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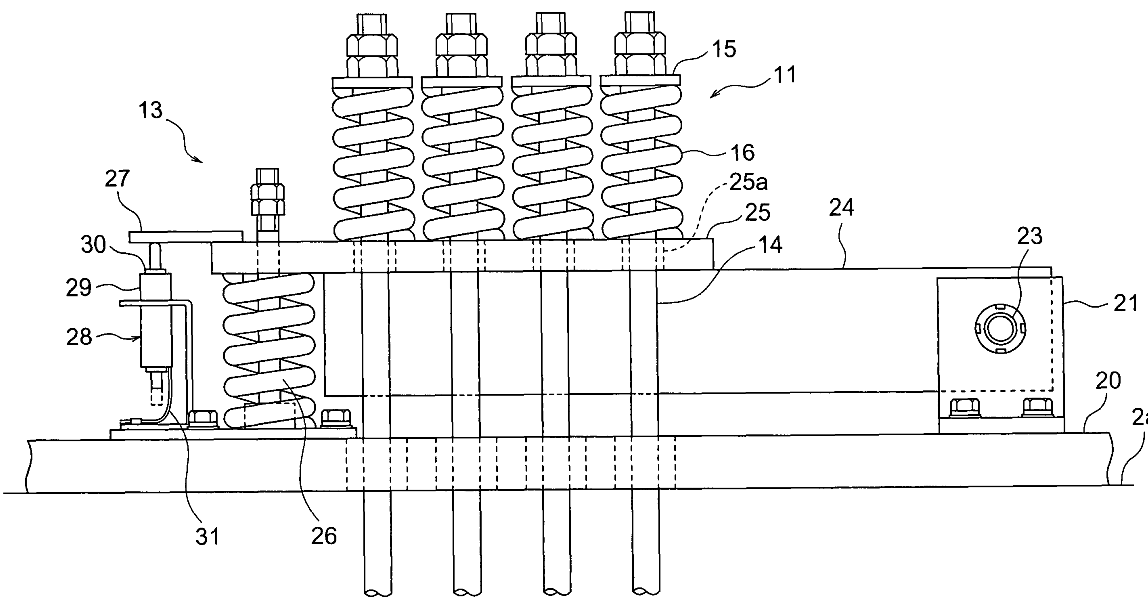
(54) ELEVATOR LOAD WEIGHING DEVICE

(57) In an elevator load weighing device, a pivoting supporting platform supporting a sum total of tensile forces acting on end portions of main ropes and being pivoted so as to correspond to a magnitude of the sum total of the tensile forces is pivotably disposed on a main rope bearing portion. An elastic member expanding and contracting so as to correspond to the sum total of the tensile forces is disposed between the pivoting supporting platform and the main rope bearing portion. A detector outputs a signal corresponding to a pivoting position of the pivoting supporting platform.

FIG. 2



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Description

TECHNICAL FIELD

[0001] The present invention relates to an elevator load weighing device for measuring a live load on a car.

BACKGROUND ART

[0002] Generally, in elevators, a car is suspended inside a hoistway by a plurality of main ropes. In an elevator using a two-to-one (2:1) roping method, for example, tensile forces arising in end portions of the main ropes are borne by a main rope bearing portion in an upper portion of the hoistway. The main rope bearing portion is a member such as a beam, etc. , secured to an upper portion inside the hoistway, or a floor portion of a machine room, for example.

[0003] Rope shackles are connected to the end portions of each of the main ropes, shackle springs expanding and contracting in response to the tensile forces arising in the end portions of the main ropes being disposed between each of the rope shackles and the main rope bearing portion.

[0004] A weighing device is disposed on the main rope bearing portion, to measure load fluctuations inside the car due to passengers, cargo, etc. When the live load inside the car exceeds a rated load, raising and lowering of the car is prevented. Furthermore, a driving force generated by the driving machine is controlled so as to correspond to the live load.

[0005] In a conventional weighing device such as that shown in Japanese Patent Publication No. HEI 8-5605 (Gazette), for example, detecting plates are mounted onto groups of two or three shackle springs. Thus, the live load inside a car is detected by detecting displacement of the detecting plates accompanying displacement of the rope shackles.

[0006] However, in conventional weighing devices, since inclination of the rope shackles changes with the main ropes depending on the position of the car, errors arise in the amount of vertical displacement of the detecting plates, also giving rise to errors in the measured value of the load weight inside the car. For this reason, there has been a risk that drive output during elevator activation maybe greater than or less than the force actually required, making riding comfort deteriorate.

DISCLOSURE OF THE INVENTION

[0007] The present invention aims to solve the above problems and an object of the present invention is to provide an elevator load weighing device enabling measuring precision to be improved.

