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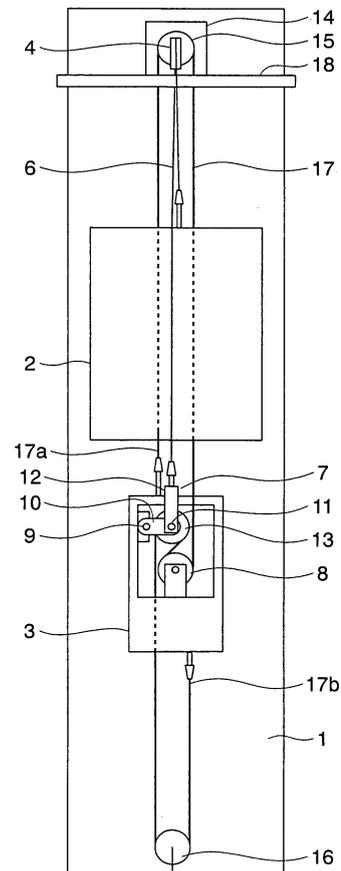
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(54) **ELEVATOR DEVICE**

(57) A counterweight is provided with a displacement body that is displaceable with respect to the counterweight. A car and the counterweight are suspended by a main rope connected to the displacement body. The counterweight is provided with a weight-side fixed pulley, and the displacement body is provided with a weight-side movable pulley. When the displacement body is pulled by the main rope to be displaced with respect to the counterweight, the weight-side movable pulley is thereby displaced away from the weight-side fixed pulley. A hoistway-side upper return pulley and a hoistway-side lower return pulley are provided in an upper portion of a hoistway and a lower portion of the hoistway, respectively. A drive rope, to which a tensile force is applied through displacement of the weight-side movable pulley away from the weight-side fixed pulley, is looped in succession around the hoistway-side upper return pulley, the weight-side fixed pulley, the weight-side movable pulley, and the hoistway-side lower return pulley. When the drive device rotates the hoistway-side upper return pulley, the car and the counterweight are thereby raised/lowered within the hoistway.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to an elevator apparatus having a main rope for suspending a car and a counterweight, and a drive rope for transmitting a driving force of a drive device to the counterweight to raise/lower the car and the counterweight.

Background Art

[0002] Conventionally, with a view to raising/lowering a car and a counterweight, there is proposed an elevator apparatus structured to move a drive rope that is different from a main rope for suspending the car and the counterweight. In this conventional elevator apparatus, a weight-side sheave is mounted on the counterweight, and a plurality of hoistway-side sheaves are disposed in an upper portion of a hoistway and a lower portion of the hoistway. The drive rope is looped around the weight-side sheave and the hoistway-side sheaves. One end of the drive rope is connected to the upper portion of the hoistway, and a tension weight for applying a tensile force to the drive rope is suspended at the other end of the drive rope. When the hoistway-side sheaves are rotated by the drive device, the drive device is thereby moved (see Patent Document 1).

[0003] Patent Document 1: International Publication 02/094701' Pamphlet

Disclosure of the Invention

Problem to be solved by the Invention

[0004] However, the tension weight applies the tensile force to the drive rope, so a space for disposition of the tension weight is required. Accordingly, the space of the hoistway cannot be saved with ease, so the elevator apparatus is increased in size.

[0005] The present invention has been made to solve the above-mentioned problem, and it is therefore an object of the present invention to provide an elevator apparatus enabling downsizing thereof.

Means for Solving the Problems

[0006] An elevator apparatus according to the present invention includes: a car and a counterweight that can be raised/lowered within a hoistway; a displacement body provided on the counterweight and displaceable with respect to the counterweight; a main rope connected to the displacement body, for suspending the car and the counterweight; a weight-side fixed pulley provided on the counterweight; a weight-side movable pulley provided on the displacement body and displaced away from the weight-side fixed pulley through displacement of the displacement body with respect to the counterweight result-

ing from pulling of the displacement body by the main rope; a hoistway-side upper return pulley provided in an upper portion of the hoistway; a hoistway-side lower return pulley provided in a lower portion of the hoistway; a drive rope having one end and the other end that are connected to the counterweight, looped in succession around the hoistway-side upper return pulley, the weight-side fixed pulley, the weight-side movable pulley, and the hoistway-side lower return pulley, and having a tensile force applied thereto through displacement of the weight-side movable pulley away from the weight-side fixed pulley; and a drive device for rotating at least one of the hoistway-side upper return pulley and the hoistway-side lower return pulley to raise/lower the car and the counterweight.

