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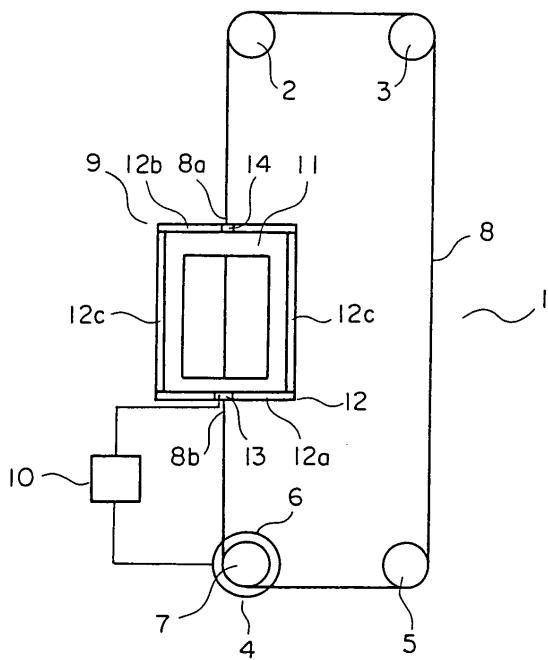
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(54) ROPE TENSION ADJESTER OF ELEVATOR

(57) A pair of sheaves, i.e. a return pulley and a driving sheave, are provided at upper and lower portions of a hoistway. An elevating body capable of being raised/lowered in the hoistway is connected with one and the other ends of a main rope looped around the sheaves. The elevating body is provided with a rope tension adjuster for adjusting a tension of the main rope. The rope tension adjuster includes a tension detecting device for detecting the tension of the main rope, and an actuator device for displacing at least one of the one end and the other end of the main rope with respect to the elevating body based on information from the tension detecting device.

FIG. 1



**Description****Technical Field**

**[0001]** The present invention relates to a rope tension adjuster of an elevator for adjusting a tension of a main rope for suspending a car within a hoistway.

**Background Art**

**[0002]** In a conventional elevator, a tension device (rope tension adjuster) having a sheave pressed against a driving rope for suspending a car may be provided on a bottom portion of a hoistway in order to maintain a tension applied to the driving rope constant. The driving rope is secured at one end thereof to an upper portion of the car, and at the other end thereof to a lower portion of the car. Three driven sheaves and one driving sheave are provided within the hoistway. In a direction from the aforementioned one end to the other end, the driving rope is sequentially looped around the three driven sheaves and the driving sheave. The sheave of the tension device is pressed against a portion of the driving rope which is located between the driven sheave and the driving sheave (see Patent Document 1).

**[0003]** Patent Document 1: JP 2004-67365 A

**Disclosure of the Invention****Problem to be solved by the Invention**

**[0004]** In the conventional tension device for the elevator constructed as described above, however, the sheave is pressed against the driving rope. Therefore, the tension device is increased in size, and the number of parts of a driving machine for displacing the sheave increases as well. Thus, a reduction in cost cannot be achieved.

**[0005]** The present invention has been made to solve the problem discussed above, and it is therefore an object of the invention to obtain a rope tension adjuster of an elevator allowing a reduction in cost.

**Means for solving the Problems**

**[0006]** According to the present invention, a rope tension adjuster of an elevator for adjusting a tension of a main rope looped around to extend between a pair of sheaves, which are provided respectively in an upper portion and a lower portion of a hoistway, and connected at one end and another end of the main rope to an elevating body that can be raised/lowered within the hoistway, includes: a tension detecting device for detecting the tension of the main rope; and an actuator device provided on the elevating body, for displacing at least one of the one end and the another end of the main rope with respect to the elevating body based on information from the tension detecting device.

**Brief Description of the Drawings****[0007]**

5 Fig. 1 is a diagram showing a structure of an elevator according to Embodiment 1 of the present invention. Fig. 2 is a lateral view showing a rope tension adjuster of the elevator of Fig. 1. Fig. 3 is a cross-sectional view taken along the line III-III of Fig. 2. Fig. 4 is a front view showing a rope tension adjuster of an elevator according to Embodiment 2 of the present invention. Fig. 5 is a cross-sectional view taken along the line V-V of Fig. 4.

