the reversing pulley 6 adjacently arranged and turned in a downward direction again. Then, the main rope 9a takes the route leading to a right side fixing portion at the upper portion of the counter weight 3.

Meanwhile, one end of the second group main rope 9b is attached to a left side portion of a lower portion of the elevator car 2 to suspend a part of the elevator car 2 while the other end of the second group main rope 9b is attached to a left side portion of an upper portion of the counter weight 3 to suspend a part of the counter weight 3. The second group main rope 9b starts from the left side fixing portion to the lower portion of the elevator car 2, is wound on the turning pulley 7b which is one of the second group turning pulleys at the left side of the elevator car 2 at the highest part of the hoistway 1, and is wound on the turning pulley 8b which is one of the second group turning pulleys placed at a portion above and at a left side of the driving sheave 4 to be directed diagonally downward. Next, the main rope 9b is wound on a lower side of the reversing pulley 6 and turned upward, is wound on an upper side of the driving sheave 4 adjacently arranged and turned in a downward direction again. Then, the main rope 9b takes the route leading to a left side fixing portion at the upper portion of the counter weight 3.

The first group main rope 9a and the second group main rope 9b intersect each other on the plane of projection seen in the axial direction at a portion where they are passed onto the reversing pulley 6 from the driving sheave 4. The first group main rope 9a and the second group main rope 9b intersect each other on the plane of projection seen in the axial direction at the portion where they are passed between the turning pulleys 8a and 8b placed above the driving sheave 4 and the reversing pulley 6 and the driving sheave 4 and the reversing pulley 6. In order to engage with the inclinations of the respective main ropes 9a and 9b, the turning pulleys 8a and 8b are inclined so that the shafts 8c and 8d are substantially in the vertical direction.

Figure 8 is a partial detailed view of Figure 7 seen from the direction B, and what is shown by the two-dot chain line in the drawing shows the position when the elevator car 2 reaches the highest part of the travel. Figure 9 is a partial detailed view of Figure 7 seen from the direction C. As shown in Figure 8, the turning pulleys 7a and 7b are placed in the space between the elevator car 2 and the hoistway 1, and even when the elevator car 2 reaches the highest part, the turning pulleys 7a and 7b do not interfere with the elevator car 2. As shown in Figure 9, the turning pulleys 8a and 8b are placed above the elevator car 2 so that parts of them overlay the elevator car when seen on the horizontal plane of projection, but the first group main rope 9a and the second group main rope 9b are placed to intersect each other on the plane of projection seen in the axial direction at the portion where they are passed between the turning pulleys 8a and 8b placed above the driving sheave 4 and the reversing pulley 6 and the driving sheave 4 and the reversing pulley 6, and therefore, the distance between the turning pulley 8a and the driving sheave 4 and the distance between the turning pulley 8b and the reversing pulley 6 become large. Since the turning pulleys 8a and 8b which are engaged with the inclinations of the respective main ropes 9a and 9b are inclined so that the shafts 8c and 8d are substantially in the vertical direction, the installation space in the vertical direction of the turning pulleys 8a and 8b becomes small, and the height direction dimension which is necessary above the elevator car is small.

Industrial Applicability

[0035] As described above, the elevator apparatus ac-

cording to this invention is preferable for use in a traction type elevator apparatus without a machine room.

Claims

1. An elevator apparatus including an elevator car which is suspended with a main rope and ascends and descends in an hoistway, a counter weight which is suspended with the main rope and ascends and descends in an opposite direction from said elevator car in the hoistway, a driving sheave on which said main rope is wound, and a traction machine which moves said elevator car and said counter weight to ascend and descend by rotating said driving sheave, **characterized by** including:

   a reversing pulley which is arranged adjacently to said driving sheave, has a parallel shaft to a shaft of said driving sheave and rotates in a reverse direction from a rotating direction of said driving sheave; a first group turning pulley which is provided other than said reversing pulley and is constituted of at least one turning pulley; and a second group turning pulley constituted of at least one turning pulley, and **characterized in that**
   said main rope is constituted of a first group main rope and a second group main rope each of which is constituted of at least one main rope,
   said first group main rope is wound on said driving sheave from one of said first group turning pulleys, and is wound on said reversing pulley so as to be turned in a reverse direction from turning with which the first group main rope is wound on said driving sheave,
   said second group main rope is wound on said reversing pulley from one of said second group turning pulleys, and is wound on said driving sheave so as to be turned in a reverse direction from turning with which the second group main rope is wound on said reversing pulley, and
   a portion of said first group main rope which is passed onto said reversing pulley from said driving sheave, and a portion of said second group main rope which is passed onto said driving sheave from said reversing pulley intersect with each other on a plane of projection seen in an axial direction of said driving sheave and said reversing pulley.

