



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.02.2011 Bulletin 2011/06

(51) Int Cl.:
B66B 11/08 (2006.01)

(21) Application number: **08765298.8**

(86) International application number:
PCT/JP2008/060485

(22) Date of filing: **06.06.2008**

(87) International publication number:
WO 2009/147749 (10.12.2009 Gazette 2009/50)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(72) Inventor: **MITSUMI, Atsushi**
Tokyo 100-8310 (JP)

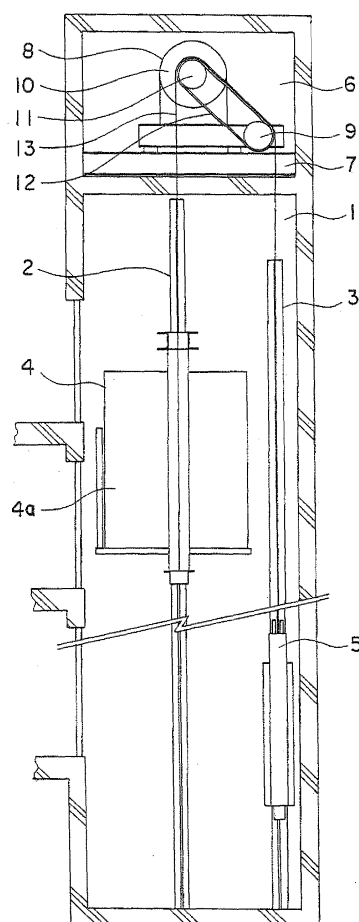
(74) Representative: **HOFFMANN EITL**
Patent- und Rechtsanwälte
Arabellastraße 4
81925 München (DE)

(71) Applicant: **Mitsubishi Electric Corporation**
Tokyo 100-8310 (JP)

(54) **ELEVATOR DEVICE**

(57) A hoisting machine has: a hoisting machine main body; and a driving sheave that is rotated by the hoisting machine main body. A deflecting sheave is disposed so as to be positioned at a distance from the driving sheave. An endless friction belt that performs a cyclic motion due to rotation of the driving sheave is wound around the driving sheave and the deflecting sheave. A main rope that suspends a car is wound continuously around the driving sheave and the deflecting sheave such that the friction belt is interposed. The main rope is moved by the cyclic motion of the friction belt, and the car is raised and lowered by the movement of the main rope.

FIG. 1



Description

(Gazette)

TECHNICAL FIELD

DISCLOSURE OF THE INVENTION

[0001] The present invention relates to a traction elevator apparatus in which a main rope that suspends a car is wound around a driving sheave of a hoisting machine, and that raises and lowers the car by rotating the driving sheave.

5 PROBLEM TO BE SOLVED BY THE INVENTION

BACKGROUND ART

[0011] However, if the main rope is wound back and forth around the driving sheave and the deflecting sheave a plurality of times, equipment such as the hoisting machine, etc., for example, must be enlarged because respective loads acting on the driving sheave and the deflecting sheave increase.

[0002] In traction elevator apparatuses in which a main rope that suspends a car and a counterweight is wound around a driving sheave of a hoisting machine, if we let μ be a coefficient of friction between the main rope and the driving sheave, K2 be a coefficient that is determined by a shape of a rope groove that is formed on an outer circumferential portion of the driving sheave, and θ be a contact angle of the main rope relative to the driving sheave, then traction capacity Γ can be expressed by Formula (1) below.

[0012] Increasing the contact angle of the main ropes relative to the driving sheave by moving the position of the hoisting machine upward to widen the distance to the respective positions of the driving sheave and the deflecting sheave in the height direction is also conceivable, but dimensions of the hoistway in the height direction are increased.

[0003]

$$\Gamma = e^{(\mu \cdot K2 \cdot \theta)} \dots (1)$$

[0013] In addition, adapting the shape of the rope groove that is formed on the driving sheave to increase the value of the coefficient K2 is also conceivable, but respective service lives of the driving sheave and the main rope will be shorter because contact surface pressure between the driving sheave and the main rope is increased.

[0004] Here, e is the natural logarithm base.

[0014] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator apparatus that enables size reductions to be achieved and that also enables extension of service life while continuing to ensure a predetermined traction capacity.

[0005] In traction elevator apparatuses of this kind, tension T1 of the main rope near the car, tension T2 of the main rope near the counterweight, and traction capacity Γ are designed so as to satisfy the relationship in Formula (2) below so as to prevent slippage from occurring between the driving sheave and the main rope.

MEANS FOR SOLVING THE PROBLEM

[0006]

$$T2/T1 \leq \Gamma \dots (2)$$

[0015] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator apparatus characterized in comprising: a car that can be raised and lowered inside a hoistway; a hoisting machine including: a hoisting machine main body; and a driving sheave that is rotated by the hoisting machine main body, the hoisting machine generating a driving force that raises and lowers the car; a deflecting sheave that is disposed so as to be positioned at a distance from the driving sheave; an endless friction belt that is wound around the driving sheave and the deflecting sheave, and that performs a cyclic motion due to rotation of the driving sheave; and a main rope that is wound continuously around the driving sheave and the deflecting sheave such that the friction belt is interposed, the main rope suspending the car.

