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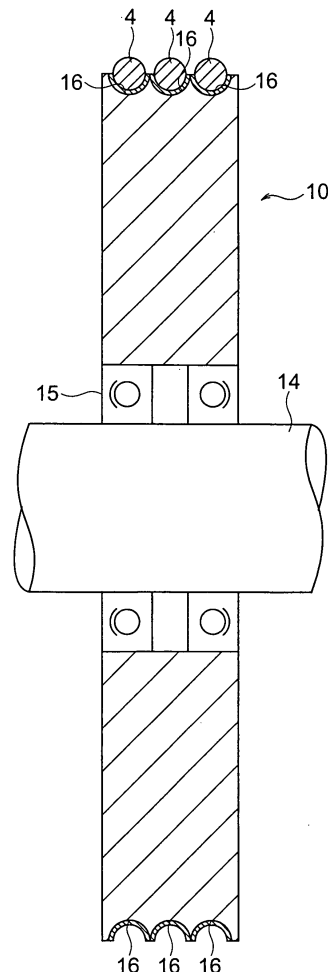
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(54) **ELEVATOR APPARATUS**

(57) A car and a counterweight are suspended within a hoistway by means of a main rope. A drive device for raising/lowering the car and the counterweight has a driving sheave around which the main rope is looped. The main rope has a surface formed of a resin. The main rope is also looped around a driven sheave, which is rotated through movement of the main rope. The driven sheave has an outer periphery portion provided with a groove portion into which the main rope is inserted. A coefficient of friction between an inner surface of the groove portion and the main rope is smaller than a coefficient of friction between iron materials.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a traction-type elevator apparatus for raising/lowering, with the aid of a driving force of a drive device, a car and a counterweight that are suspended within a hoistway by means of a main rope.

Background Art

[0002] In a conventional elevator apparatus, with a view to reducing the size of a hoisting machine, a main rope for suspending a car and a counterweight may be looped according to a 2:1 roping method. In the elevator apparatus constructed as described above, the car is provided with a car suspending pulley, and the counterweight is provided with a counterweight suspending pulley. The hoisting machine, which has a driving sheave, is provided at a bottom within a hoistway. In addition, a car-side return pulley and a counterweight-side return pulley are provided in an upper portion of the hoistway. The main rope is connected at one end thereof and the other end thereof to an upper portion of the hoistway. The main rope, which extends from the above-mentioned one end thereof to the other end thereof, is sequentially looped around the car suspending pulley, the car-side return pulley, the driving sheave, the counterweight-side return pulley, and the counterweight suspending pulley (see Patent Document 1).

[0003] Patent Document 1: JP 2004-269074 A

Disclosure of the Invention

Problems to be solved by the Invention

[0004] Conventionally, in installing an elevator apparatus, an operation of looping a main rope around respective sheaves while dragging the main rope around among the respective sheaves is performed in order to suspend a car and a counterweight by means of the main rope. If the main rope is let go through carelessness at this moment, the sheaves rotate due to the weight of the main rope, so there is a risk that the main rope may fall at a high speed. Thus, after the respective sheaves have been fitted with detents to be prevented from rotating, the main rope is looped around the respective sheaves.

[0005] In general, sheaves for an elevator apparatus such as a driving sheave, a car suspending pulley, a car-side return pulley and the like, and a main rope for the elevator apparatus are made of iron. In recent years, there has been proposed a main rope having a surface formed of a resin in order to increase the coefficient of friction with the driving sheave made of iron and improve the traction abilities of the sheaves. However, in a case where this main rope is applied to the aforementioned elevator apparatus, since the frictional forces acting be-

tween the respective sheaves and the main rope are large and the number of the sheaves is large as well, a great effort is required in dragging the main rope when the sheaves are fitted with detents, respectively. As a result, the operation of looping the main rope is troublesome.