**Best Modes for carrying out the Invention**

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

**Embodiment 1**

20 **[0009]** Fig. 1 is a diagram showing a structure of an elevator according to Embodiment 1 of the present invention. Referring to the figure, a first upper return pulley 2 and a second upper return pulley 3, which are sheaves disposed apart from each other in a horizontal direction, are provided in an upper portion within a hoistway 1. A driving device 4 and a lower return pulley 5, which are disposed apart from each other in the horizontal direction, are provided in a lower portion within the hoistway 1.

25 **[0010]** The driving device 4 has a driving device main body 6, and a driving sheave 7 rotated by the driving device main body 6. The driving sheave 7 and the lower return pulley 5 are disposed substantially at the same height. The driving sheave 7 and the first upper return pulley 2, which are disposed on a common vertical line, constitute a pair of sheaves.

30 **[0011]** A plurality of main ropes 8 (only one of them is shown in Fig. 1 for the sake of simplicity) are looped around the first upper return pulley 2, the second upper return pulley 3, the lower return pulley 5, and the driving sheave 7. A car 9 as an elevating body is suspended within the hoistway 1 by means of the main ropes 8. The car 9 is raised/lowered within the hoistway 1 due to a driving force of the driving device 4. A control device 10 for controlling an operation of the elevator is provided within the hoistway 1. The driving device 4 is controlled by the control device 10.

35 **[0012]** The car 9 has a car body 11, and a car frame 12 surrounding and supporting the car body 11. The car frame 12 has lower frames 12a disposed on a lower portion of the car body 11, an upper frame 12b disposed on an upper portion of the car body 11, and a pair of longitudinal frames 12c connecting the lower frames 12a and the upper frame 12b together. The lower frames 12a (i.e.,

a lower portion of the car 9) are provided with a rope tension adjuster 13 for adjusting tensions of the main ropes 8. The upper frame 12b (i.e., an upper portion of the car) is provided with a cleat portion 14 for connecting the main ropes 8 to the car 9.

**[0013]** The main ropes 8 have first connection portions (one end) 8a each of which is connected to the upper portion of the car 9 via the cleat portion 14 and second connection portions (the other end) 8b each of which is connected to the lower portion of the car 9 via the rope tension adjuster 13. In a direction from the first connection portions 8a to the second connection portions 8b, the main ropes 8 are sequentially looped around the first upper return pulley 2, the second upper return pulley 3, the lower return pulley 5, and the driving sheave 7. The main ropes 8 are moved in a circulating manner as the car 9 is raised/lowered.

**[0014]** Fig. 2 is a lateral view showing the rope tension adjuster 13 of Fig. 1. Fig. 3 is a cross-sectional view taken along the line III-III of Fig. 2. Referring to the figures, the lower frames 12a are designed as a pair of horizontal frames that are disposed apart from each other in a depth direction of the car 9. The lower frames 12a are provided with a pair of actuator devices 15 for displacing the second connection portions 8b with respect to the car 9. The respective actuator devices 15 are disposed apart from each other in a width direction of the car 9. Each of the main ropes 8 is passed through a space between the respective actuator devices 15.

**[0015]** The actuator devices 15 each have a rotational driving portion 16, which includes a motor, and a screw shaft 17, which extends upward from the rotational driving portion 16, and is rotated by the rotational driving portion 16 on its own axis. A displacement plate 18 displaceable in a vertical direction with respect to the car 9 is supported between the respective screw shafts 17. The displacement plate 18 is screwed on the respective screw shafts 17 due to a ball screw structure. The displacement plate 18 is displaced in an axial direction of the screw shafts 17 through rotation of the screw shafts 17 on their own axes. That is, the displacement plate 18 is displaced toward the car body 11 due to rotation of the respective screw shafts 17 in one direction, and away from the car body 11 due to reversal of the rotational direction of the respective screw shafts 17.

**[0016]** A plurality of tension detecting devices 19 for detecting tensions of the main ropes 8 are provided on the displacement plate 18. The respective main ropes 8 are passed through the displacement plate 18 and the respective tension detecting devices 19. Each of the second connection portions 8b is fitted with each of rope fittings 20 laid on the tension detecting devices 19. Each of the rope fittings 20 is pressed against the displacement plate 18 via each of the tension detecting devices 19 due to a tension of each of the main ropes 8. Thus, the second connection portions 8b are displaced together with the displacement plate 18. A tension of each of the main ropes 8 is detected when each of the tension detecting

devices 19 measures a load with which each of the rope fittings 20 is pressed against the displacement plate 18. Each of the tension detecting devices 19 generates a signal (information) corresponding to the tension applied to each of the main ropes 8.