[0007] Here, Formula (2) represents the relationship between the respective tensions T1 and T2 and the traction capacity Γ when T2 is greater than T1.

[0008] To increase the traction capacity Γ , the value of at least one of the coefficient of friction μ , the coefficient K2, or the contact angle θ need only be increased according to Formula (1).

[0009] In conventional elevator apparatuses, attempts have been made to improve traction capacity by winding the main rope a plurality of times back and forth around the driving sheave and a deflecting sheave that is disposed away from the driving sheave to increase the contact angle of the main rope relative to the driving sheave (See Patent Literature 1).

BRIEF DESCRIPTION OF THE DRAWINGS

[Patent Literature 1]

[0016]

[0010] Japanese Patent Laid-Open No. 2002-145556

Figure 1 is a longitudinal section that shows an elevator apparatus according to Embodiment 1 of the

present invention;

Figure 2 is a cross section that shows a driving sheave and a friction belt from Figure 1;

Figure 3 is a longitudinal section that shows an elevator apparatus according to Embodiment 2 of the present invention;

Figure 4 is a longitudinal section that shows an elevator apparatus according to Embodiment 3 of the present invention; and

Figure 5 is a plan that shows the elevator apparatus from Figure 4.

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] Preferred embodiments of the present invention will now be explained with reference to the drawings.

Embodiment 1

[0018] Figure 1 is a longitudinal section that shows an elevator apparatus according to Embodiment 1 of the present invention. In the figure, a pair of car guide rails 2 and a pair of counterweight guide rails 3 are installed inside a hoistway 1. A car 4 is disposed hoistably between the car guide rails 2, and a counterweight 5 is disposed hoistably between the counterweight guide rails 3.

[0019] The car 4 has a front surface, a back surface, a pair of side surfaces, a bottom surface, and a ceiling surface. A car doorway 4a is disposed on the front surface of the car 4. The back surface of the car 4 faces the front of the car 4 in a depth direction of the car 4. The side surfaces of the car 4 are disposed between the car guide rails 2, and face each other in a direction of frontage of the car doorway 4a.

[0020] The counterweight 5 is raised and lowered near the back surface of the car 4. Consequently, the car 4 and the counterweight 5 are disposed so as to line up with each other in the depth direction of the car 4 in a projected plane when the hoistway 1 is projected vertically. Moreover, a plane that includes the car guide rails 2 and a plane that includes the counterweight guide rails 3 are parallel.

[0021] A machine room 6 is disposed in an upper portion of the hoistway 1. A machine base 7 is fixed to a floor surface of the machine room 6. A hoisting machine 8 and a deflecting sheave 9 are supported by the machine base 7.

[0022] The hoisting machine 8 generates a driving force that raises and lowers the car 4 and the counterweight 5. The hoisting machine 8 has: a hoisting machine main body 10 that includes a motor; and a driving sheave 11 that is disposed on the hoisting machine main body 10, and that is rotated by the hoisting machine main body 10. The driving sheave 11 is rotated around a sheave shaft that is disposed horizontally.

[0023] The deflecting sheave 9 is disposed so as to be positioned at a distance from the driving sheave 11. The deflecting sheave 9 is rotatably disposed on a sheave

shaft that is arranged so as to be parallel to the sheave shaft of the driving sheave 11. In addition, the deflecting sheave 9 is disposed at a position that is lower than the position of the driving sheave 11. The driving sheave 11 and the deflecting sheave 9 are composed of a steel material or cast iron, etc., for example.

[0024] An endless friction belt 12 is wound around the driving sheave 11 and the deflecting sheave 9. A predetermined tension is applied to the friction belt 12 by adjusting the distance between the driving sheave 11 and the deflecting sheave 9. The friction belt 12 is moved cyclically in response to the rotation of the driving sheave 11. The deflecting sheave 9 is rotated in response to the cyclic motion of the friction belt 12.

[0025] A plurality of main ropes 13 are wound continuously around the driving sheave 11 and the deflecting sheave 9 such that the friction belt 12 is interposed. The car 4 and the counterweight 5 are suspended inside the hoistway 1 by the main ropes 13. In this example, the main ropes 13 are constituted by metal ropes. Furthermore, in this example, first end portions of the main ropes 13 are connected to the car 4, and second end portions of the main ropes 13 are connected to the counterweight 5.

[0026] The main ropes 13 are moved together with the cyclic motion of the friction belt 12. The car 4 and the counterweight 5 are raised and lowered the inside of the hoistway 1 by the movement of the main ropes 13. When the car 4 and the counterweight 5 are raised and lowered, the car 4 is guided by the car guide rails 2, and the counterweight 5 is guided by the counterweight guide rails 3.