[0006] Even after the car and the counterweight have been suspended by means of the main rope, a long time is required until a tensile force applied to the main rope along an entire length thereof is homogenized, due to the frictional forces acting between the respective sheaves and the main rope. A long time is also required in, for example, adjusting a clearance between a shock absorber provided at a bottom of a hoistway and a lower portion of the counterweight.

[0007] The present invention has been made to solve the above-mentioned problems, and it is therefore an object of the present invention to obtain an elevator apparatus which makes it possible to facilitate an operation of looping a main rope around a plurality of sheaves and homogenize with ease a tensile force applied to the main rope along an entire length thereof even when the main rope has a surface formed of a resin.

Means for solving the Problems

[0008] An elevator apparatus according to the present invention includes: a car and a counterweight that can be raised/lowered within a hoistway; a main rope having a surface formed of a resin, for suspending the car and the counterweight within the hoistway; a drive device having a driving sheave around which the main rope is looped, for rotating the driving sheave to raise/lower the car and the counterweight; and a driven sheave around which the main rope is looped, for being rotated through movement of the main rope, in which: the driven sheave has an outer periphery portion provided with a groove portion into which the main rope is inserted; and the groove portion has an inner surface whose coefficient of friction with the main rope is smaller than a coefficient of friction between iron materials.

Brief Description of the Drawings

[0009]

Fig. 1 is a schematic diagram showing an elevator apparatus according to Embodiment 1 of the present invention.

Fig. 2 is a sectional view showing a car-side return pulley of Fig. 1.

Fig. 3 is a sectional view showing an outer periphery portion of the car-side return pulley of Fig. 2.

Fig. 4 is a sectional view showing an outer periphery portion of a car-side return pulley according to Embodiment 2 of the present invention.

Fig. 5 is a sectional view showing an outer periphery portion of a car-side return pulley according to Em-

bodiment 3 of the present invention.

Best Modes for carrying out the Invention

[0010] Preferred embodiments of the present invention will be described hereinafter with reference to the drawings.

Embodiment 1

[0011] Fig. 1 is a schematic diagram showing an elevator apparatus according to Embodiment 1 of the present invention. Referring to Fig. 1, a car 2 and a counterweight 3 are suspended within a hoistway 1 by means of a plurality of main ropes 4. A hoisting machine (drive device) 5 for generating a driving force for raising/lowering the car 2 and the counterweight 3 is provided at a bottom within the hoistway 1. The hoisting machine 5 has a hoisting machine body 6 including a motor, and a driving sheave 7 for being rotated by the hoisting machine body 6.

[0012] A pair of car suspending pulleys 8 are provided on a lower portion of the car 2. A counterweight suspending pulley 9 is provided on an upper portion of the counterweight 3. A car-side return pulley 10 and a counterweight-side return pulley 11 are provided in an upper portion within the hoistway 1. Further, a car-side cleat device 12 and a counterweight-side cleat device 13 are provided in the upper portion within the hoistway 1.

[0013] One end 4a of each of the main ropes 4 is connected to the car-side cleat device 12, and the other end 4b of each of the main ropes 4 is connected to the counterweight-side cleat device 13. Each of the main ropes 4, which extends from the above-mentioned one end 4a thereof to the other end 4b thereof, is sequentially looped around the respective car suspending pulleys 8, the car-side return pulley 10, the driving sheave 7, the counterweight-side return pulley 11, and the counterweight suspending pulley 9.

[0014] The respective main ropes 4 are moved through rotation of the driving sheave 7. When the respective main ropes 4 are moved, the car suspending pulleys 8, the counterweight suspending pulley 9, the car-side return pulley 10, and the counterweight-side return pulley 11 are rotated. That is, the car suspending pulleys 8, the counterweight suspending pulley 9, the car-side return pulley 10, and the counterweight-side return pulley 11 are designed as driven sheaves, which are rotated through movement of the respective main ropes 4. The car 2 and the counterweight 3 are raised/lowered within the hoistway 1 through movement of the respective main ropes 4.