[0008] In order to achieve the above object, according to one aspect of the present invention, there is provided an elevator load weighing device disposed between a plurality of rope fasteners connected to end portions of a plurality of main ropes and a main rope bearing portion for bearing tensile forces acting on the end portions of the main ropes, the elevator load weighing device detecting a weight from the tensile forces, the elevator load weighing device including: a pivoting supporting platform pivotably disposed on the main rope bearing portion, supporting a sum total of the tensile forces, and being pivoted so as to correspond to a magnitude of the sum total of the tensile forces; an elastic member disposed between the pivoting supporting platform and the main rope bearing portion, and expanding and contracting so as to correspond to the sum total of the tensile forces; and a detector for outputting a signal corresponding to a pivoting position of the pivoting supporting platform.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figure 1 is a structural diagram showing an elevator according to Embodiment 1 of the present invention;
Figure 2 is a side elevation showing a weighing device from Figure 1;
Figure 3 is a plan showing the weighing device from Figure 2;
Figure 4 is a side elevation showing an elevator load weighing device according to Embodiment 2 of the present invention; and
Figure 5 is a plan showing an elevator load weighing device according to Embodiment 3 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

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

Embodiment 1

[0011] Figure 1 is a structural diagram showing an elevator according to Embodiment 1 of the present invention. In the figure, a machine room 2 is disposed in an upper portion of a hoistway 1. A driving machine (a hoisting machine) 3 having a drive sheave 3a is installed inside the machine room 2. A plurality of main ropes 4 (only one is shown in Figure 1) are wound around the drive sheave 3a.

[0012] A car 5 and a counterweight 6 are suspended inside the hoistway 1 by the main ropes 4, and are raised and lowered inside the hoistway 1 by a driving force from the driving machine 3. The car 5 has: a car frame 7; and a cabin 8 supported inside the car frame 7. A pair of car suspension sheaves 9a and 9b around which the main ropes 4 are wound are disposed on a upper portion (upper beam) of the car frame 7. A counterweight suspension sheave 10 around which the main ropes 4 are wound is disposed on an upper portion of the counterweight 6.

[0013] The main ropes 4 have car end portions 4a and counterweight end portions 4b. The car end portions 4a are connected to a machine room floor portion 2a constituting a main rope bearing portion by means of car rope fasteners 11. The counterweight end portions 4b are connected to the machine room floor portion 2a by means of counterweight rope fasteners 12. In other words, tensile forces arising in the car end portions 4a and the counterweight end portions 4b are borne by the machine room floor portion 2a.

[0014] The main ropes 4 are wound in sequence from the car end portions 4a, around the car suspension sheaves 9a and 9b, the drive sheave 3, and the counterweight suspension sheave 10 to the counterweight end portions 4b. In other words, the car 5 and the counterweight 6 are suspended by a two-to-one (2:1) roping method.

[0015] A weighing device 13 for measuring a live load on the car 5 is disposed between the car rope fasteners 11 and the machine room floor portion 2a.

[0016] Now, in a two-to-one (2:1) roping method, if we let N be the number of main ropes 4, Wc be a deadweight of the car 5, Wr be a deadweight of car portions of the main ropes 4 (portions positioned between the weighing device 13 and the drive sheave 3a), and W be the live load inside the cabin 8, then the tensile force P arising in the car portion of one main rope 4 is given by:

$$P = (Wc + Wr + W)/(2 \times N)$$

[0017] Furthermore, when the live load W is zero (no-load), P is given by:

$$P = (Wc + Wr)/(2 \times N)$$

[0018] However, Wr varies depending on the position of the car 5.

[0019] Next, Figure 2 is a side elevation showing the weighing device 13 from Figure 1, and Figure 3 is a plan showing the weighing device 13 from Figure 2. In the figures, each of the car rope fasteners 11 has: a shackle rod 14 connected to a car end portion 4a; an individual spring bearing (upper portion spring bearing) 15 mounted to an upper end portion of the shackle rod 14; and a shackle spring 16 placed in contact with the individual spring bearing 15, and expanding and contracting in response to tensile forces arising in the car end portion 4a.

[0020] A base 20 is secured onto the machine room floor portion 2a. A bearing portion 21 is secured onto the base 20. A pivoting shaft 23 extending horizontally is disposed on the bearing portion 21. A pivoting supporting platform 24 pivotable around the pivoting shaft 23 is mounted to the pivoting shaft 23.

[0021] The pivoting supporting platform 24 has a shared spring bearing (lower portion spring bearing) 25 bearing lower end portions of all of the shackle springs 16. A plurality of rope fastener penetrating apertures 25a through which the shackle rods 14 pass are disposed on the shared spring bearing 25. The pivoting supporting platform 24 supports the sum total of the tensile forces arising in the car end portions 4a.

[0022] A pair of weighing springs 26 functioning as an elastic member are disposed between the shared spring bearing 25 and the base 20. The pivoting supporting platform 24 pivots so as to correspond to the magnitude of the sum total of the tensile forces arising in the car end portions 4a. The weighing springs 26 also expand and contract so as to correspond to the magnitude of the sum total of the tensile forces arising in the car end portions 4a.