[0027] Figure 2 is a cross section that shows the driving sheave 11 and the friction belt 12 from Figure 1. In the figure, a plurality of interfitting grooves 14 that are parallel to a direction of rotation of the driving sheave 11 are disposed on an outer circumferential portion of the driving sheave 11. In this example, the cross-sectional shapes of the interfitting grooves 14 are constituted by a V shape that has a base side.

[0028] The friction belt 12 is composed of a wear-resistant high friction material. Examples of high friction materials include urethane rubbers, resins, etc. Consequently, the material of the friction belt 12 is constituted by a material that is softer than the respective materials of the driving sheave 11, the deflecting sheave 9, and the main ropes 13. A plurality of interfitting protruding portions 15 that can be fitted together with the interfitting grooves 14 are disposed on an inner circumferential surface of the friction belt 12. A plurality of rope grooves 16 into which the respective main ropes 13 are inserted are disposed on an outer circumferential surface of the friction belt 12. The respective interfitting protruding portions 15 and the respective rope grooves 16 are disposed so as to be parallel to a longitudinal direction of the friction belt 12. Moreover, in this example, a width dimension of the friction belt 12 is identical to a thickness dimension of the driving sheave 11.

[0029] A plurality of core bodies 17 that are parallel to

a longitudinal direction of the friction belt 12 are embedded inside the friction belt 12. The respective core bodies 17 are each configured endlessly. The respective core bodies 17 are disposed side by side in a width direction of the friction belt 12. In addition, the respective core bodies 17 are composed of a material (a high strength material) that has higher strength than the high friction material of the friction belt 12. In this example, steel wires are used for the core bodies 17. Prevention of breakage of the friction belt 12 is thereby achieved.

[0030] Predetermined frictional forces are generated between the driving sheave 11 and the friction belt 12, between the deflecting sheave 9 and the friction belt 12, and between the respective main ropes 13 and the friction belt 12. The friction belt 12 thereby performs a cyclic motion that corresponds to the rotation of the driving sheave 11, and the respective main ropes 13 perform motion that corresponds to the cyclic motion of the friction belt 12.

[0031] Maximum frictional forces between the driving sheave 11 and the friction belt 12 and between the deflecting sheave 9 and the friction belt 12 are greater than the maximum frictional force between the respective main ropes 13 and the friction belt 12. Here, "maximum frictional force" means frictional force before slippage occurs between the members that contact each other. Consequently, even if the respective main ropes 13 slip relative to the friction belt 12, the friction belt 12 is prevented from slipping relative to both the driving sheave 11 and the deflecting sheave 9.

[0032] In an elevator apparatus of this kind, because an endless friction belt 12 is wound around a driving sheave 11 and a deflecting sheave 9, and respective main ropes 13 that suspend a car 4 are wound continuously onto both the driving sheave 11 and the deflecting sheave 9 such that the friction belt 12 is interposed, torque from the driving sheave 11 can be also be exerted at the position of the deflecting sheave 9 due to the cyclic motion of the friction belt 12. Consequently, torque from the driving sheave 11 can be transmitted to the respective main ropes 13 at both the driving sheave 11 and the deflecting sheave 9. Thus, an angle obtained by adding the contact angle of the main ropes 13 relative to the deflecting sheave 9 to the contact angle of the main ropes 13 relative to the driving sheave 11 constitutes the contact angle that contributes to traction capacity, enabling the traction capacity to be improved.

[0033] Because the friction belt 12 is interposed between the driving sheave 11 and the main ropes 13 and between the deflecting sheave 9 and the main ropes 13, contact between metals that arises between the driving sheave 11 and the main ropes 13 and between the deflecting sheave 9 and the main ropes 13 can be avoided, enabling extension of service life of the driving sheave 11, the deflecting sheave 9, and the main ropes 13, respectively. In addition, because extension of the service life of the main ropes 13 can be achieved, diameters of the main ropes 13 can be reduced, enabling respective diameters of the driving sheave 11 and the deflecting

sheave 9 to be reduced while maintaining a ratio (D/d ratio) between the diameter of the driving sheave 11 and the diameter of the main ropes 13. Size reductions of the hoisting machine 8 and the deflecting sheave 9 can thereby be achieved, enabling overall size reductions of the elevator apparatus.

[0034] Because rope grooves 16 into which the main ropes 13 are inserted are disposed on the friction belt 12, the main ropes 13 can be made less likely to dislodge from the friction belt 12.