2. The elevator apparatus according to claim 1, **characterized in that**
   a shaft of the driving sheave and a shaft of the reversing pulley are placed to be horizontal,
   the first group turning pulley is constituted of one turning pulley with a shaft placed to be horizontal,
   the second group turning pulley is constituted of one turning pulley with a shaft placed to be horizontal,
   said first group turning pulley and second group turning pulley are placed above shafts of said driving sheave and said reversing pulley,
   in a route of the first group main rope, which leads to the counter weight from the elevator car, the first main rope is wound on said first group turning pulleys, said driving sheave and said reversing pulley in this order,
   in a route of the second group main rope, which leads to the counter weight from the elevator car, the second main rope is wound on said first group turning pulleys, said reversing pulley and said driving sheave in this order.

3. The elevator apparatus according to claim 1, **characterized in that**
   a shaft of the driving sheave and a shaft of the reversing pulley are placed above the counter weight to be in a horizontal direction,
   one of the first group turning pulleys and one of the second group turning pulleys are placed above the shafts of said driving sheave and said reversing pulley,
   another one of said first group turning pulleys and another one of said second group turning pulleys are placed above the elevator car, or either another one of said first group turning pulleys or another one of said second group turning pulleys is placed above the elevator car,
   in a route of the first group main rope, which leads to the counter weight from the elevator car, the first main rope is wound on one or two of said first group turning pulleys, said driving sheave and said reversing pulley in this order, and
   in a route of the second group main rope, which leads to the counter weight from the elevator car, the second main rope is wound on one or two of said first group turning pulley, said reversing pulley and said driving sheave in this order.

4. The elevator apparatus according to claim 1, **characterized in that**
   a shaft of the driving sheave and a shaft of the reversing pulley are placed above the elevator car to be in a vertical direction,
   one of the first group turning pulleys and one of the second group turning pulleys are placed above the elevator car so that shafts are horizontal, another one of said first group turning pulleys and another one of said second group turning pulleys are placed above the counter weight so that shafts are horizontal,
   in a route of the first group main rope, which leads to the counter weight from the elevator car, the first main rope is wound on one of said first group turning pulley placed above the elevator car, said driving sheave, said reversing pulley, and another one of

said first group turning pulley placed above said counter weight in this order,
in a route of the second group main rope, which leads to the counter weight from the elevator car, the second main rope is wound on one of said second group turning pulleys placed above the elevator car, said reversing pulley, said driving sheave, and another one of said second group turning pulleys placed above said counter weight in this order.

5. The elevator apparatus according to claim 1, **characterized in that**
a shaft of the driving sheave and a shaft of the reversing pulley are placed above the counter weight to be in a horizontal direction,
one of the first group turning pulleys and one of the second group turning pulleys are placed above shafts of said driving sheave and said reversing pulley,
another one of said first group turning pulleys and another one of said second group turning pulleys are placed above the elevator car,
in a route of the first group main rope, which leads to the counter weight from the elevator car, the first main rope is wound on two of said first group turning pulleys, said driving sheave and said reversing pulley in this order,
in a route of the second group main rope, which leads to the counter weight from the elevator car, the second main rope is wound on two of said first group turning pulleys, said reversing pulley and said driving sheave in this order,
a portion of said first group main rope which is passed onto said driving sheave from one of said first group turning pulleys and a portion of said second group main rope which is passed onto said reversing pulley from one of said second group turning pulleys intersect each other on a plane of projection seen in an axial direction of said driving sheave and said reversing pulley.

6. The elevator apparatus according to any one of claims 1 to 5, **characterized in that**
the traction machine which rotates the driving sheave does not have a brake device, and the reversing pulley includes a brake device for stopping rotation.

7. The elevator apparatus according to any one of claims 1 to 6, **characterized in that**
the driving sheave, the reversing pulley and the turning pulley except for said reversing pulley, and the traction machine are placed in the hoistway.

8. The elevator apparatus according to any one of claims 1 to 5, and claim 7, **characterized by** including a second driving sheave which is rotated in the same direction as the reversing pulley by a second traction machine which is different from the traction machine, instead of the reversing pulley.