[0023] An actuating segment 27 is secured to a tip portion of the shared spring bearing 25. A detector 28 for outputting a signal corresponding to the pivoting position of the pivoting supporting platform 24 is disposed on the base 20. The detector 28 has: a tubular coil portion 29; and a core portion 30 inserted through the coil portion 29. The coil portion 29 is fixed relative to the base 20, and the core portion 30 is moved vertically inside the coil portion 29 together the vertical movement of the actuating segment 27. The detector 28 is connected to an elevator control board (not shown) by means of a signal line 31.

[0024] The weighing device 13 includes: the base 20, the bearing portion 21, the pivoting shaft 23, the pivoting supporting platform 24 including the shared spring bearing 25, the weighing springs 26, the actuating segment 27, the detector 28, and the signal line 31.

[0025] In a weighing device 13 of this kind, the pivoting supporting platform 24 pivots around the pivoting shaft 23 so as to correspond to the magnitude of the sum total of the tensile forces arising in the car end portions 4a, and the actuating segment 27 is displaced vertically by the pivoting of the pivoting supporting platform 24. The displacement of the actuating segment 27 is detected by the detector 28, and a signal corresponding to the pivoting position of the pivoting supporting platform 24 is output from the detector 28.

[0026] The signal output from the detector 28 is sent to the elevator control board by means of the signal line 31. In the elevator control board, changes in the sum total of the tensile forces arising in the car end portions 4a are determined from the signal from the detector 28.

[0027] Specifically, the amount of vertical movement of the actuating segment 27 is converted to an amount of electricity (voltage) by the detector 28, and output as a signal. Since a change in the amount of electricity that changes in proportion to the vertical movement of the actuating segment 27 is proportional to a change in tensile force in the main ropes 4, the change in tensile force can be found from the amount of electricity.

[0028] Here, it is the change in the sum total of the tensile forces arising in the car end portions 4a of the main ropes 4 that is found directly from the signals from the detector 28, and this change includes not only changes in live load inside the cabin 8, but also weight changes in the car portions of the main ropes 4 accompanying the positional changes of the car 5. This sum total of the tensile forces affects the driving torque of the driving machine 3, and riding comfort can be improved by controlling the drive output during activation so as to correspond to the changes in tensile force.

[0029] Furthermore, changes in live load inside the cabin 8 can be found from changes in tensile force arising in the car end portions 4a. Specifically, as described above, in addition to the live load W, the deadweight Wc of the car 5 and the weight Wr of the car portions of the main ropes 4 are included in the tensile force P, but the deadweight Wc of the car 5 is a known value, enabling the weight Wr of the main ropes 4 to be easily found from the position of the car 5.

[0030] The sum total of the tensile forces Pt arising in the car end portions 4a is given by:

$$Pt = P \times n = (Wc + Wr + W)/2$$

[0031] Because the tensile forces Pt can be found from the signals from the detector 28, the live load W inside the cabin 8 is given by:

$$W = 2Pt - Wc - Wr$$

[0032] Wr can be found easily from the position of the car 5.

[0033] In a weighing device 13 of this kind, because the pivoting supporting platform 24 pivots so as to correspond to the tensile forces arising in the car end portions 4a without being affected by changes in the inclination of the main ropes 4, the measuring precision of the live load inside the cabin 8 can be improved. Furthermore, because it is only necessary for one detector 28 to be used regardless of the number of main ropes 4, the cost of the weighing device 13 can be reduced.

Embodiment 2

[0034] Figure 4 is a side elevation showing an elevator load weighing device according to Embodiment 2 of the present invention. In the figure, a detected segment 32 is secured to a tip portion of a shared spring bearing 25. A detector 33 for outputting a signal corresponding to a pivoting position of a pivoting supporting platform 24 is disposed on a base 20. The detector 33 is disposed so as to face the detected segment 32, and detects the distance to the detected segment 32.

[0035] Any well-known distance sensor such as, for example, those using electrostatic capacity, flux change, or reflection of a detecting light beam, etc., can be used for the detector 33. In other words, the detector 33 detects the distance to the detected segment 32 without contacting the detected segment 32. The detector 33 is connected to an elevator control board by means of a signal line 31. The rest of the construction is similar to that of Embodiment 1.

[0036] Using a non-contact type detector 33 in this manner, the measuring precision of the live load inside the cabin 8 can also be improved and the cost of the weighing device can also be reduced. Furthermore, since the mechanical service life of a non-contact type detector 33 is longer than a type of detector having a sliding portion, extension of the overall service life of the weighing device can be achieved, and time spent on maintenance can be reduced.