[0035] Because maximum frictional forces between the driving sheave 11 and the friction belt 12 and between the deflecting sheave 9 and the friction belt 12 are greater than maximum frictional force between the main ropes 13 and the friction belt 12, the friction belt 12 can be made less likely to slip relative to both the driving sheave 11 and the deflecting sheave 9, enabling extension of service life of the friction belt 12. In other words, if slippage occurs between the driving sheave 11 and the friction belt 12 and between the deflecting sheave 9 and the friction belt 12, the friction belt 12 is abraded. A worn friction belt 12 is even more likely to slip relative to the driving sheave 11. Consequently, if abrasion of the friction belt 12 progresses, the friction belt 12 will ultimately slip completely relative to the driving sheave 11 and the driving force from the driving sheave 11 will not be transmitted to the main ropes 13. Consequently, by making the friction belt 12 less likely to slip relative to both the driving sheave 11 and the deflecting sheave 9, progression of abrasion of the friction belt 12 can be suppressed, enabling extension of the service life of the friction belt 12.

Embodiment 2

[0036] Figure 3 is a longitudinal section that shows an elevator apparatus according to Embodiment 2 of the present invention. An elevator apparatus according to this example is a type of elevator apparatus in which no machine room is disposed (a machine-roomless elevator apparatus). Consequently, a hoisting machine 8 and a deflecting sheave 9 are disposed inside a hoistway 1.

[0037] The hoisting machine 8 is a thin hoisting machine in which an axial dimension is smaller than a radial dimension. The hoisting machine 8 has: a thin hoisting machine main body 10 that includes a motor; and a driving sheave 11 that is disposed on the hoisting machine main body 10, and that is rotated by the hoisting machine main body 10.

[0038] The driving sheave 11 and the deflecting sheave 9 are disposed so as to be spaced apart from each other in a horizontal direction. In other words, the driving sheave 11 and the deflecting sheave 9 is disposed at positions that have identical height. The rest of the configuration is similar to that of Embodiment 1.

[0039] In an elevator apparatus of this kind, because a driving sheave 11 and a deflecting sheave 9 are disposed at positions that have identical height, dimensions in a height direction of a space for installing the hoisting

machine 8 and the deflecting sheave 9 can be reduced. Thus, size reductions in the height direction of the hoistway 1 can be achieved. Because the contact angles that contribute to traction capacity are also similar to those of Embodiment 1 if the driving sheave 11 and the deflecting sheave 9 are disposed at positions that have identical height, improvements in traction capacity can also be achieved.

Embodiment 3

[0040] Figure 4 is a longitudinal section that shows an elevator apparatus according to Embodiment 3 of the present invention. Figure 5 is a plan that shows the elevator apparatus from Figure 4. In the figure, a counterweight 5 is raised and lowered near one side surface of a car 4. Consequently, the car 4 and the counterweight 5 are disposed so as to line up with each other in a width direction of the car 4 (a direction of frontage of a car doorway 4a) in a projected plane when a hoistway 1 is projected vertically. Moreover, a plane that includes respective counterweight guide rails 3 is perpendicular to a plane that includes respective car guide rails 2.

[0041] A fixed member 21 is fixed between respective upper portions of a first car guide rail 2 and a first counterweight guide rail 3. A fixed member 22 is fixed to an upper portion of the second car guide rail 2. A fixed member 23 is fixed between respective upper end portions of each of the counterweight guide rails 3. As shown in Figure 4, the fixed member 23 is disposed at a position that is higher than a position of the fixed member 21.

[0042] A hoisting machine 8 is supported by the fixed member 21. A first rope fastening portion 24 is disposed on the fixed member 22. A deflecting sheave 9 is supported by the fixed member 23, and a second rope fastening portion 25 is disposed on the fixed member 23. As shown in Figure 5, the hoisting machine 8 and the deflecting sheave 9 are disposed at positions that are outside a region of the car 4 in the projected plane when the hoistway 1 is projected vertically. The deflecting sheave 9 is disposed at a position that is higher than a position of the driving sheave 11.

[0043] A pair of car suspending sheaves 26 are disposed on a lower portion of the car 4, and a counterweight suspending sheave 27 is disposed on an upper portion of the counterweight 5.

[0044] The car 4 and the counterweight 5 are suspended by a plurality of main ropes 13. First end portions of the respective main ropes 13 are connected to the first rope fastening portion 24, and second end portions of the respective main ropes 13 are connected to the second rope fastening portion 25. The respective main ropes 13 are wound in sequence from the first rope fastening portion 24 around the respective car suspending sheaves 26, the driving sheave 11, the deflecting sheave 9, and the counterweight suspending sheave 27, to the second rope fastening portion 25. The respective main ropes 13 are wound onto the driving sheave 11 and the deflecting

sheave 9 such that a friction belt 12 is interposed. The car 4 and the counterweight 5 are raised and lowered inside of the hoistway 1 by rotation of the driving sheave 11. The rest of the configuration is similar to that of Embodiment 2.