Fig.1

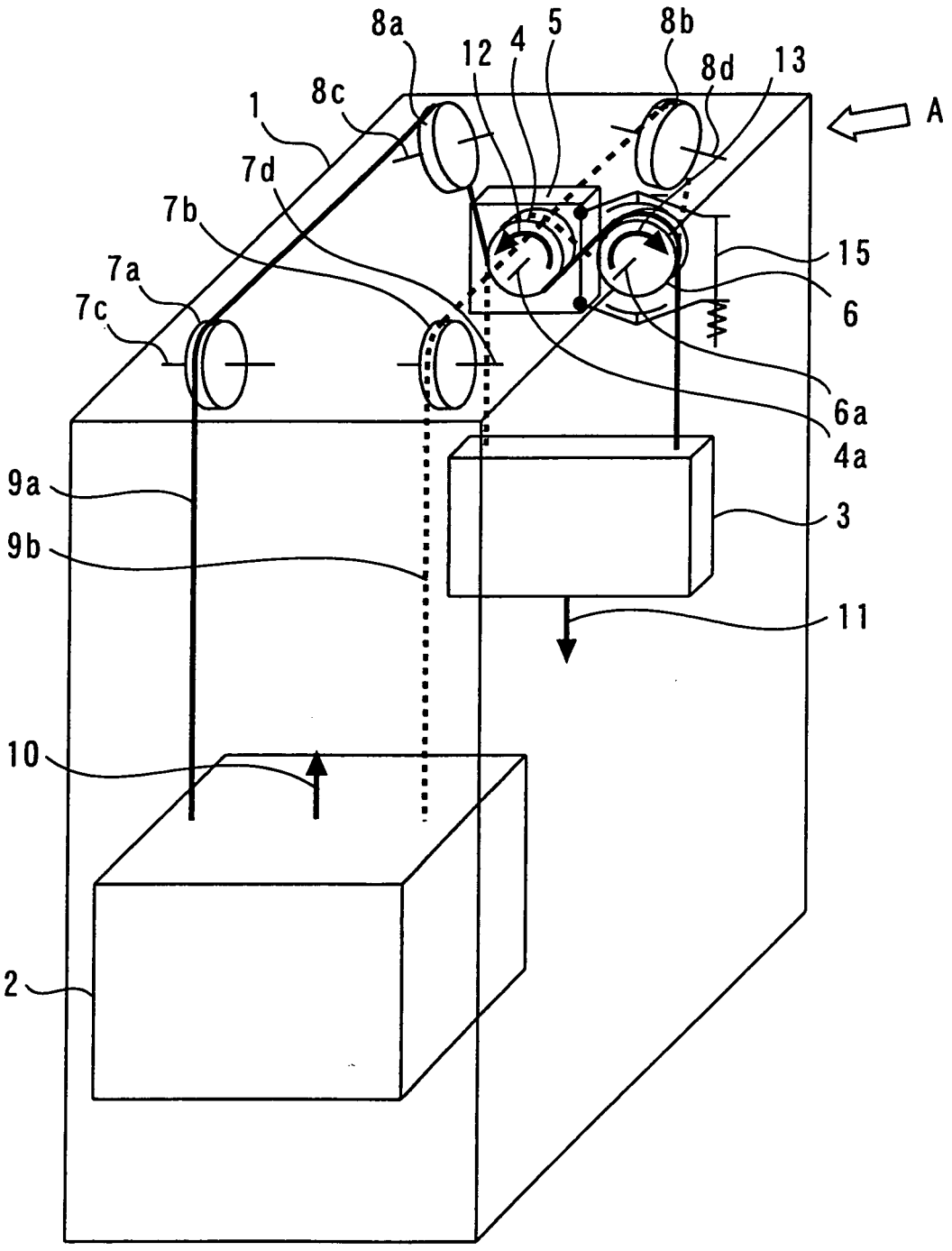


Fig.2

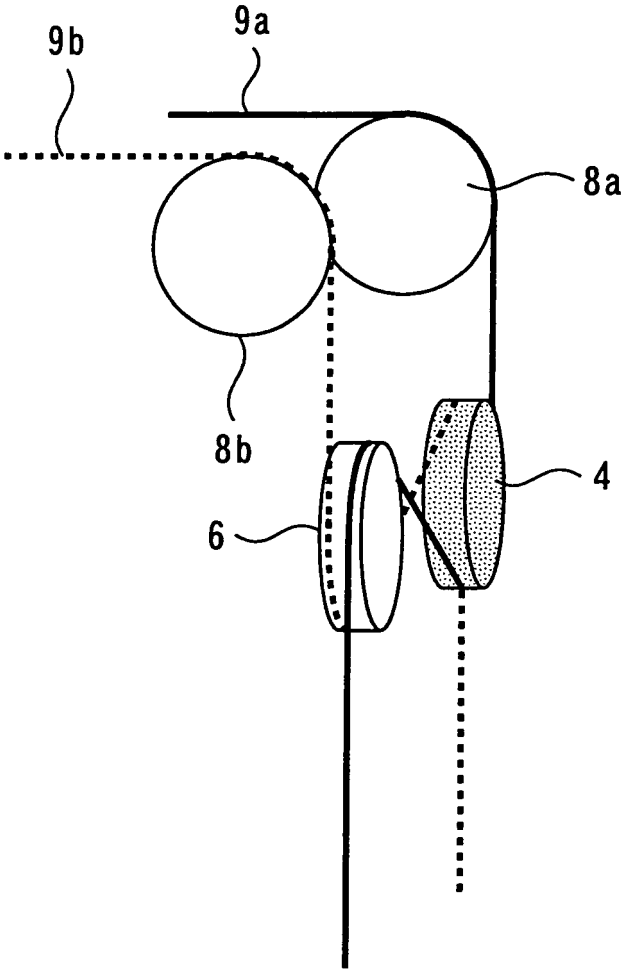