**[0017]** The tension detecting devices 19 are electrically connected to the actuator devices 15 and the control device 10 (Fig. 1), respectively. Information from the respective tension detecting devices 19 is transmitted to the actuator devices 15 and the control device 10. The actuator devices 15 rotate the screw shafts 17 based on the information from the tension detecting devices 19 respectively. That is, each of the actuator devices 15 rotates each of the screw shafts 17 such that the displacement plate 18 moves toward the car body 11 when the tension applied to each of the main ropes 8 has decreased, and each of the actuator devices 15 rotates each of the screw shafts 17 such that the displacement plate 18 moves away from the car body 11 when the tension applied to each of the main ropes 8 has increased.

**[0018]** The control device 10 acquires information from the respective tension detecting devices 19 as information on the weight of the car 9. The control device 10 controls the operation of the elevator based on the information from the respective tension detecting devices 19. The rope tension adjuster 13 has the actuator devices 15, the displacement plate 18, the tension detecting devices 19, and the rope fittings 20.

**[0019]** Next, an operation will be described. When the elevator is in operation, the tensions of the respective main ropes 8 are constantly detected by the tension detecting devices 19. Information on the detected tensions of the main ropes 8 is constantly output from the tension detecting devices 19 to the actuator devices 15 and the control device 10, respectively.

**[0020]** When the tensions detected by the tension detecting devices 19 have risen above a predetermined upper limit for some reason, the screw shafts 17 are rotated by the rotational driving portions 16, respectively. Thus, the displacement plate 18 is displaced away from the car body 11, namely, downward. When the displacement plate 18 is displaced downward, the second connection portions 8b are also displaced together with the displacement plate 18. Thus, the tensions of the main ropes 8 are reduced and adjusted to a value within a predetermined range.

**[0021]** When the tensions detected by the tension detecting devices 19 have dropped below a predetermined lower limit for some reason, the screw shafts 17 are rotated respectively by the rotational driving portions 16 reversely to the direction in which the screw shafts 17 are rotated when the tensions applied to the main ropes 8 have risen above the upper limit. Thus, the displacement plate 18 and the second connection portions 8b are displaced toward the car body 11, namely, upward. Thus, the tensions applied to the main ropes 8 are increased and adjusted to a value within a predetermined range.

**[0022]** In the rope tension adjuster 13 for the elevator constructed as described above, the tensions of the main ropes 8 are detected by the tension detecting devices 19, respectively, and the car 9 is provided with the actuator devices 15 for displacing the second connection portions 8b of the main ropes 8 with respect to the car 9 based on information from the tension detecting devices 19. Therefore, the sheave to be pressed against the main ropes 8 to adjust the tensions applied thereto can be dispensed with. Accordingly, the tensions of the main ropes 8 can be adjusted with a simple construction, and a reduction in the number of parts or a reduction in size can be achieved. Thus, a reduction in cost can be achieved, and the space for installing the rope tension adjuster 13 can be reduced.

**[0023]** The actuator devices 15 are provided on the lower portion of the car 9, so the rope tension adjuster 13 can be disposed within a region of the car 9 on a vertical projection plane of the hoistway 1. As a result, the cross-sectional area of the elevator on a horizontal plane can be reduced.

**[0024]** The second connection portions 8b of the main ropes 8 are displaced in the vertical direction with respect to the car 9 by means of the actuator devices 15, so there is no need to change the direction of the main ropes 8. As a result, the rope tension adjuster 13 can further be simplified in structure.

**[0025]** While in the foregoing example, the rope tension adjuster 13 is provided on the lower portion of the car 9, the rope tension adjuster 13 may also be provided on the upper portion of the car 9. In this case, the cleat portion 14 is provided on the lower portion of the car 9. Further, the first connection portions 8a are connected to the rope tension adjuster 13, and the second connection portions 8b are connected to the cleat portion 14. In adjusting the tensions applied to the main ropes 8, the first connection portions 8a are displaced with respect to the car 9.

**[0026]** Further, the rope tension adjuster 13 may also be provided on one of the longitudinal frames 12c constituting the lateral portion of the car 9. In this case, the rope tension adjuster 13 is supported by a horizontal beam extending in the horizontal direction from an intermediate portion of the one of the longitudinal frames 12c. In this manner, the range of displacements of the second connection portions 8b can be confined within the height dimension of the car 9, so the height dimension of the hoistway 1 can be reduced.