Brief Description of the Drawings

[0007]

Fig. 1 is a lateral view showing an elevator apparatus according to Embodiment 1 of the present invention. Fig. 2 is a top view showing the elevator apparatus of Fig. 1.

Fig. 3 is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention. Fig. 4 is a top view showing the elevator apparatus of Fig. 3.

30 Best Modes for carrying out the Invention

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

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Embodiment 1

[0009] Fig. 1 is a lateral view showing an elevator apparatus according to Embodiment 1 of the present invention. Fig. 2 is a top view showing the elevator apparatus of Fig. 1. Referring to Figs. 1 and 2, a car 2 and a counterweight 3 are provided within a hoistway 1 in a manner allowing the car 2 and the counterweight 3 to be raised/lowered. A pair of main rope return pulleys 4 and 5 are provided in an upper portion of the hoistway 1. A plurality of main ropes 6 are looped around the main rope return pulleys 4 and 5. The car 2 and the counterweight 3 are suspended within the hoistway 1 by the main ropes 6.

[0010] The counterweight 3 is provided with a displacement body 7 that is displaceable vertically with respect to the counterweight 3, and a weight-side fixed pulley 8 that is fixed in position with respect to the counterweight 3.

[0011] The displacement body 7 has a turning lever 10 that is turnable around a first horizontal shaft 9 mounted on the counterweight 3, and a main rope connection member 12 that is turnable around a second horizontal shaft 11 mounted at a tip of the turning lever 10 (end of

turning lever 10 on the other side of first horizontal shaft 9 side).

[0012] Each of the main ropes 6 is connected at one end thereof to the main rope connection member 12, and at the other end thereof to an upper portion of the car 2. Accordingly, the displacement body 7 receives from each of the main ropes 6 a force serving to displace the displacement body 7 upward with respect to the counterweight 3 (force serving to pull up displacement body 7 with respect to counterweight 3). That is, the displacement body 7 is pulled by the main ropes 6 to be displaced upward with respect to the counterweight 3.

[0013] The displacement body 7 is provided with a weight-side movable pulley 13 that is rotatable around the second horizontal shaft 11. The weight-side movable pulley 13 is disposed above the weight-side fixed pulley 8. Accordingly, when the displacement body 7 is pulled by the main ropes 6 to be displaced upward with respect to the counterweight 3, the weight-side movable pulley 13 is thereby displaced away from the weight-side fixed pulley 8.

[0014] A drive device 14 for generating a driving force for raising/lowering the car 2 and the counterweight 3, and a hoistway-side upper return pulley 15 provided on the drive device 14 are provided in the upper portion of the hoistway 1. The drive device 14 is disposed above the counterweight 3. The drive device 14 is designed as a low-profile hoisting machine with an axial dimension smaller than a radial dimension. The hoistway-side upper return pulley 15 is rotated around an upper rotary shaft disposed horizontally, due to the driving force of the drive device 14.

[0015] A hoistway-side lower return pulley 16 is provided in a lower portion of the hoistway 1. The hoistway-side lower return pulley 16 is rotatable around a lower rotary shaft disposed horizontally.

[0016] A drive rope 17, which is moved together with the counterweight 3, is looped in succession around the hoistway-side upper return pulley 15, the weight-side fixed pulley 8, the weight-side movable pulley 13, and the hoistway-side lower return pulley 16. The drive rope 17 is designed as a resin-coated rope having an outer layer coated with resin.

[0017] The drive rope 17 has one end 17a connected to an upper portion of the counterweight 3, and the other end 17b connected to a lower portion of the counterweight 3. The drive rope 17, which extends from one end 17a to the other end 17b, is looped around the hoistway-side upper return pulley 15, the weight-side fixed pulley 8, the weight-side movable pulley 13, and the hoistway-side lower return pulley 16 in this order. That portion of the drive rope 17 which is looped around the weight-side fixed pulley 8 and that portion of the drive rope 17 which is looped around the weight-side movable pulley 13 are curved in opposite directions.