Fig.3

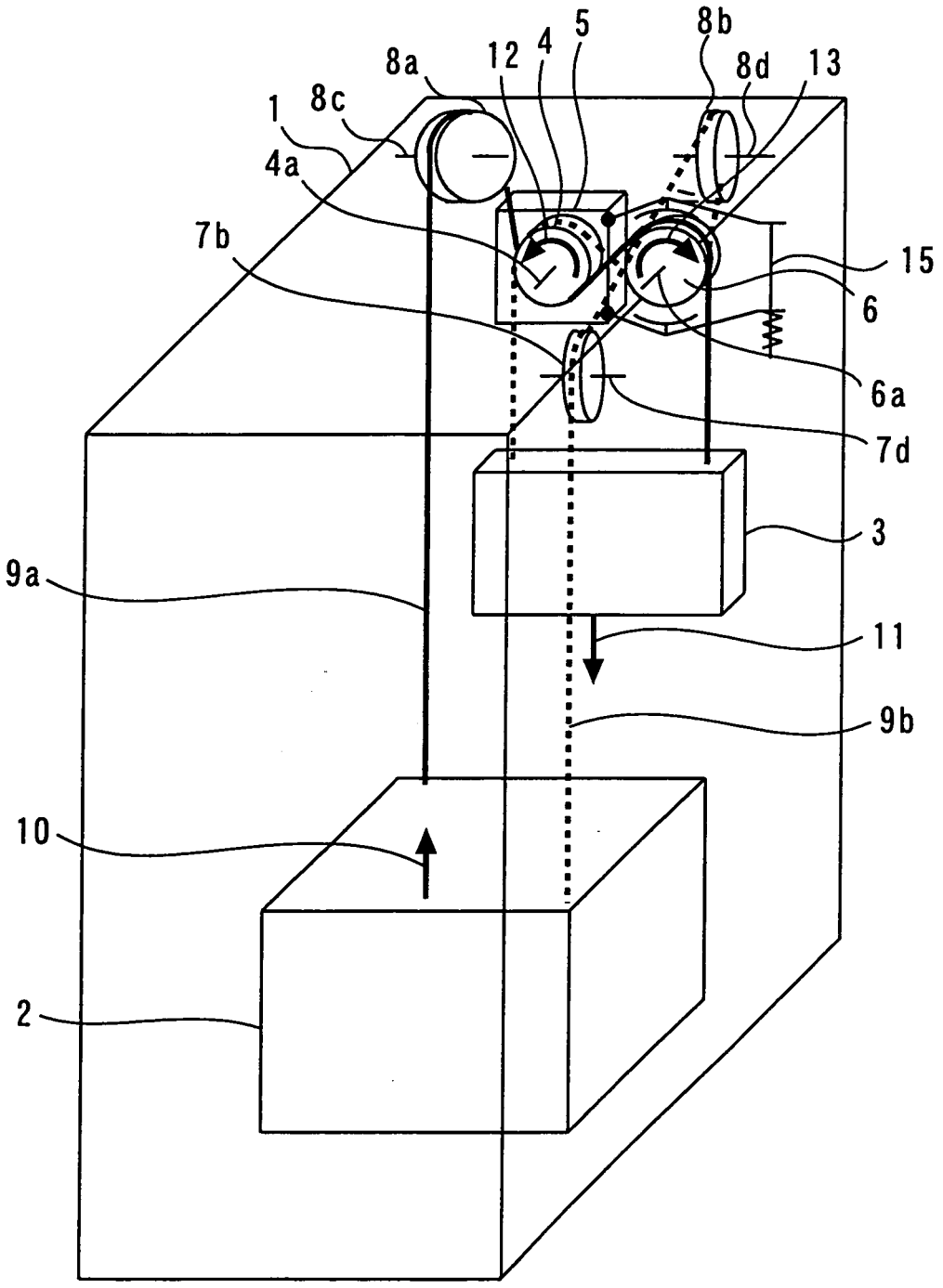


Fig.4