[0015] Each of the main ropes 4 is covered with a resinous covering member so as to be prevented from slipping with respect to the respective sheaves 7 to 11. That is, the respective main ropes 4 have surfaces formed of a resin. Mentionable as a material of the covering member is, for example, a resin such as urethane rubber. In

a case where urethane rubber is adopted as the material of the covering member, the coefficient of friction between a sheave, which is formed of iron, and a main rope is substantially equal to or larger than 0.4.

[0016] Fig. 2 is a sectional view showing the car-side return pulley 10 of Fig. 1. Referring to Fig. 2, the car-side return pulley 10 is provided on a horizontally extending stationary shaft 14. A bearing 15 is interposed between the car-side return pulley 10 and the stationary shaft 14. The car-side return pulley 10 is rotatable around the stationary shaft 14.

[0017] A plurality of groove portions 16 extending in a circumferential direction of the car-side return pulley 10 are provided in an outer periphery portion of the car-side return pulley 10. The main ropes 4 are inserted in the groove portions 16, respectively.

[0018] Fig. 3 is a sectional view showing the outer periphery portion of the car-side return pulley 10 of Fig. 2. Referring to Fig. 3, linings 17 forming inner surfaces of the groove portions 16 are provided therein, respectively. The main ropes 4 are in contact with the linings 17, respectively. A coefficient of friction between the linings 17 and the main ropes 4 is smaller than a coefficient of friction between iron materials. That is, the linings 17 are made of a material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials. Mentionable as the material of the linings 17 are, for example, a fluorinated resin (Teflon®), a plated material scattered with a solid lubricant, and the like. It has been experimentally confirmed that there is no hindrance to the operation of looping the main ropes 4 when the coefficient of friction between the main ropes 4 and the linings 17 is smaller than the coefficient of friction between the iron materials. In this example, the coefficient of friction between the linings 17 and the main ropes 4 is smaller than about 0.2, which is a value smaller than the coefficient of friction between the iron materials. The respective car suspending pulleys 8, the counterweight suspending pulley 9, and the counterweight-side return pulley 11 are constructed in the same manner as the car-side return pulley 10.

[0019] A plurality of groove portions (not shown), into which the main ropes 4 are inserted respectively, are provided in an outer periphery portion of the driving sheave 7. The respective groove portions of the driving sheave 7 has inner surfaces formed of iron. That is, the coefficient of friction between the inner surfaces of the groove portions 16 provided in the driven sheaves 8 to 11 and the main ropes 4 is smaller than a coefficient of friction between the inner surfaces of the groove portions provided in the driving sheave 7 and the main ropes 4.

[0020] Next, a procedure followed in looping the respective main ropes 4 around the driving sheave 7 and the driven sheaves 8 to 11 will be described. First of all, in order to prevent the car 2 and the counterweight 3 from falling, a chain or the like is used, for example, to suspend the car 2 and the counterweight 3 to fix them within the hoistway 1. The respective car suspending pulleys 8, the

counterweight suspending pulley 9, the car-side return pulley 10, and the counterweight-side return pulley 11 are fitted with detents so as to be prevented from rotating through contact with the main ropes 4.

[0021] After that, the above-mentioned one end 4a of each of the main ropes 4 is connected to the car-side cleat device 12. After that, the respective main ropes 4 are sequentially looped around the respective car suspending pulleys 8, the car-side return pulley 10, the drive sheave 7, the counterweight-side return pulley 11, and the counterweight suspending pulley 9 while being dragged. Then, the other end 4b of each of the main ropes 4 is connected to the counterweight-side cleat device 13.