[0018] The displacement body 7 is constantly urged to be pulled up with respect to the counterweight 3 through the suspension of the car 2 and the counterweight 3 by

the main ropes 6. Thus; the displacement body 7 is displaced upward with respect to the counterweight 3, and the weight-side movable pulley 13 is displaced away from the weight-side fixed pulley 8. A tensile force is applied to the drive rope 17 through displacement of the weight-side movable pulley 13 away from the weight-side fixed pulley 8. Thus, a frictional force is secured between each of the weight-side fixed pulley 8, the weight-side movable pulley 13, the hoistway-side upper return pulley 15, and the hoistway-side lower return pulley 16 and the drive rope 17.

[0019] When the drive device 14 rotates the hoistway-side upper return pulley 15, the drive rope 17 is thereby moved together with the counterweight 3. The car 2 is moved in the opposite direction from the counterweight 3 through the movement of the counterweight 3.

[0020] The main rope return pulleys 4 and 5, the drive device 14, and the hoistway-side upper return pulley 15 are supported by a support pedestal 18 fixed to the upper portion of the hoistway 1.

[0021] In the elevator apparatus constructed as described above, when the main ropes 6 for suspending the car 2 and the counterweight 3 pull up the displacement body 7 with respect to the counterweight 3, the weight-side movable pulley 13 is displaced away from the weight-side fixed pulley 8. Thus, a tensile force is applied to the drive rope 17 which is looped in succession around the weight-side movable pulley 13 and the weight-side fixed pulley 8. Therefore, the tensile force can be applied to the drive rope 17 due to forces exerted by the main ropes 6 to suspend the counterweight 3. Thus, there is no need to separately provide a dedicated tension weight for applying a tensile force to the drive rope 17. Accordingly, the space of the hoistway 1 can be saved, so the elevator apparatus can be downsized.

[0022] The drive device 14 is designed as a low-profile hoisting machine, so the space for installation of the drive device 14 can be reduced. As a result, the elevator apparatus can further be downsized.

[0023] The drive rope 17 is designed as a resin-coated rope coated with resin, so the coefficient of friction between each of the weight-side fixed pulley 8, the weight-side movable pulley 13, the hoistway-side upper return pulley 15, and the hoistway-side lower return pulley 16 and the drive rope 17 can be enhanced. Thus, the drive rope 17 can be prevented from slipping with respect to each of the pulleys 8, 13, 15, and 16. The curving performance of the drive rope 17 can also be improved. Therefore, for example, the outer diameter of each of the pulleys 8, 13, 15, and 16 can be reduced, so the space of the hoistway 1 can further be saved.

[0024] That portion of the drive rope 17 which is looped around the weight-side fixed pulley 8 and that portion of the drive rope 17 which is looped around the weight-side movable pulley 13 are curved in opposite directions, so the weight-side fixed pulley 8 and the weight-side movable pulley 13 can be disposed on the same plane. As a result, the space for installation of the weight-side fixed

pulley 8 and the weight-side movable pulley 13 can be reduced.

[0025] While in the foregoing example, the hoistway-side upper return pulley 15 is directly rotated due to the driving force of the drive device 14, the hoistway-side lower return pulley 16 may be directly rotated due to the driving force of the drive device 14. In this case, the drive device 14 is disposed in the lower portion of the hoistway 1. The hoistway-side lower return pulley 16 is provided on the drive device 14.

[0026] While in the foregoing example, the main rope connection member 12 is displaced vertically with respect to the counterweight 3 through the turning of the turning lever 10, the main rope connection member 12 may be displaced vertically with respect to the counterweight 3 by providing the counterweight 3 with a guide member for guiding the main rope connection member 12.

[0027] While in the foregoing example, only the drive rope 17 is designed as a resin-coated rope, each of the main ropes 6 may also be designed as a resin-coated rope.

Embodiment 2

[0028] Fig. 3 is a lateral view showing an elevator apparatus according to Embodiment 2 of the present invention. Fig. 4 is a top view showing the elevator apparatus of Fig. 3. Referring to Figs. 3 and 4, a first deflector pulley 21 and a second deflector pulley 22, which are disposed horizontally apart from each other, are provided in the upper portion of the hoistway 1. The first deflector pulley 21 and the second deflector pulley 22 are disposed above the counterweight 3. Each of the first deflector pulley 21 and the second deflector pulley 22 is rotatable around a rotary shaft disposed horizontally. In addition, the first deflector pulley 21 and the second deflector pulley 22 are supported by the support pedestal 18.