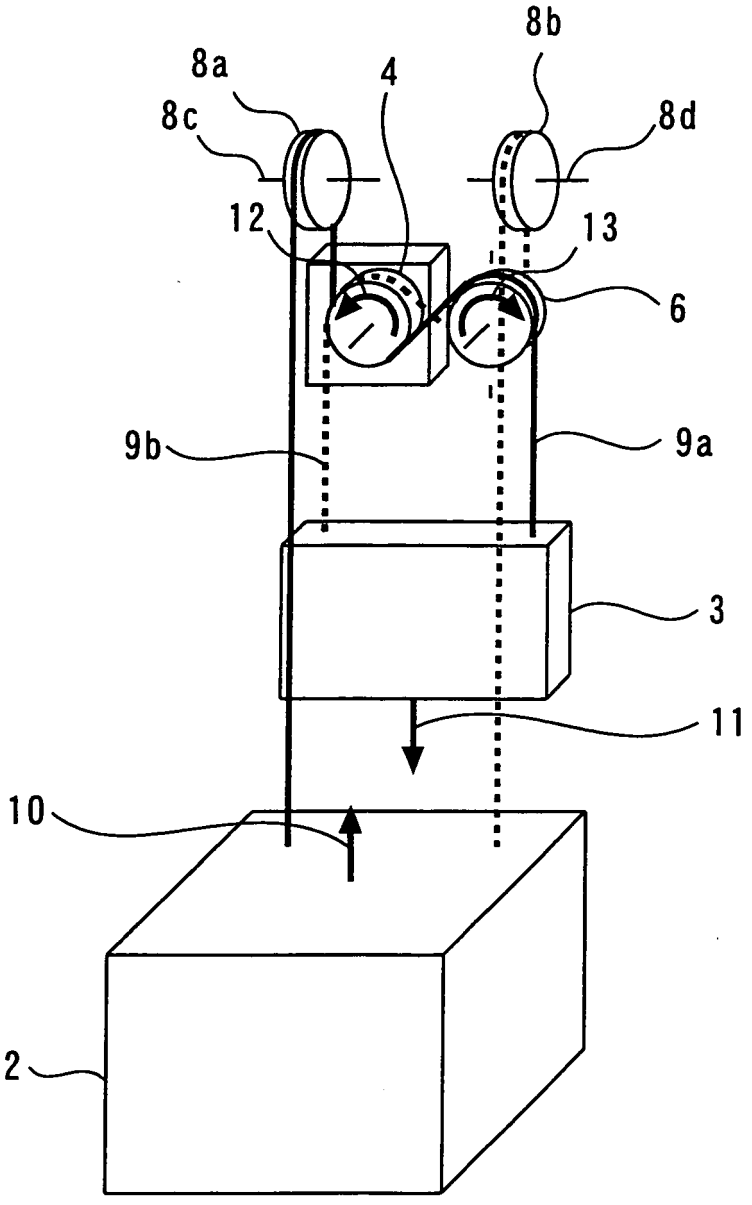


Fig.5

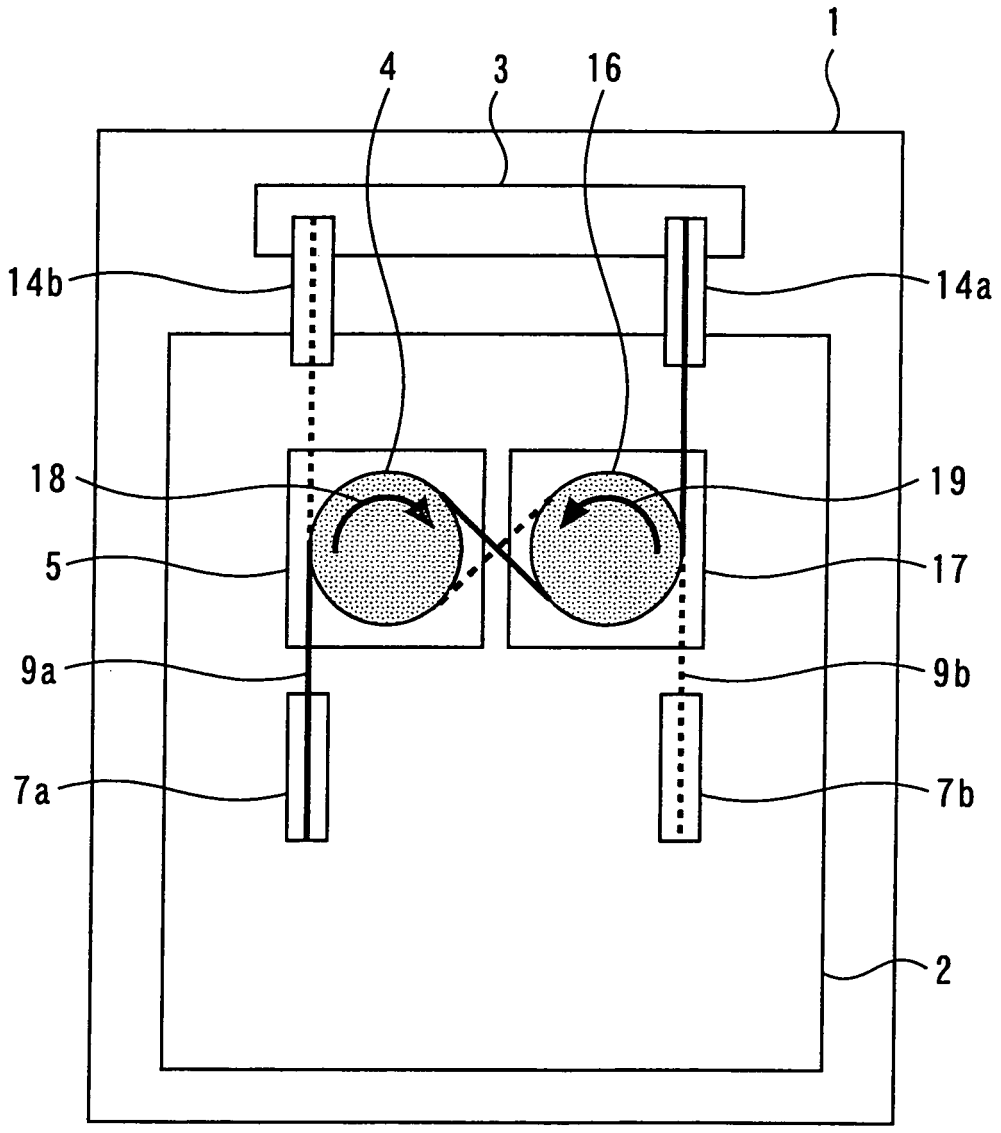


Fig.6