Embodiment 3

[0037] Figure 5 is a plan showing an elevator load weighing device according to Embodiment 3 of the present invention. In Embodiment 1, as shown in Figure 3, an even number (eight) of car rope fasteners 11 corresponding to the number of main ropes 4 are disposed in two rows of four. In contrast to this, in Embodiment 3, since an odd number (seven) of car rope fasteners 11 corresponding to the number of main ropes 4 are disposed in two rows, four main ropes 4 are disposed in a first row, and three in a second row.
[0038] Consequently, there is an unoccupied rope fastener penetrating aperture 25a in which no car rope fastener 11 is disposed at an end portion of the second row near the pivoting shaft 23. Thus, a distribution density of the car rope fasteners 11 relative to the rope fastener penetrating apertures 25a is greater at an end distant from the pivoting shaft 23 than at an end close to the pivoting shaft 23. Furthermore, the unoccupied rope fastener penetrating aperture 25a in which no car rope fastener 11 is disposed is closed by a disk-shaped cap 34 functioning as a closing member.
[0039] The amount of load acting on the weighing springs 26 will now be calculated for a case in which a large portion of the car rope fasteners 11 are disposed at the end distant from the pivoting shaft 23, and for a case in which a large portion thereof are disposed at the end close to the pivoting shaft 23.
[0040] Let us make L1 be the distance from the pivoting shaft 23 to the rope fastener penetrating apertures 25a, L2 = L1 + a, L3 = L1 + 2 x a, L4 = L1 + 3 x a, L5 = L1 + b be the distance from the pivoting shaft 23 to the weighing springs 26, and P be the tensile force arising in the car portion of one main rope 4.
[0041] If the rope fastener penetrating aperture 34 at a distance L1, which is close to the pivoting shaft 23, is unoccupied, as shown in Figure 5, in other words, if a large portion of the main ropes 4 are disposed at the end distant from the pivoting shaft 23, the amount of load R1 on the weighing springs 26 is given by:

$$
\begin{aligned}
R1 &= (PL1 + 2PL2 + 2PL3 + 2PL4)/L5 \\
&= (7L1 + 12a)P/(L1 + b)
\end{aligned}
$$

[0042] On the other hand, although not shown, if the rope fastener penetrating aperture 34 at a distance L4, which is distant from the pivoting shaft 23, is unoccupied, the amount of load R2 on the weighing springs 26 is given by:

$$
\begin{aligned}
R2 &= (2PL1 + 2PL2 + 2PL3 + PL4)/L5 \\
&= (7L1 + 9a)P/(L1 + b)
\end{aligned}
$$

[0043] Consequently, R1 is greater than R2 (R1 > R2), making the expansion and contraction of the weighing springs 26 greater when the rope fastener penetrating aperture 34 at a distance L1, which is close to the pivoting shaft 23, is unoccupied. For this reason, by making the distribution density of the car rope fasteners 11 at the end distant from the pivoting shaft 23 greater than the distribution density of the car rope fasteners 11 at the end close to the pivoting shaft 23, the amount of pivoting of the pivoting supporting platform 24 is enhanced, enabling detecting precision to be improved.
[0044] If the unoccupied rope fastener penetrating aperture 25a is closed by the disk-shaped cap 34 in advance before being shipped from a factory, the car rope fastener 11 cannot be disposed incorrectly during installation, enabling installation workability to be improved.
[0045] Moreover, in Embodiment 3, a cap 34 was disclosed as the closing member, but the closing member may also be adhesive tape, etc.
[0046] The present invention can also be applied to machine-roomless elevators, which do not have a machine room. In that case, the main rope bearing portion may be a member such as a beam, etc., secured to an upper portion inside the hoistway.
[0047] In addition, in the above examples, an elevator using a two-to-one (2:1) roping method is disclosed, but the roping method is not particularly limited thereto. For example, the present invention can also be applied to an elevator using a one-to-one (1:1) roping method. In an elevator using a one-to-one (1:1) roping method, car end portions of main ropes are connected to an upper beam of a car frame. In other words, the main rope bearing portion is the upper beam. Consequently, a weighing device is mounted to the upper beam in a vertically-inverted state compared to Embodiments 1 to 3.

Claims

1. An elevator load weighing device disposed between a plurality of rope fasteners connected to end portions of a plurality of main ropes and a main rope bearing portion for bearing tensile forces acting on the end portions of the main ropes, the elevator load weighing device detecting a live load from the tensile forces,
the elevator load weighing device comprising:

   a pivoting supporting platform pivotably disposed on the main rope bearing portion, supporting a sum total of the tensile forces, and being pivoted so as to correspond to a magnitude of the sum total of the tensile forces;
   an elastic member disposed between the pivoting supporting platform and the main rope bearing portion, and expanding and contracting so as to correspond to the sum total of the tensile forces; and
   a detector for outputting a signal corresponding to a pivoting position of the pivoting supporting platform.

2. The elevator load weighing device according to Claim 1, wherein a detected segment is secured to the pivoting supporting platform, and the detector is a non-contact type that detects a distance to the detected segment without contacting the detected segment.