[0029] The hoistway-side upper return pulley 15 is disposed horizontally apart from each of the first deflector pulley 21 and the second deflector pulley 22. The hoistway-side upper return pulley 15 is rotatable around a rotary shaft disposed vertically.

[0030] The drive device 14 is disposed below the hoistway-side upper return pulley 15. The drive device 14 is disposed such that the radial direction thereof extends horizontally. That is, the drive device 14 is leveled. The drive device 14 and the hoistway-side upper return pulley 15 are disposed above the car 2.

[0031] At least one of the main rope return pulleys 4 and 5, the first deflector pulley 21, and the second deflector pulley 22 has an upper end located higher than that of each of the drive device 14 and the hoistway-side upper return pulley 15. At least one of the main rope return pulleys 4 and 5, the first deflector pulley 21, and the second deflector pulley 22 has a lower end located lower than that of each of the drive device 14 and the hoistway-side upper return pulley 15. In this example, the upper end of each of the main rope return pulleys 4 and 5 is located higher than the drive device 14 and the

hoistway-side upper return pulley 15, and the lower end of each of the first deflector pulley 21 and the second deflector pulley 22 is located lower than the drive device 14 and the hoistway-side upper return pulley 15.

[0032] The drive rope 17, which extends from one end 17a thereof connected to the upper portion of the counterweight 3 to the other end 17b thereof connected to the lower portion of the counterweight 3, is looped around the first deflector pulley 21, the hoistway-side upper return pulley 15, the second deflector pulley 22, the weight-side fixed pulley 8, the weight-side movable pulley 13, and the hoistway-side lower return pulley 16 in this order. That portion of the drive rope 17 which is looped around the weight-side fixed pulley 8 and that portion of the drive rope 17 which is looped around the weight-side movable pulley 13 are curved in the same direction. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0033] In the elevator apparatus constructed as described above, the first deflector pulley 21 and the second deflector pulley 22 are provided in the upper portion of the hoistway 1, the hoistway-side upper return pulley 15, which is rotatable around the rotary shaft disposed vertically, is disposed horizontally apart from the first deflector pulley 21 and the second deflector pulley 22, and the drive rope 17 is looped in succession around the first deflector pulley 21, the hoistway-side upper return pulley 15, and the second deflector pulley 22 in this order. Therefore, the same effect as in Embodiment 1 of the present invention is achieved. Also, the hoistway-side upper return pulley 15 can be disposed horizontally, so the height dimension of the hoistway 1 can further be reduced.

[0034] The upper end of at least one of the main rope return pulleys 4 and 5, the first deflector pulley 21, and the second deflector pulley 22 is located higher than that of each of the drive device 14 and the hoistway-side upper return pulley 15, and the lower end of at least one of the main rope return pulleys 4 and 5, the first deflector pulley 21, and the second deflector pulley 22 is located lower than that of each of the drive device 14 and the hoistway-side upper return pulley 15. Therefore, the height dimension of the hoistway 1 can be prevented from being increased due to disposition of the drive device 14 and the hoistway-side upper return pulley 15 in the upper portion of the hoistway 1.

[0035] That portion of the drive rope 17 which is looped around the weight-side fixed pulley 8 and that portion of the drive rope 17 which is looped around the weight-side movable pulley 13 are curved in the same direction, so the life of the drive rope 17 can be prolonged.

Claims

1. An elevator apparatus, comprising:

a car and a counterweight that can be raised/

lowered within a hoistway;
 a displacement body provided on the counterweight and displaceable with respect to the counterweight;
 a main rope connected to the displacement body, for suspending the car and the counterweight;
 a weight-side fixed pulley provided on the counterweight;
 a weight-side movable pulley provided on the displacement body and displaced away from the weight-side fixed pulley through displacement of the displacement body with respect to the counterweight resulting from pulling of the displacement body by the main rope;
 a hoistway-side upper return pulley provided in an upper portion of the hoistway;
 a hoistway-side lower return pulley provided in a lower portion of the hoistway;
 a drive rope having one end and the other end that are connected to the counterweight, looped in succession around the hoistway-side upper return pulley, the weight-side fixed pulley, the weight-side movable pulley, and the hoistway-side lower return pulley, and having a tensile force applied thereto through displacement of the weight-side movable pulley away from the weight-side fixed pulley;
 and
 a drive device for rotating at least one of the hoistway-side upper return pulley and the hoistway-side lower return pulley to raise/lower the car and the counterweight.