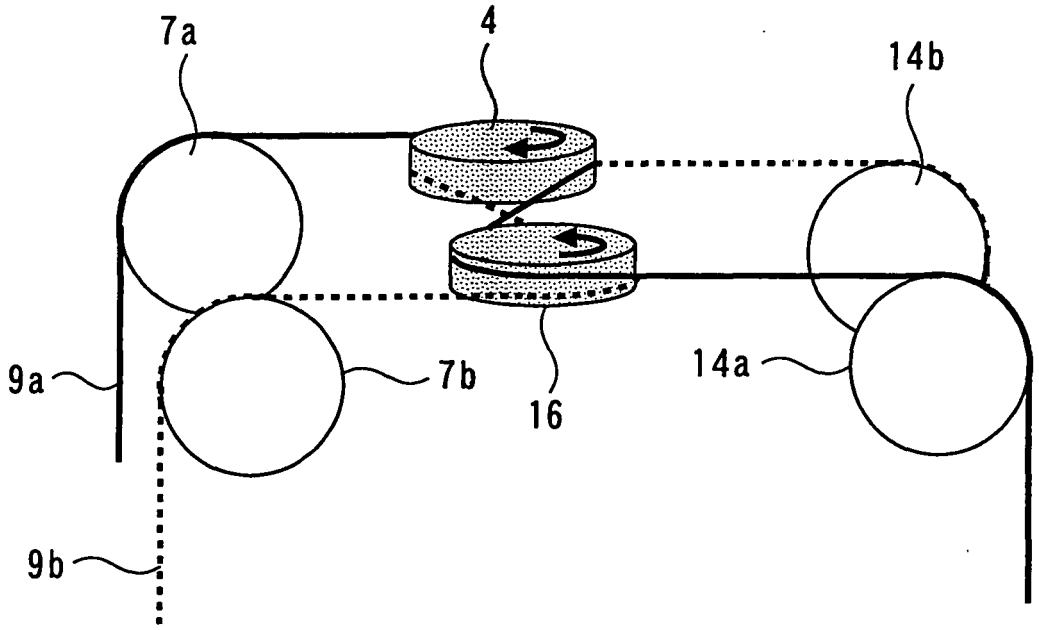


Fig.7

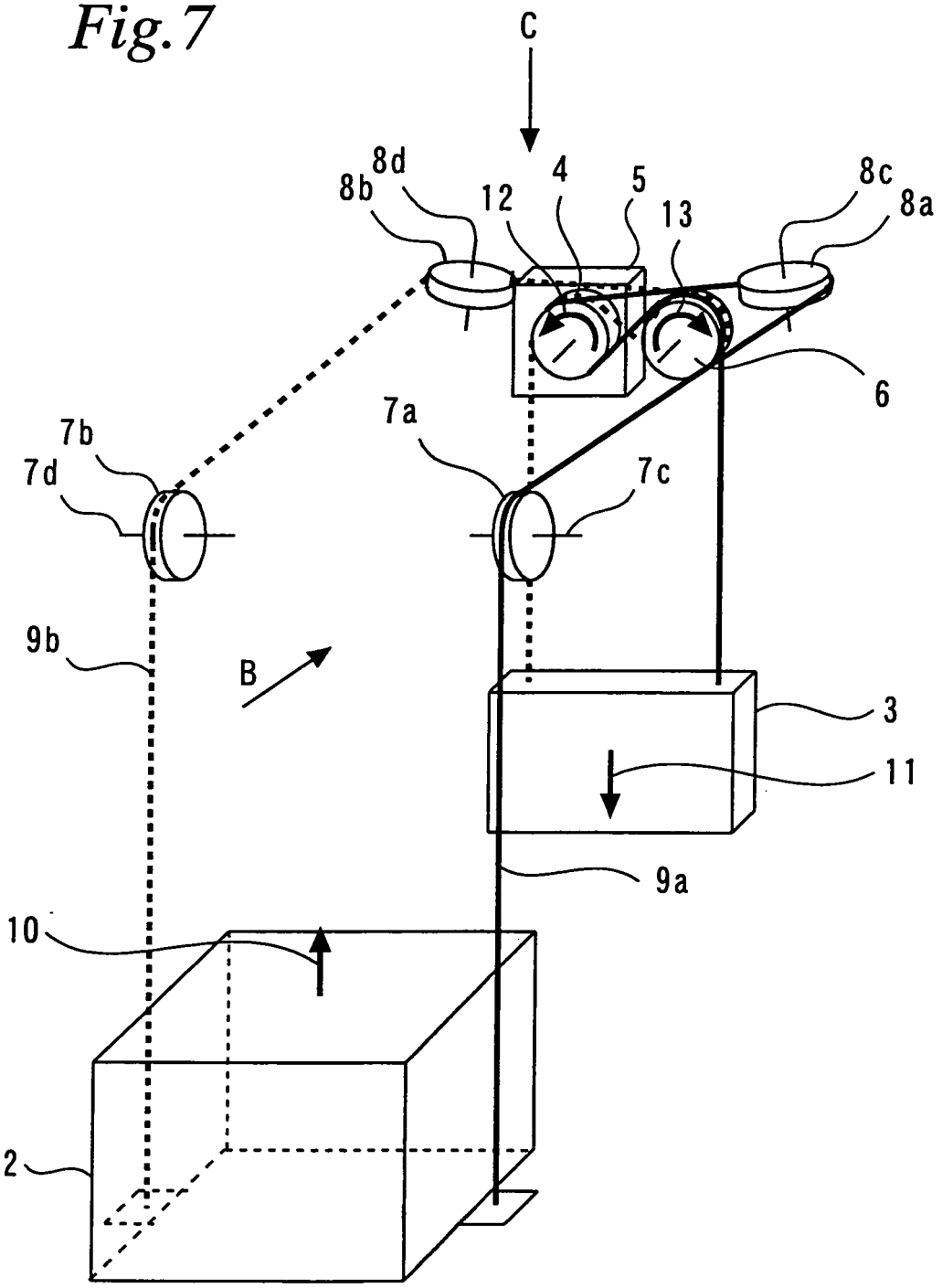