3. The elevator load weighing device according to Claim 1, wherein a plurality of rope fastener penetrating apertures through which the rope fasteners pass are disposed on the pivoting supporting platform, the rope fasteners are fewer in number than the rope fastener penetrating apertures, and a distribution density of the rope fasteners relative to the rope fastener penetrating apertures is greater at an end that is distant from a pivoting shaft of the pivoting supporting platform than at an end that is close to the pivoting shaft.

4. The elevator load weighing device according to Claim 3, further comprising a closing member for closing an unoccupied rope fastener penetrating aperture.

FIG. 1

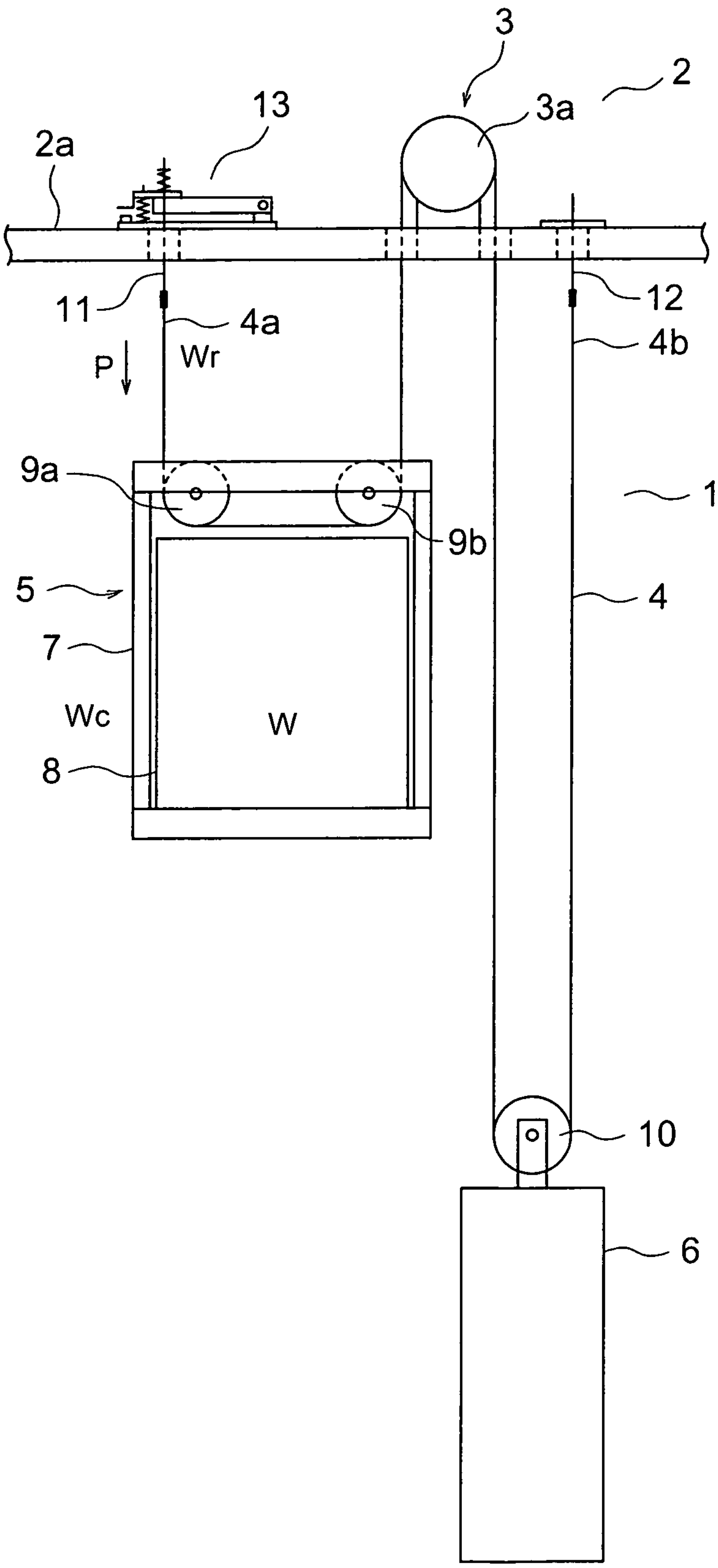


FIG. 2

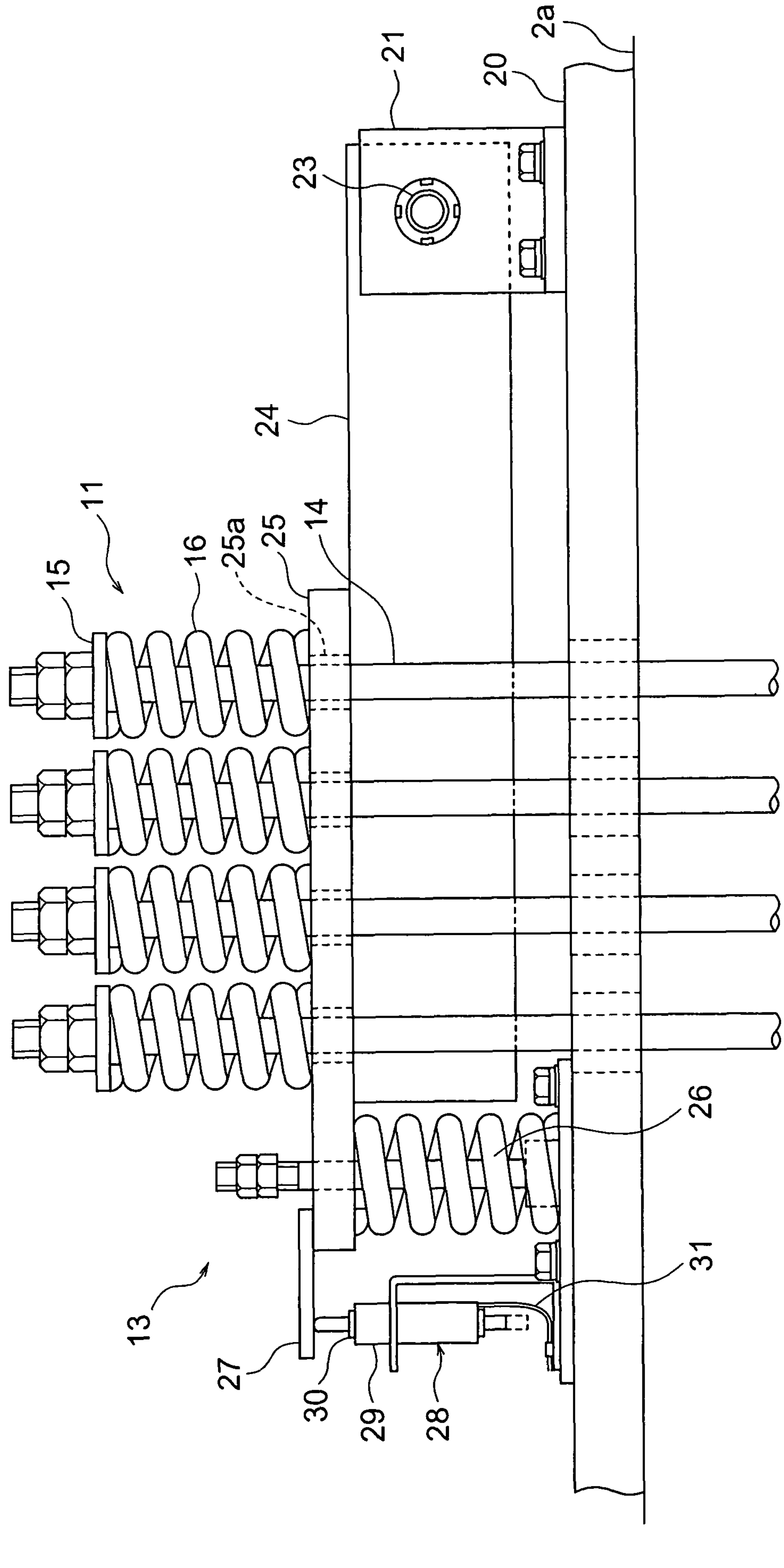


FIG. 3

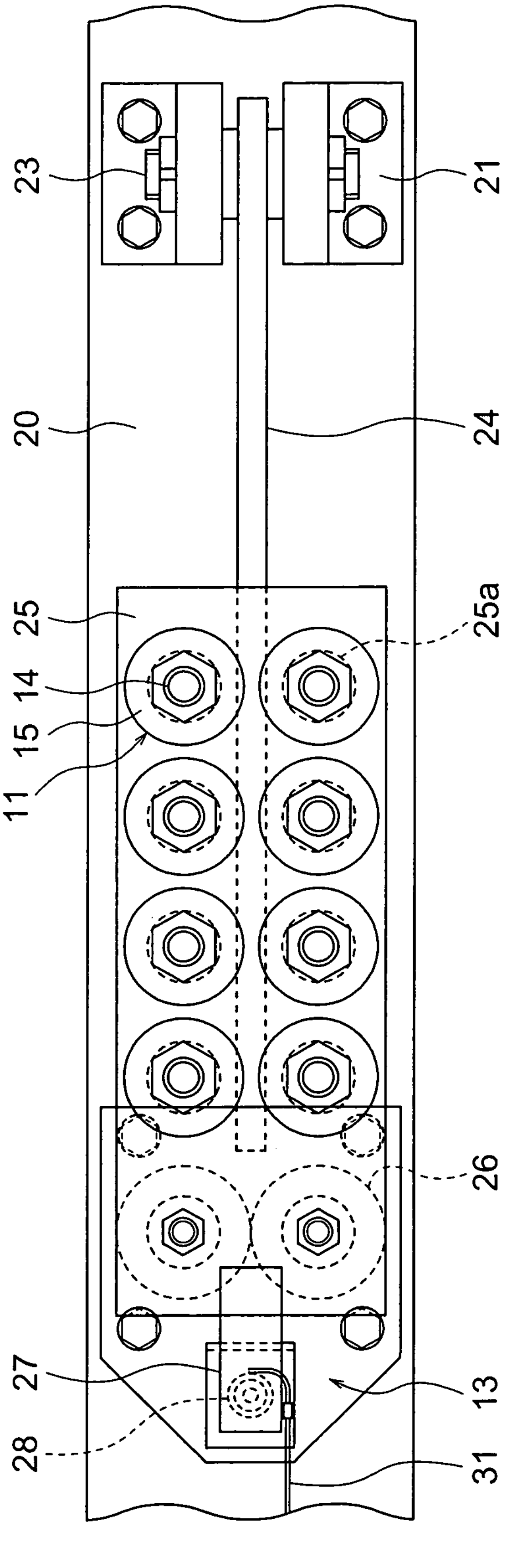


FIG. 4

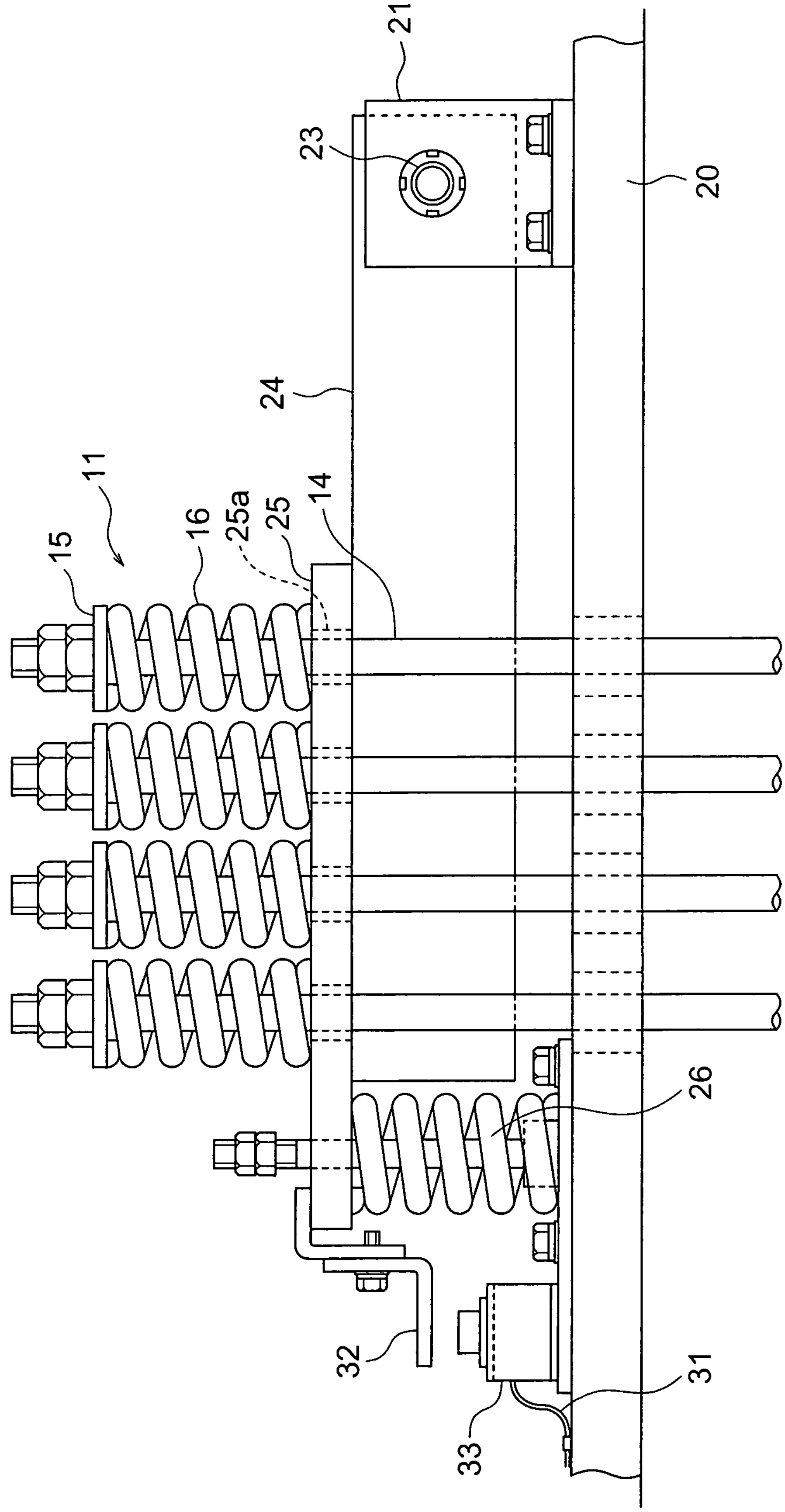
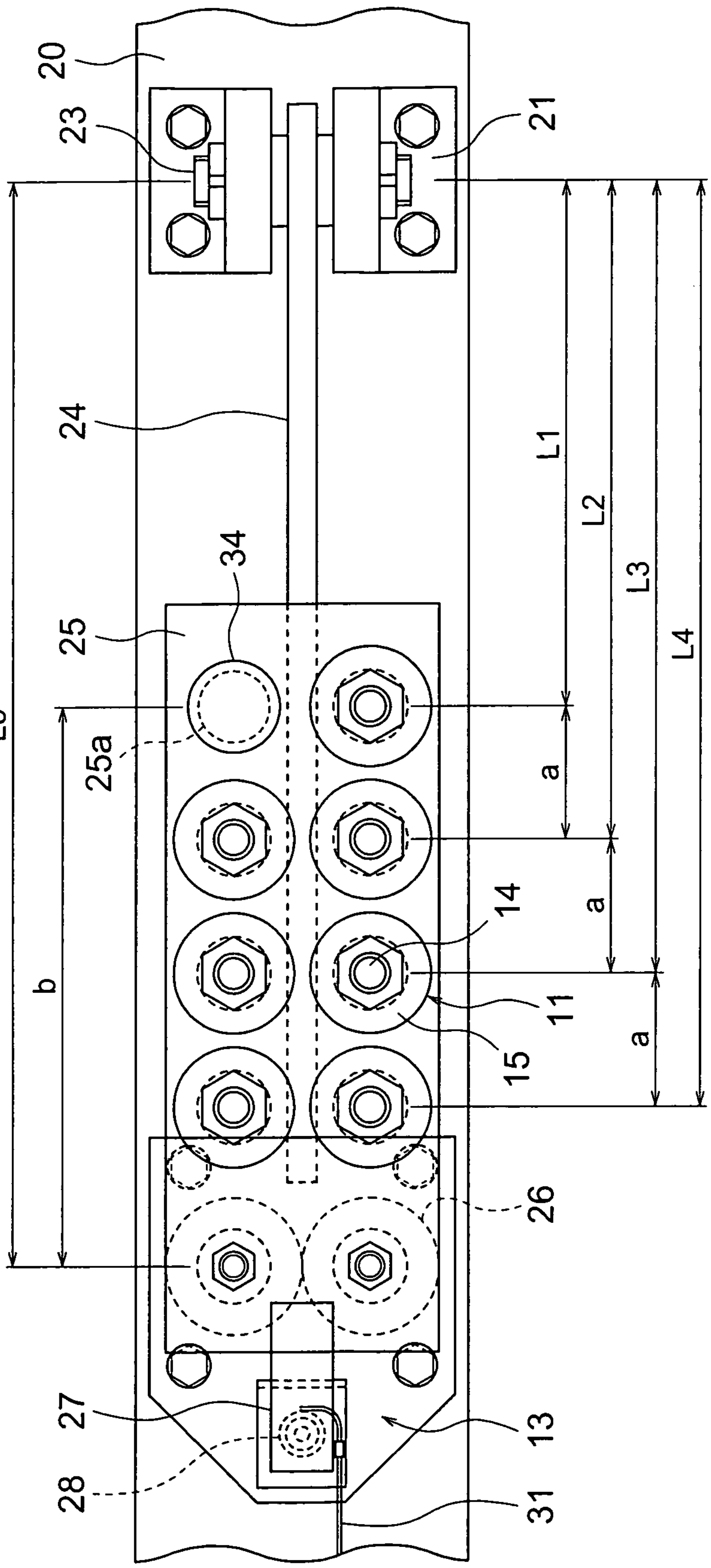


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B5/14, B66B7/08

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] B66B1/00-B66B7/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Toroku Jitsuyo Shinan Koho	1994-2003

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 6-255933 A (Otis Elevator Co.), 13 September, 1994 (13.09.94), Par. No. [0014] (Family: none)	1-2 3-4
Y	JP 5-264328 A (Inventio AG.), 12 October, 1993 (12.10.93), Par. Nos. [0016] to [0017] & CA 2084121 A & FI 930331 A & EP 0553422 A1 & US 5306879 A & SK 355292 A	1-2
Y	JP 2581357 B2 (Mitsubishi Electric Corp.), 12 February, 1997 (12.02.97), Pay attention to compression spring (16) for return & JP 5-97351 A	1-2

[X] 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	Date of mailing of the international search report
25 December, 2003 (25.12.03)	20 January, 2004 (20.01.04)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/04404

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0849207 A1 (KONE OY), 24 June, 1998 (24.06.98), & CA 2224027 A & FI 965139 A & CN 1185407 A & AU 4681797 A & JP 10-194625 A & BR 9706440 A & US 6021873 A & KR 255467 B & AU 724219 B & JP 3234558 B2	1

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