[0022] After that, the car-side cleat device 12 and the counterweight-side cleat device 13 are operated to adjust the tensile forces applied to the respective main ropes 4, so the vertical positions of the above-mentioned one end 4a and the other end 4b of each of the respective main ropes 4 are adjusted. In a case where discrepancies occur among the magnitudes of the tensile forces applied to the common main ropes 4 at this moment, the main ropes 4 slip with respect to the driven sheaves 8 to 11 in such a direction that the magnitudes of the tensile forces applied to the main ropes 4 along the entire length thereof are homogenized (such a direction that the discrepancies among the tensile forces decrease) while the discrepancies among the magnitudes of the tensile forces are still small.

[0023] After that, the car 2 and the counterweight 3 are released, and the detents fitted to the driven sheaves 8 to 11 are removed. In this manner, the respective main ropes 4 are looped around the driving sheave 7 and the driven sheaves 8 to 11.

[0024] In the elevator apparatus constructed as described above, the coefficient of friction between the inner surfaces of the respective groove portions 16 provided in the outer periphery portions of the driven sheaves 8 to 11 and the main ropes 4 is smaller than the coefficient of friction between the iron materials. Therefore, even when the surfaces of the main ropes 4 are formed of a resin unlikely to cause slippage, the main ropes 4 can be made liable to slip with respect to the driven sheaves 8 to 11. As a result, the operation of looping the main ropes 4 around the driving sheave 7 and the driven sheaves 8 to 11 can be facilitated. Even in a case where discrepancies occur among the magnitudes of the tensile forces within the common main ropes 4 as a result of the looping of the main ropes 4 around the driven sheaves 8 to 11, the main ropes 4 can be caused to slip with respect to the driven sheaves 8 to 11 while the discrepancies among the magnitudes of the tensile forces are still small. As a result, the tensile forces applied to the respective main ropes 4 along the entire length thereof can be homogenized with ease.

[0025] Further, the linings 17 forming the inner surfaces of the groove portions 16 are provided therein and made of, for example, a fluorinated resin or the like.

Therefore, even when the surfaces of the main ropes 4 are formed of a resin unlikely to cause slippage, the main ropes 4 can be made likely to slip with respect to existing driven sheaves merely by providing (coating) groove portions of the driven sheaves with linings, respectively. Accordingly, the driven sheaves 8 to 11 can be manufactured at low cost and with ease through effective utilization of the existing driven sheaves.

10 Embodiment 2

[0026] In the foregoing example, the linings 17 are provided in the groove portions 16 respectively to reduce the coefficient of friction between the main ropes 4 and the groove portions 16. However, the outer periphery portions themselves of the driven sheaves 8 to 11 may be made out of a material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials so as to reduce the coefficient of friction between the inner surfaces of the groove portions and the main ropes 4.

[0027] That is, Fig. 4 is a sectional view showing the outer periphery portion of the car-side return pulley 10 according to Embodiment 2 of the present invention. Referring to Fig. 4, the car-side return pulley 10 has a sheave body 21, and a sheave outer periphery portion 22 provided on the sheave body 21 so as to surround it. The sheave body 21 is made of iron. The sheave outer periphery portion 22 is made of a material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials. Mentionable as the material of the sheave outer periphery portion 22 is, for example, ultra high molecular polyethylene, high-density polyethylene, polypropylene, or the like.

[0028] The sheave outer periphery portion 22 is provided with a plurality of groove portions 23 into which the main ropes 4 are inserted, respectively. The main ropes 4 are in contact with inner surfaces of the groove portions 23, respectively. The inner surfaces of the respective groove portions 23 are formed of the material of the sheave outer periphery portion 22. That is, the coefficient of friction between the inner surfaces of the groove portions 23 and the main ropes 4 is smaller than the coefficient of friction between the iron materials. In this example, the coefficient of friction between the groove portions 23 and the main ropes 4 is smaller than 0.2. The respective car suspending pulleys 8, the counterweight suspending pulley 9, and the counterweight-side return pulley 11 (Fig. 1) are constructed in the same manner as the car-side return pulley 10 (Fig. 4). Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0029] In the elevator apparatus constructed as described above, the sheave outer periphery portion 22 of each of the driven sheaves 8 to 11 is made of, for example, ultra high molecular polyethylene or the like. Therefore, the coefficient of friction between the inner surfaces of the groove portions 23 provided in the sheave outer