## Embodiment 2

**[0027]** Fig. 4 is a front view showing a rope tension adjuster of an elevator according to Embodiment 2 of the present invention. Fig. 5 is a cross-sectional view taken along the line V-V of Fig. 4. Referring to the figures, upper frames 12b (the upper portion of the car 9) are provided with a rope tension adjuster 31 for adjusting the tensions of the main ropes 8. The first connection portions 8a are

connected to the car 9 via the rope tension adjuster 31.

**[0028]** The upper frames 12b are designed as a pair of horizontal frames disposed apart from each other in the depth direction of the car 9. The main ropes 8 pass through a space between those horizontal frames. A lower frame 12a (lower portion of the car 9) is provided with the cleat portion 14 for connecting the second connection portions 8b to the car 9.

**[0029]** A pair of support portions 32 are fixed to lower faces of the upper frames 12b (faces on the car body 11 side), respectively. The actuator devices 15 are supported on the support portions 32, respectively. The rotational driving portions 16 are fixed to lateral faces of the support portions 32 respectively. The screw shafts 17 extend in the horizontal direction along the upper frames 12b, respectively. That is, the respective actuator devices 15 are disposed in a fallen state such that axes of the screw shafts 17 extend in the horizontal direction along the upper frames 12b, respectively.

**[0030]** The displacement plate 18, which can be displaced in the axial direction of the screw shafts 17, is provided therebetween. The displacement plate 18 is screwed on the respective screw shafts 17 due to a ball screw structure. The displacement plate 18 is displaced in the horizontal direction through rotation of the respective screw shafts 17. In addition, the tension detecting devices 19 for detecting the tensions applied to the main ropes 8 are provided on a lateral face of the displacement plate 18.

**[0031]** A plurality of turning sheaves 33 are supported by the upper frames 12b. Each of the turning sheaves 33 can rotate about a horizontal shaft extending in the depth direction of the car 9. The main ropes 8 are looped around the turning sheaves 33. The main ropes 8, which extend in the vertical direction, are so changed in a direction as to extend in a horizontal direction toward the displacement plate 18 by means of the turning sheaves 33. The displacement plate 18 is displaced toward and away from the respective turning sheaves 33 due to rotation of the respective screw shafts 17.

**[0032]** The respective main ropes 8, whose direction has been changed to the horizontal direction, pass through the displacement plate 18 and the tension detecting devices 19. The first connection portions 8a are fitted with the rope fittings 20 for retaining the first connection portions 8a on the displacement plate 18. The respective rope fittings 20 are pressed against the displacement plate 18 via the tension detecting devices 19 due to the tensions of the main ropes 8. The tension of each of the main ropes 8 is detected when each of the tension detecting devices 19 measures a load with which each of the rope fittings 20 is pressed against each of the tension detecting devices 19.

**[0033]** Each of the actuator devices 15 rotates each of the screw shafts 17 based on information from each of the tension detecting devices 19. That is, each of the actuator devices 15 rotates each of the screw shafts 17 such that the displacement plate 18 is displaced toward

each of the turning sheaves 33 when the tension of each of the main ropes 8 is decreased, and each of the actuator devices 15 rotates each of the screw shafts 17 such that the displacement plate 18 is displaced away from each of the turning sheaves 33 when the tension of each of the main ropes 8 is increased.

**[0034]** The first connection portions 8a are displaced together with the displacement plate 18. That is, the actuator devices 15 displace the first connection portions 8a in the horizontal direction with respect to the car 9, based on the information from the tension detecting devices 19.

**[0035]** The rope tension adjuster 31 has the actuator devices 15, the displacement plate 18, the tension detecting devices 19, the rope fittings 20, and the turning sheaves 33. Embodiment 2 of the present invention is identical to Embodiment 1 of the present invention in other constructional details and other operational details.

**[0036]** In the rope tension adjuster 31 for the elevator constructed as described above, the upper frames 12b are provided with the turning sheaves 33 for changing the direction of the main ropes 8 from the vertical direction to the horizontal direction, and the first connection portions 8a are displaced in the horizontal direction with respect to the car 9. Therefore, the tensions of the main ropes 8 can be adjusted through displacement of the first connection portions 8a in the horizontal direction, and the dimension of the rope tension adjuster 31 can be reduced as to a height direction of the car 9. Accordingly, the dimension of the elevator can be reduced as to a height direction of the hoistway 1, so the elevator can further be reduced in size.