2. An elevator apparatus, comprising:

a car and a counterweight that can be raised/lowered within a hoistway;
 a displacement body provided on the counterweight and displaceable with respect to the counterweight;
 a main rope connected to the displacement body, for suspending the car and the counterweight;
 a weight-side fixed pulley provided on the counterweight;
 a weight-side movable pulley provided on the displacement body and displaced away from the weight-side fixed pulley through displacement of the displacement body with respect to the counterweight resulting from pulling of the displacement body by the main rope;
 a first deflector pulley and a second deflector pulley that are provided in an upper portion of the hoistway;
 a hoistway-side upper return pulley disposed horizontally apart from the first deflector pulley and the second deflector pulley and rotatable

around a rotary shaft disposed vertically;
 a hoistway-side lower return pulley provided in a lower portion of the hoistway;
 a drive rope having one end and the other end that are connected to the counterweight, looped in succession around the first deflector pulley, the hoistway-side upper return pulley, the second deflector pulley, the weight-side fixed pulley, the weight-side movable pulley, and the hoistway-side lower return pulley, and having a tensile force applied thereto through displacement of the weight-side movable pulley away from the weight-side fixed pulley; and
 a drive device for rotating the hoistway-side upper return pulley to raise/lower the car and the counterweight.

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

at least one of the main rope return pulley, the first deflector pulley, and the second deflector pulley has an upper end located higher than that of each of the hoistway-side upper return pulley and the drive device; and
 at least one of the main rope return pulley, the first deflector pulley, and the second deflector pulley has a lower end located lower than that of each of the hoistway-side upper return pulley and the drive device.

4. An elevator apparatus according to Claim 1 or 2, wherein the drive device comprises a low-profile hoisting machine.

5. An elevator apparatus according to Claim 1 or 2, wherein at least one of the main rope and the drive rope comprises a resin-coated rope coated with resin.