periphery portion 22 and the main ropes 4 can be made smaller than the coefficient of friction between the iron materials. Thus, the main ropes 4 can be made likely to slip with respect to the driven sheaves 8 to 11, so the operation of looping the main ropes 4 around the driving sheave 7 and the driven sheaves 8 to 11 can be facilitated. Further, the tensile forces applied to the respective main ropes 4 along the entire length thereof can be easily homogenized as well. Further, even when the groove portions 23 have been abraded due to the friction between the main ropes 4 and the groove portions 23, the coefficient of friction between the main ropes 4 and the groove portions 23 can be kept small. Still further, even when the interiors of the groove portions cannot be coated with linings for some reason, the driven sheaves 8 to 11 can be manufactured with ease.

Embodiment 3

[0030] In Embodiment 2 of the present invention, only the outer periphery portions of the driven sheaves 8 to 11 are made of the material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials. However, the driven sheaves 8 to 11 themselves may be made of a material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials.

[0031] That is, Fig. 5 is a sectional view showing the outer periphery portion of the car-side return pulley 10 according to Embodiment 3 of the present invention. Referring to Fig. 5, the car-side return pulley 10 is made of the same material as the sheave outer periphery portion 22 according to Embodiment 2 of the present invention. The outer periphery portion of the car-side return pulley 10 is provided with a plurality of groove portions 31 into which the main ropes 4 are inserted, respectively. The main ropes 4 are in contact with inner surfaces of the groove portions 31, respectively. The inner surfaces of the respective groove portions 31 are formed of the material of the car-side return pulley 10. That is, the coefficient of friction between the inner surfaces of the groove portions 31 and the main ropes 4 is smaller than the coefficient of friction between the iron materials. In this example, the coefficient of friction between the groove portions 31 and the main ropes 4 is smaller than 0.2. The respective car suspending pulleys 8, the counterweight suspending pulley 9, and the counterweight-side return pulley 11 (Fig. 1) are constructed in the same manner as the car-side return pulley 10 (Fig. 5). Embodiment 3 of the present invention is identical to Embodiment 1 of the present invention in other constructional details.

[0032] As described above, even when the driven sheaves 8 to 11 themselves are made of the material whose coefficient of friction with the main ropes 4 is smaller than the coefficient of friction between the iron materials, the operation of looping the main ropes 4 around the driving sheave 7 and the driven sheaves 8 to 11 can

be facilitated, and the tensile forces applied to the respective main ropes 4 along the entire length thereof can be easily homogenized as well, as in the case of Embodiment 2 of the present invention. Further, even when the groove portions 31 have been abraded due to the friction between the main ropes 4 and the groove portions 31, the coefficient of friction between the main ropes 4 and the groove portions 31 can be kept small. Still further, the respective driven sheaves 8 to 11 can be manufactured through integral molding. Consequently, the driven sheaves 8 to 11 can be manufactured more easily.

Claims

1. An elevator apparatus, comprising:

a car and a counterweight that can be raised/lowered within a hoistway;
a main rope having a surface formed of a resin, for suspending the car and the counterweight within the hoistway;
a drive device having a driving sheave around which the main rope is looped, for rotating the driving sheave to raise/lower the car and the counterweight; and
a driven sheave around which the main rope is looped, for being rotated through movement of the main rope, wherein:

the driven sheave has an outer periphery portion provided with a groove portion into which the main rope is inserted; and
the groove portion has an inner surface whose coefficient of friction with the main rope is smaller than a coefficient of friction between iron materials.

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

the groove portion has a lining provided therein which forms the inner surface of the groove portion; and
the lining is made of a material whose coefficient of friction with the main rope is smaller than the coefficient of friction between the iron materials.