Fig.8

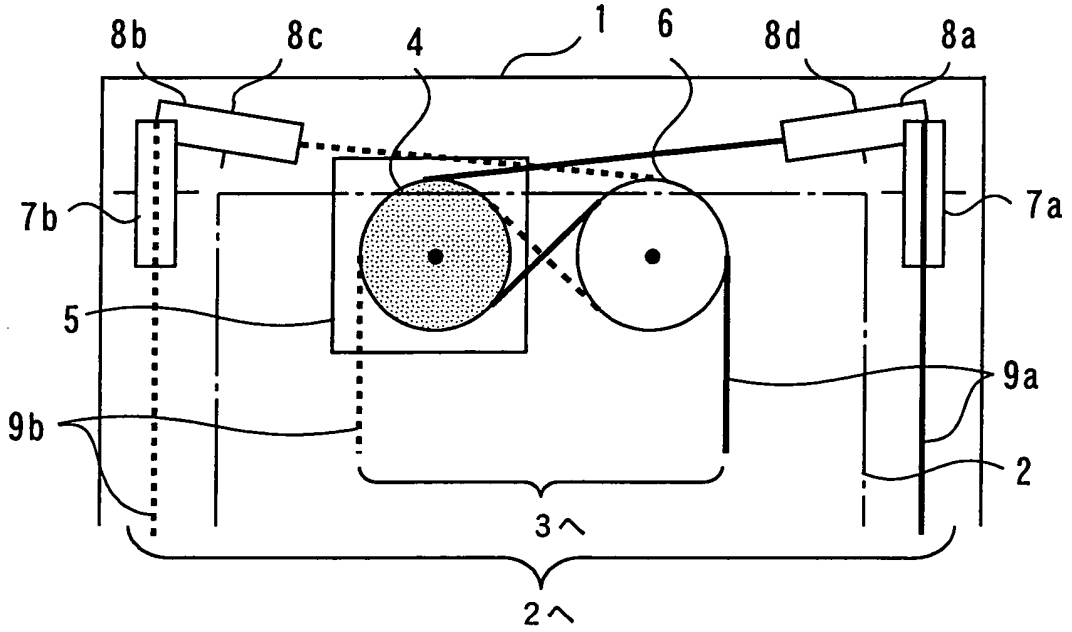
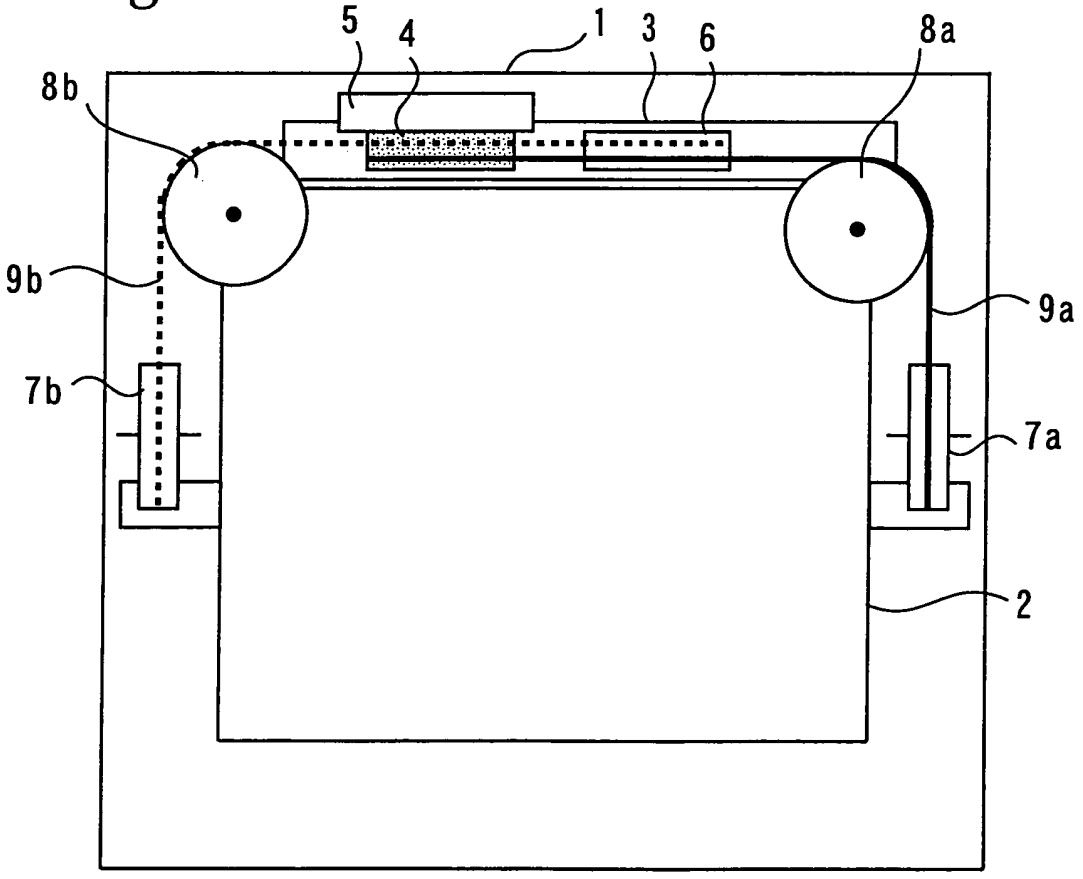