FIG. 1

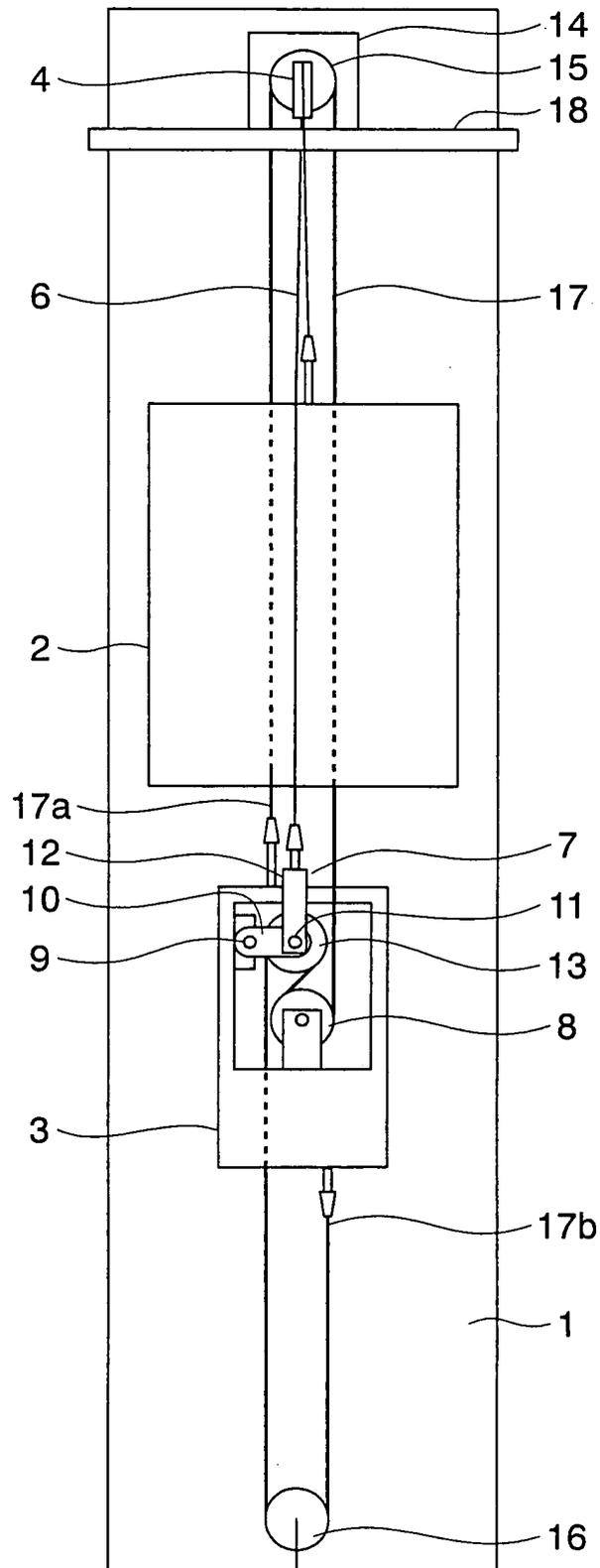


FIG. 2

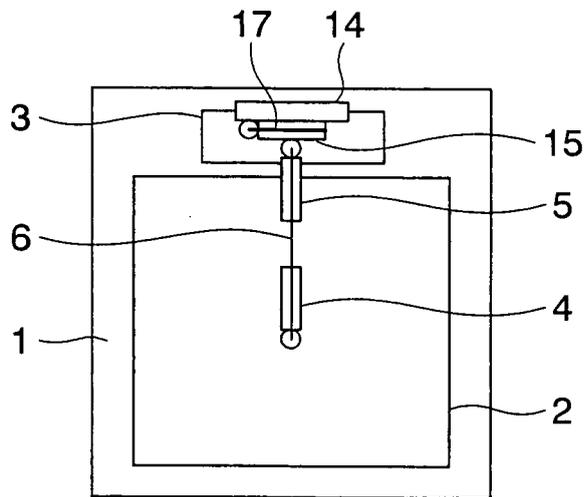


FIG. 3

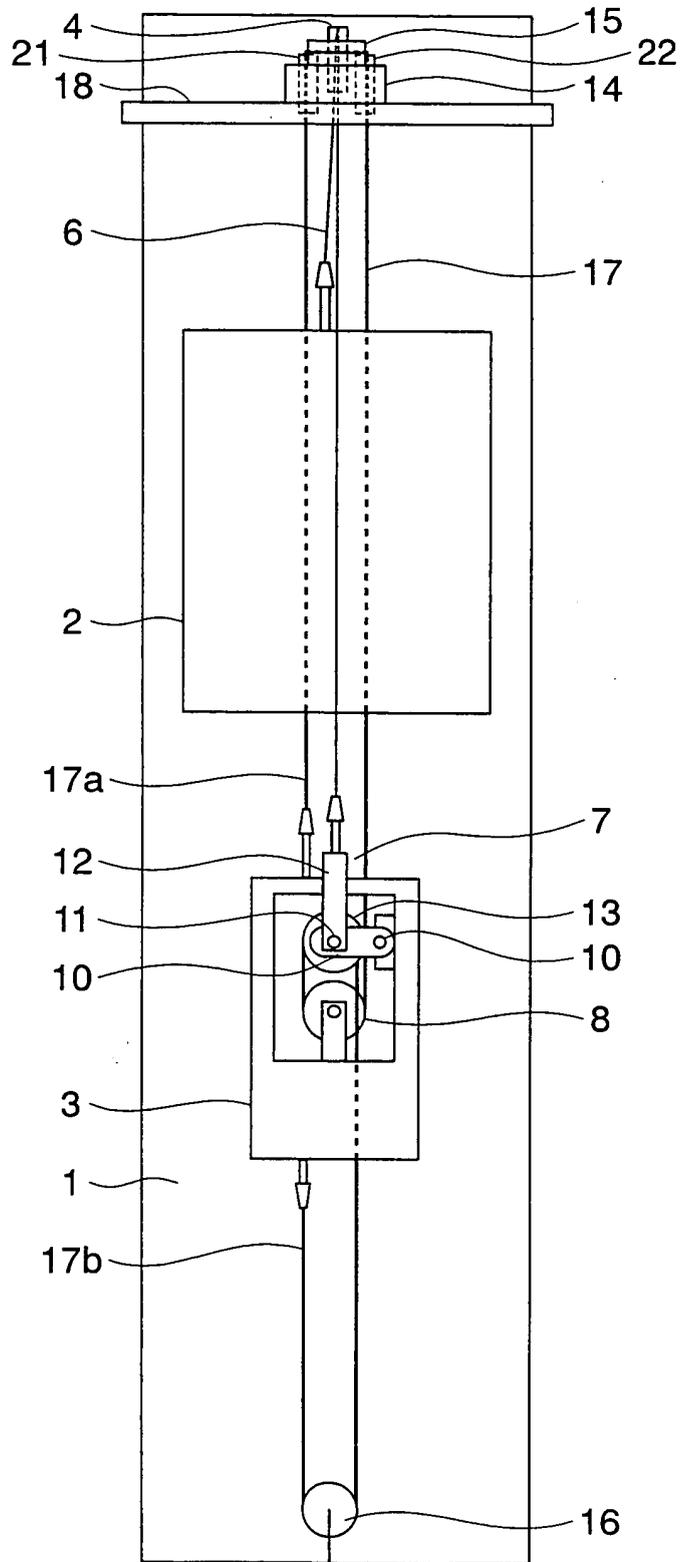
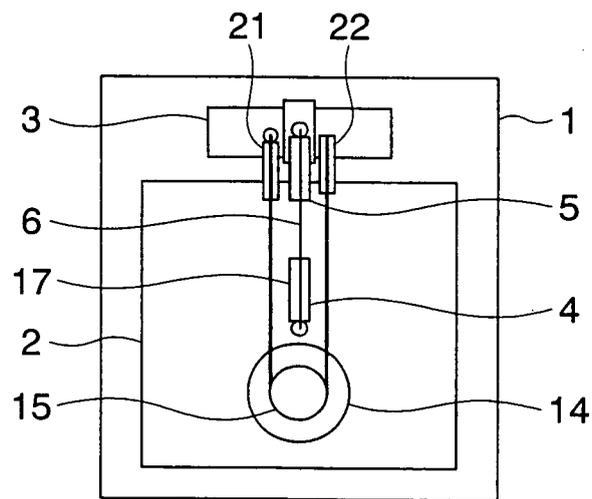