3. An elevator apparatus according to Claim 1, wherein the outer periphery portion of the driven sheave is made of a material whose coefficient of friction with the main rope is smaller than the coefficient of friction between the iron materials.

4. An elevator apparatus according to Claim 1, wherein the driven sheave is made of a material whose coefficient of friction with the main rope is smaller than the coefficient of friction between the iron materials.

5. An elevator apparatus according to Claim 3 or 4, wherein the material whose coefficient of friction with the main rope is smaller than the coefficient of friction between the iron materials comprises one of ultra high molecular polyethylene, high-density polyethylene, and polypropylene.

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FIG. 1

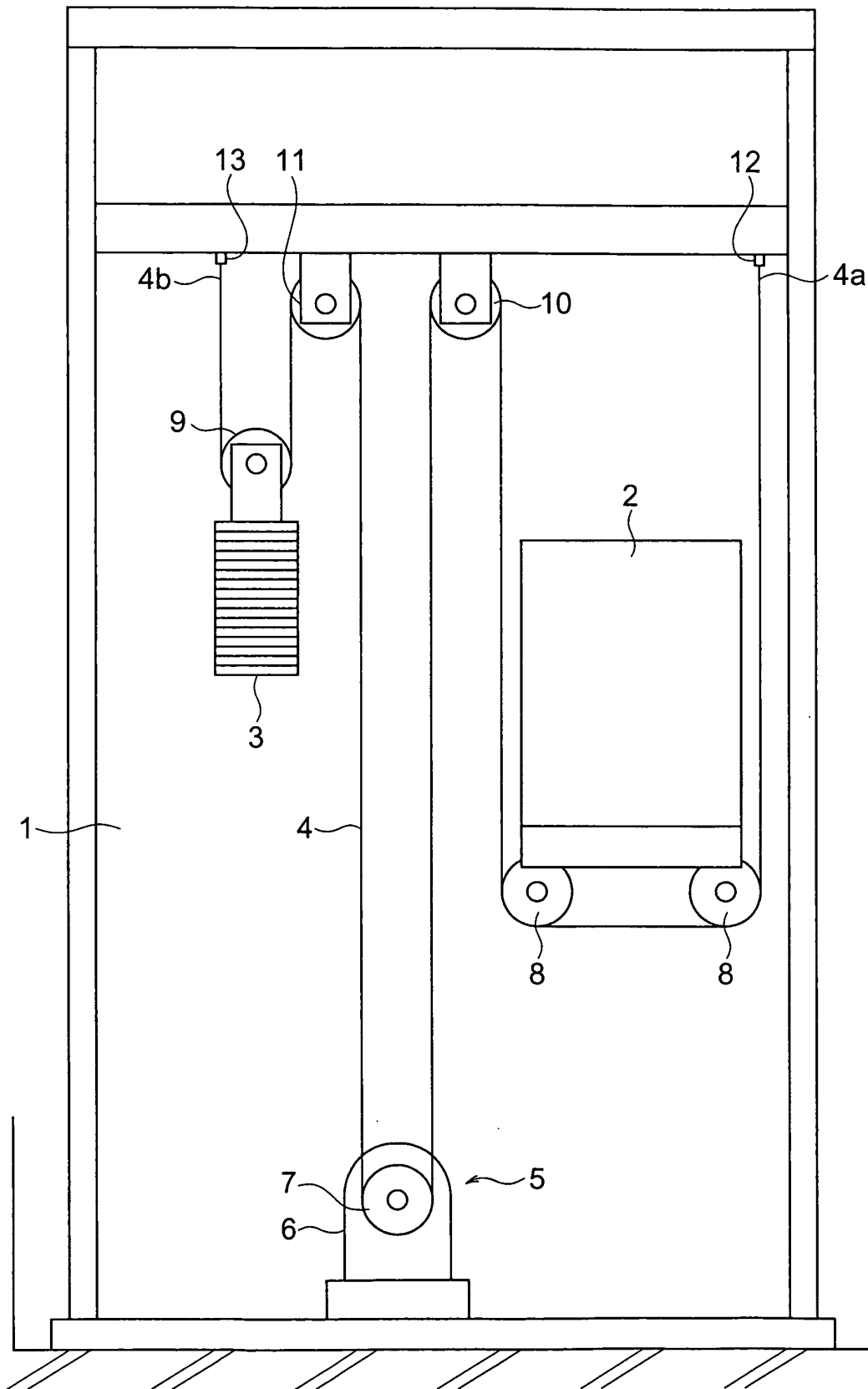


FIG. 2

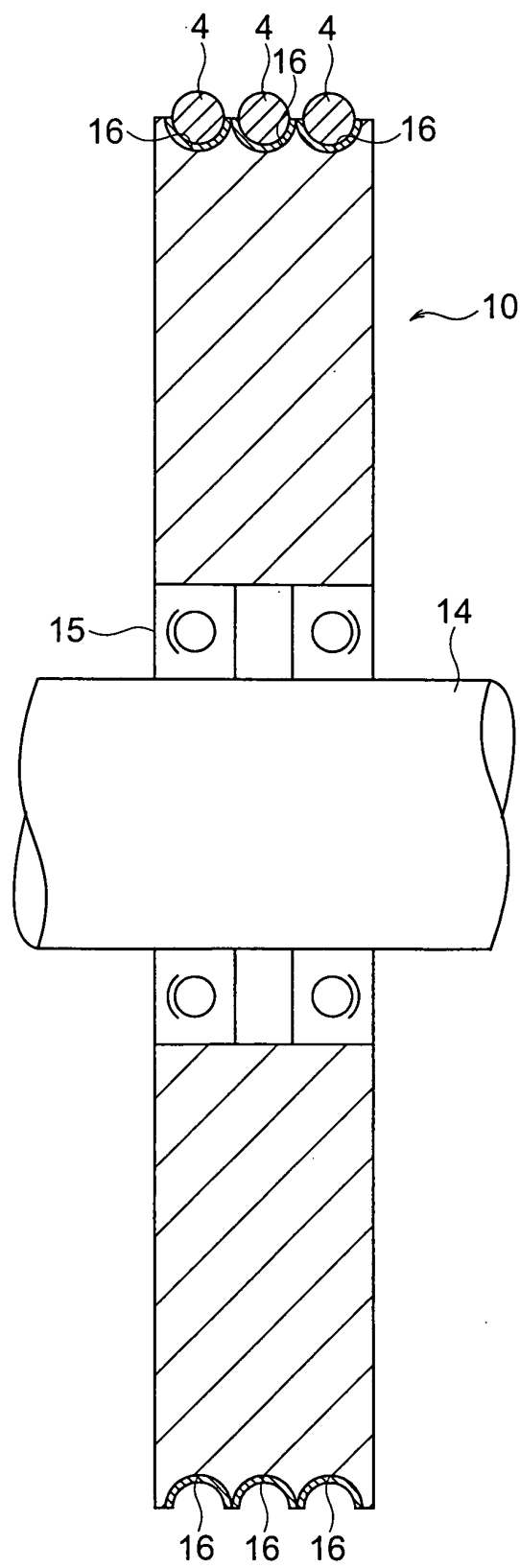


FIG. 3

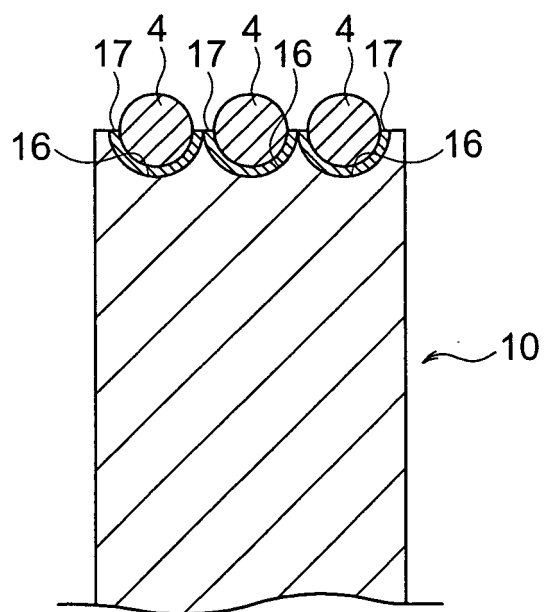


FIG. 4

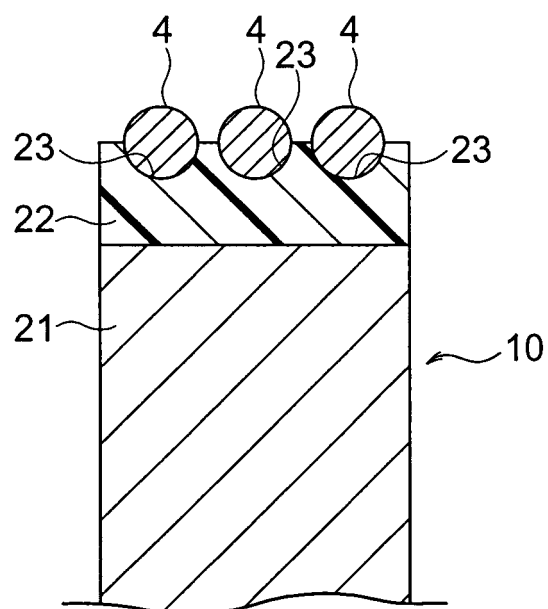
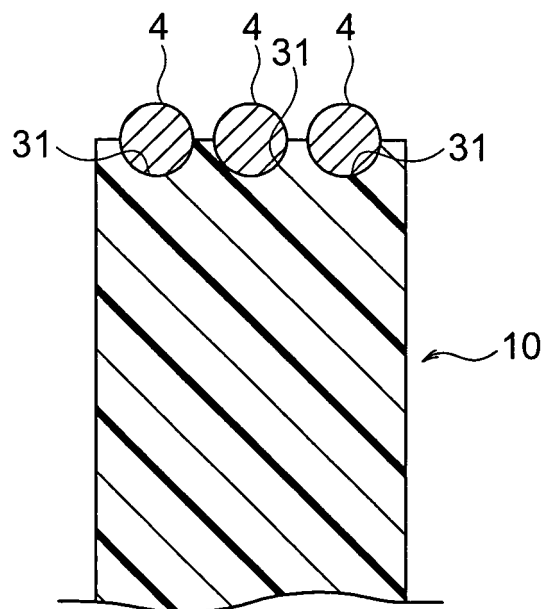


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/012904

A. CLASSIFICATION OF SUBJECT MATTER

B66B7/06 (2006.01)

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)

B66B7/00 (2006.01) - **B66B11/08** (2006.01)

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	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	JP 2003-221176 A (Kone Corp.), 05 August, 2003 (05.08.03), Par. Nos. [0039] to [0040] & FI 20020043 A & EP 1327598 A1 & CA 2468798 A1 & AU 2003201170 A1 & CN 1445154 A	3-5

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Date of the actual completion of the international search
06 April, 2006 (06.04.06)Date of mailing of the international search report
18 April, 2006 (18.04.06)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/012904

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 2004/002868 A1 (Mitsubishi Electric Corp.), 08 January, 2004 (08.01.04), Abstract; page 3, lines 11 to 15; Figs. 2 to 3 & CN 1535240 A & US 2004/0231312 A1 & EP 1516845 A1	1

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REFERENCES CITED IN THE DESCRIPTION

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