Fig.9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/013841

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B7/06, B66B11/08

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	1996-2005
Kokai Jitsuyo Shinan Koho	1971-2005	Toroku Jitsuyo Shinan Koho	1994-2005

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.
A A	JP 9-156855 A (Mitsubishi Electric Corp.), 17 June, 1997 (17.06.97), Pay attention to Par. No. [0045]; Fig. 8 Pay attention to Par. Nos. [0042] to [0044]; Figs. 3, 7, 32 (Family: none)	1-3,5,7 6
A	WO 03/031310 A1 (Mitsubishi Electric Corp.), 17 April, 2003 (17.04.03), Pay attention to description; page 6, line 17 to page 7, line 4; Figs. 6 to 7 & EP 1431231 A1	1-3,5,7

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

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Date of the actual completion of the international search 21 June, 2005 (21.06.05)	Date of mailing of the international search report 05 July, 2005 (05.07.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/013841

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 2004-168517 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 17 June, 2004 (17.06.04), Pay attention to abstract; Figs. 1 to 2 (Family: none)	1,4
A	JP 11-310372 A (Toshiba Elevator and Building Systems Corp.), 09 November, 1999 (09.11.99), Pay attention to Par. Nos. [0055] to [0063]; Figs. 7 to 8	1
A	Pay attention to Par. Nos. [0070] to [0073]; Figs. 11 to 12 & US 6247557 B1 & EP 0953538 A2 & CN 1233583 A	8
A	JP 2000-247559 A (Hitachi, Ltd.), 12 September, 2000 (12.09.00), Pay attention to abstract; Fig. 1 (Family: none)	1
A	JP 2002-326778 A (ShinMaywa Industries, Ltd.), 12 November, 2002 (12.11.02), Pay attention to abstract; Fig. 3 (Family: none)	1,5,8
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 79586/1992(Laid-open No. 42882/1994) (Obayashi Corp.), 07 June, 1994 (07.06.94), Pay attention to abstract; Par. Nos. [0011] to [0013]; Figs. 1, 5 to 6 (Family: none)	1
A	JP 2002-504473 A (Otis Elevator Co.), 12 February, 2002 (12.02.02), Pay attention to abstract; Fig. 11 & US 6193016 B1 & WO 99/43601 A2	1,8
A	JP 2002-68641 A (Mitsubishi Electric Corp.), 08 March, 2002 (08.03.02), Pay attention to abstract; Par. No. [0038]; Figs. 1 to 2, 5 to 6 (Family: none)	1,4
A	WO 02/072461 A1 (Mitsubishi Electric Corp.), 19 September, 2002 (19.09.02), Pay attention to abstract; Fig. 1 & US 2003/0155185 A1 & EP 1367017 A1	6

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/013841

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/22486 A1 (Mitsubishi Electric Corp.), 21 March, 2002 (21.03.02), Pay attention to abstract; Figs. 1 to 2 & EP 1319627 A1	1,4,7
A	JP 2002-532367 A (Otis Elevator Co.), 02 October, 2002 (02.10.02), Par. Nos. [0009] to [0018]; Figs. 2 to 3 & US 6202793 B1 & EP 1144297 A1 & WO 00/37350 A1 & CN 1331654 A	1

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002080178 A **[0003]**
- JP 2001048450 A **[0003]**
- WO 2002504473 A **[0003]**