[0045] In an elevator apparatus of this kind, because a deflecting sheave 9 is disposed at a position that is higher than a position of a driving sheave 11, an upper limit position of a range in which a counterweight 3 is raised and lowered can be set higher while maintaining dimensions of a hoistway 1 by raising and lowering the counterweight 3 below the deflecting sheave 9. Consequently, from the viewpoint of layout design, enlargement of the hoistway 1 can be prevented even if dimensions of the counterweight 3 are increased in the height direction.

[0046] In other words, because the hoisting machine 8 is larger than the deflecting sheave 9, if the hoisting machine 8 is disposed above the counterweight 3, the upper limit position of the range that the counterweight 3 is raised and lowered will be lower than if the deflecting sheave 9 is disposed above the counterweight 3. Even if the deflecting sheave 9 is disposed above the counterweight 3, the dimensions of the hoistway 1 will be increased in the height direction if the driving sheave 11 is disposed at a position that is higher than the position of the deflecting sheave 9. Consequently, by disposing the deflecting sheave 9 at a position that is higher than the position of the driving sheave 11, and raising and lowering the counterweight 3 below the deflecting sheave 9, the upper limit position of the range in which the counterweight 3 is raised and lowered can be set higher while maintaining the dimensions of the hoistway 1.

[0047] Improvements in traction capacity can also be achieved if the deflecting sheave 9 is disposed at a position that is higher than the position of the driving sheave 11, because the contact angles that contribute to traction capacity are similar to those of Embodiment 2.

Claims

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

- a car that can be raised and lowered inside a hoistway;
- a hoisting machine comprising: a hoisting machine main body; and a driving sheave that is rotated by the hoisting machine main body, the hoisting machine generating a driving force that raises and lowers the car;
- a deflecting sheave that is disposed so as to be positioned at a distance from the driving sheave;
- an endless friction belt that is wound around the driving sheave and the deflecting sheave, and that performs a cyclic motion due to rotation of the driving sheave; and
- a main rope that is wound continuously around

the driving sheave and the deflecting sheave such that the friction belt is interposed, the main rope suspending the car.

2. An elevator apparatus according to Claim 1, **characterized in that** a rope groove into which the main rope is inserted is disposed on the friction belt. 5
3. An elevator apparatus according to either of Claims 1 or 2, **characterized in that** maximum frictional forces between the driving sheave and the friction belt and between the deflecting sheave and the friction belt are greater than a maximum frictional force between the main rope and the friction belt. 10
4. An elevator apparatus according to any of Claims 1 through 3, **characterized in that** the driving sheave and the deflecting sheave are disposed at positions that have identical height. 15
5. An elevator apparatus according to any of Claims 1 through 3, **characterized in that** the deflecting sheave is disposed at a position that is higher than a position of the driving sheave. 20