FIG. 4



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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2006/310988
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<p>A. CLASSIFICATION OF SUBJECT MATTER <i>B66B11/00(2006.01) i, B66B7/06(2006.01) i, B66B11/08(2006.01) i</i></p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																							
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) <i>B66B1/00-B66B20/00</i></p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched <i>Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007</i> <i>Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007</i></p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>																							
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>JP 57-184083 A (Hitachi, Ltd.), 12 November, 1982 (12.11.82), (Family: none)</td> <td>1-3</td> </tr> <tr> <td>A</td> <td>WO 2002/094701 A1 (Mitsubishi Electric Corp.), 28 November, 2002 (28.11.02), & EP 1396456 A1 & CN 1440363 A</td> <td>1-5</td> </tr> <tr> <td>A</td> <td>JP 2000-063057 A (Meidensha Corp.), 29 February, 2000 (29.02.00), (Family: none)</td> <td>1-3</td> </tr> <tr> <td>A</td> <td>JP 06-080347 A (C. Haushahn GmbH & Co.), 22 March, 1994 (22.03.94), & US 5398781 A & US 5437347 A & EP 0554712 A2</td> <td>1-3</td> </tr> </tbody> </table> <p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p> <p>* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family</p> <table border="1"> <tr> <td>Date of the actual completion of the international search 16 February, 2007 (16.02.07)</td> <td>Date of mailing of the international search report 27 February, 2007 (27.02.07)</td> </tr> <tr> <td>Name and mailing address of the ISA/ Japanese Patent Office</td> <td>Authorized officer</td> </tr> <tr> <td>Facsimile No.</td> <td>Telephone No.</td> </tr> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	JP 57-184083 A (Hitachi, Ltd.), 12 November, 1982 (12.11.82), (Family: none)	1-3	A	WO 2002/094701 A1 (Mitsubishi Electric Corp.), 28 November, 2002 (28.11.02), & EP 1396456 A1 & CN 1440363 A	1-5	A	JP 2000-063057 A (Meidensha Corp.), 29 February, 2000 (29.02.00), (Family: none)	1-3	A	JP 06-080347 A (C. Haushahn GmbH & Co.), 22 March, 1994 (22.03.94), & US 5398781 A & US 5437347 A & EP 0554712 A2	1-3	Date of the actual completion of the international search 16 February, 2007 (16.02.07)	Date of mailing of the international search report 27 February, 2007 (27.02.07)	Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	Facsimile No.	Telephone No.
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REFERENCES CITED IN THE DESCRIPTION

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