25

30

35

40

45

50

55

FIG. 1

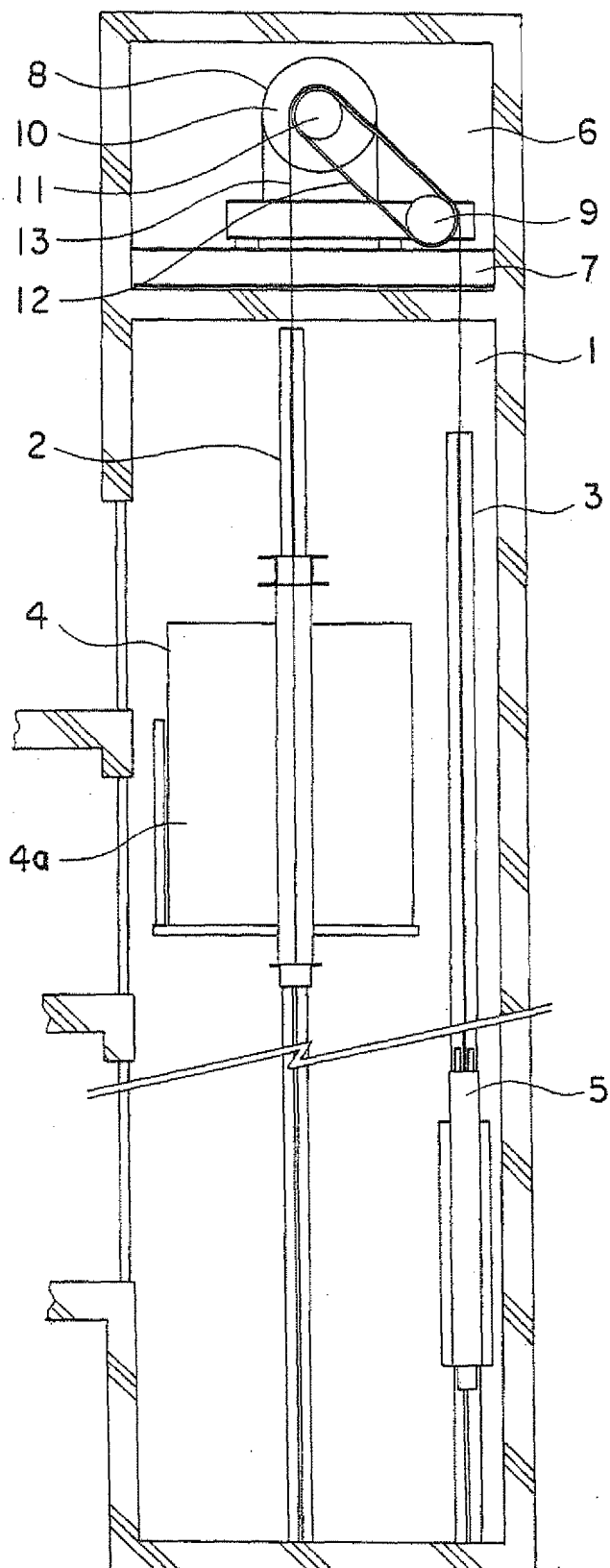


FIG. 2

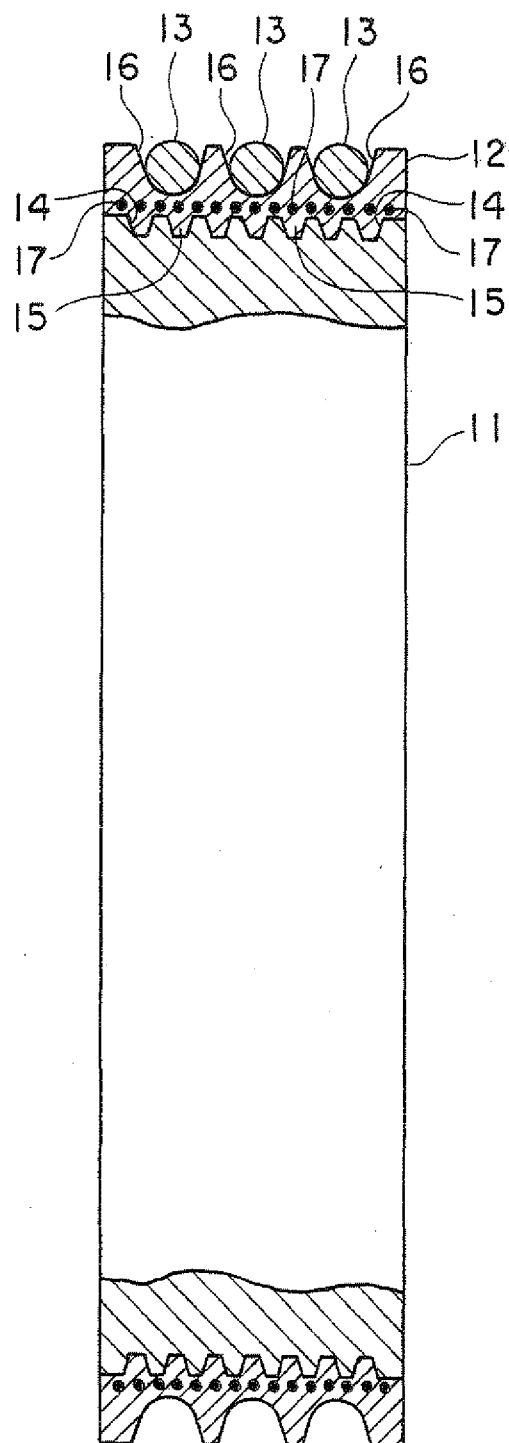


FIG. 3

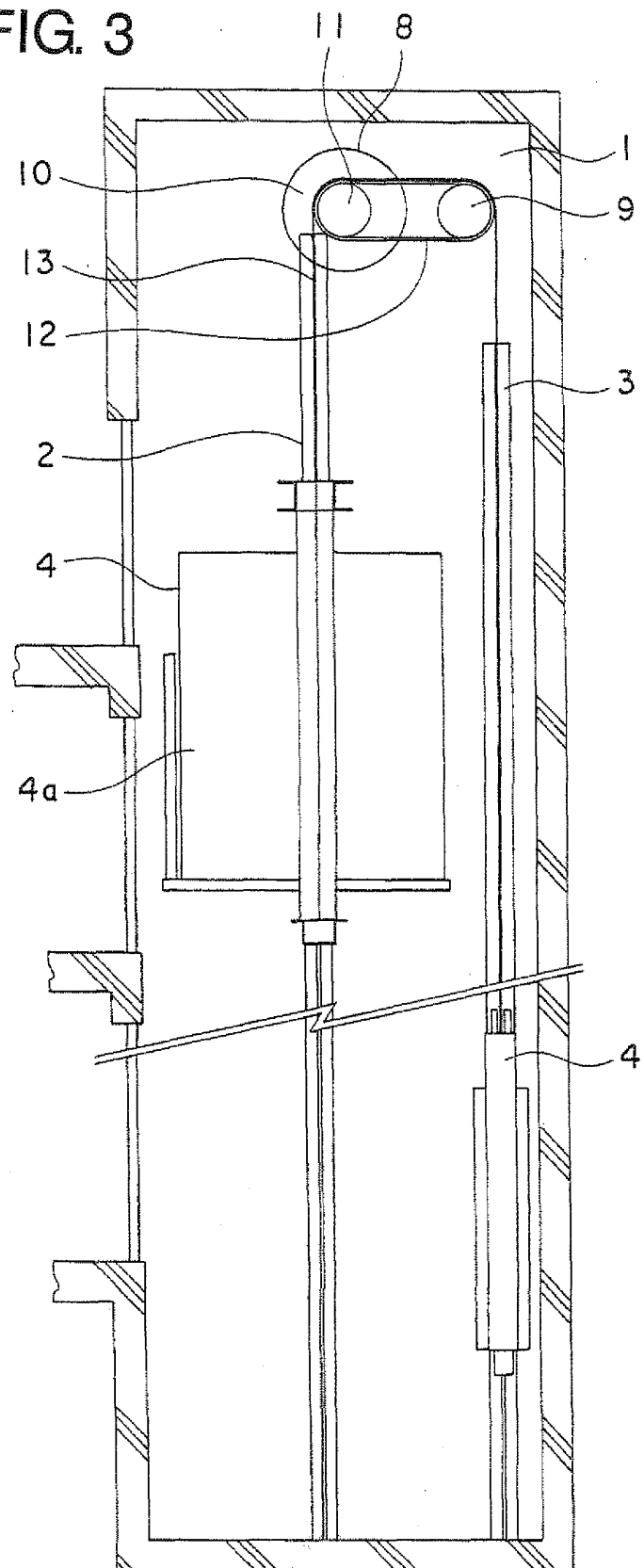


FIG. 4

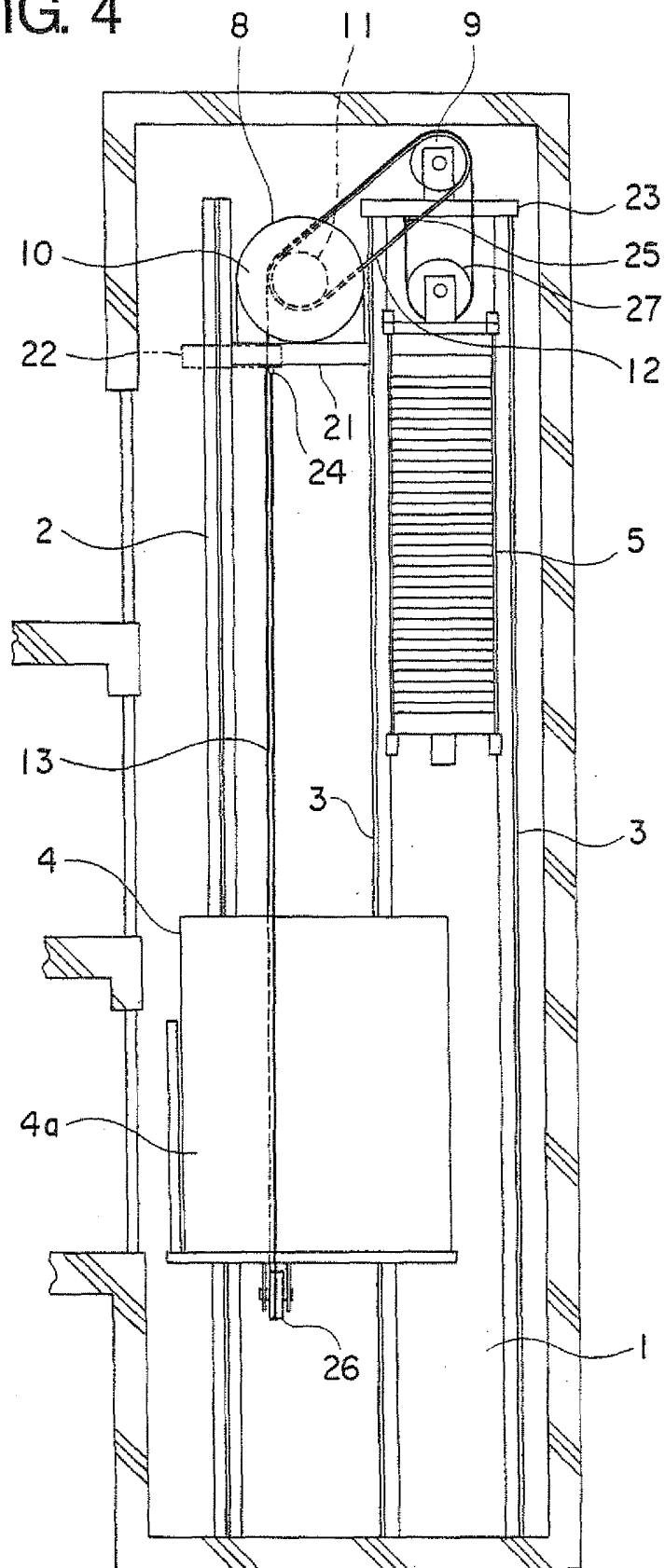
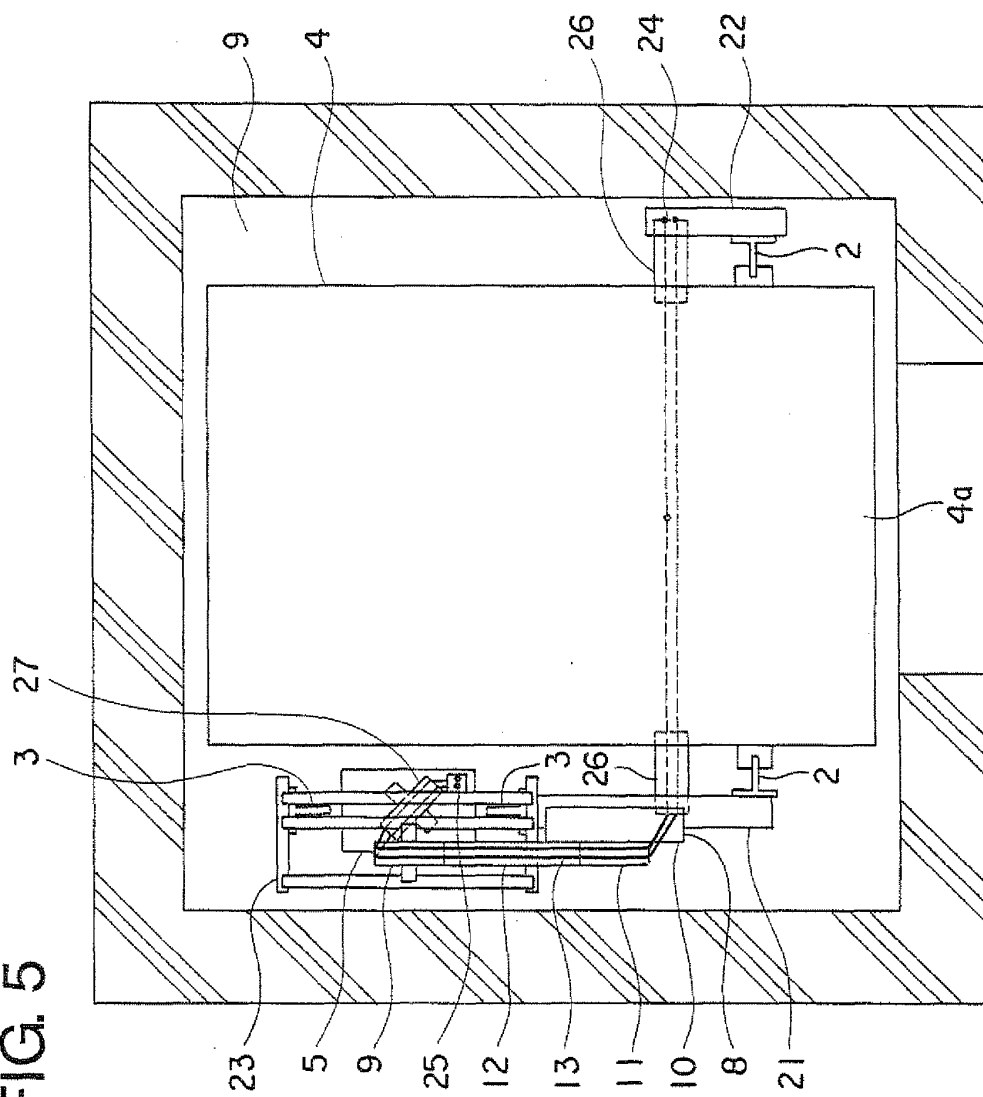


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/060485

A. CLASSIFICATION OF SUBJECT MATTER

B66B11/08 (2006.01) i

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)

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	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2008-081256 A (Toshiba Elevator and Building Systems Corp.), 10 April, 2008 (10.04.08), (Family: none)	1-4 5
X	JP 2004-323213 A (Fujitec Co., Ltd.), 18 November, 2004 (18.11.04), (Family: none)	1-3
Y	JP 2004-026424 A (Toshiba Elevator and Building Systems Corp.), 29 January, 2004 (29.01.04), Par. Nos. [0008] to [0010], [0015] to [0024]; Fig. 1 (Family: none)	5

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier 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

Date of the actual completion of the international search
12 February, 2009 (12.02.09)Date of mailing of the international search report
24 February, 2009 (24.02.09)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2002145556 A, Gazette [0010]