**[0037]** In the foregoing example, the rope tension adjuster 31 is provided on the upper portion of the car 9. However, the rope tension adjuster 31 may also be provided on the lower portion of the car 9. In this case, the cleat portion 14 is provided on the upper portion of the car 9. Further, the second connection portions 8b are connected to the rope tension adjuster 31, and the first connection portions 8a are connected to the cleat portion 14. In adjusting the tensions of the main ropes 8, the second connection portions 8b are displaced with respect to the car 9.

**[0038]** In the foregoing respective embodiments of the present invention, only the first connection portions 8a or only the second connection portions 8b are displaced with respect to the car 9. However, the first connection portions 8a and the second connection portions 8b may also be displaced with respect to the car 9 respectively by means of the rope tension adjuster.

5 a hoistway, and connected at one end and another end of the main rope to an elevating body that can be raised/lowered within the hoistway, **characterized by** comprising:

a tension detecting device for detecting the tension of the main rope; and  
an actuator device provided on the elevating body, for displacing at least one of the one end and the another end of the main rope with respect to the elevating body based on information from the tension detecting device.

10 2. The rope tension adjuster of an elevator according to Claim 1, **characterized in that** the actuator device is provided on an upper portion, a lower portion, or a lateral portion of the elevating body.

15 3. The rope tension adjuster of an elevator according to Claim 1 or 2, **characterized in that** the actuator device displaces at least one of the one end and the another end of the main rope in a vertical direction with respect to the elevating body.

20 25 4. The rope tension adjuster of an elevator according to Claim 1 or 2, **characterized by** further comprising a turning sheave provided on the elevating body, for changing a direction in which the main rope extends from a vertical direction to a horizontal direction, and **characterized in that** the actuator portion displaces the main rope, which is turned to extend in the horizontal direction by the turning sheave, in the horizontal direction with respect to the elevating body.

## Claims

1. A rope tension adjuster of an elevator for adjusting 55 a tension of a main rope looped around to extend between a pair of sheaves, which are provided respectively in an upper portion and a lower portion of

FIG. 1

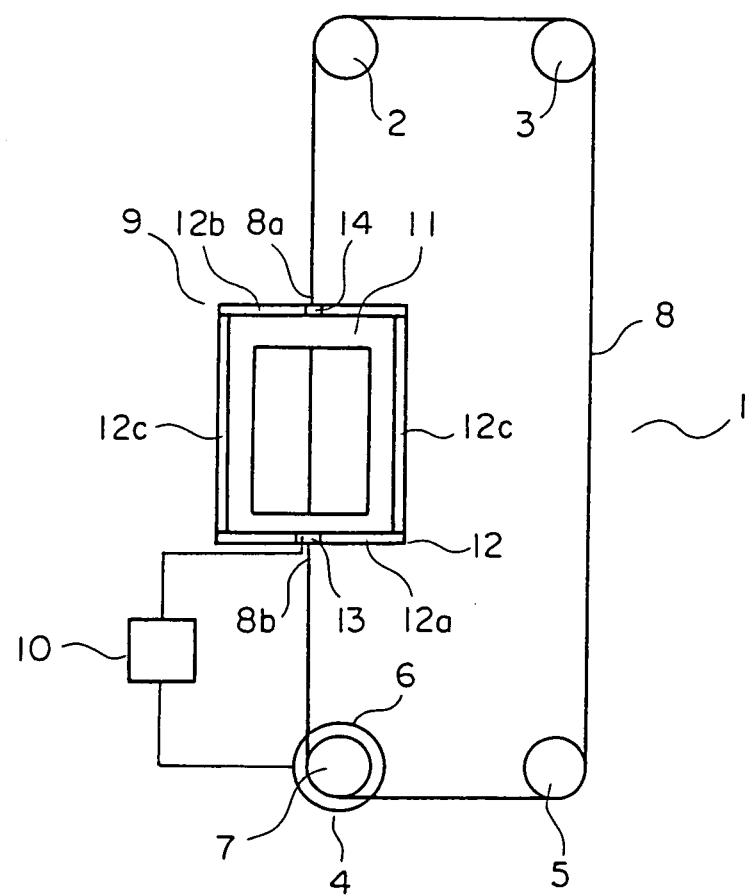


FIG. 2

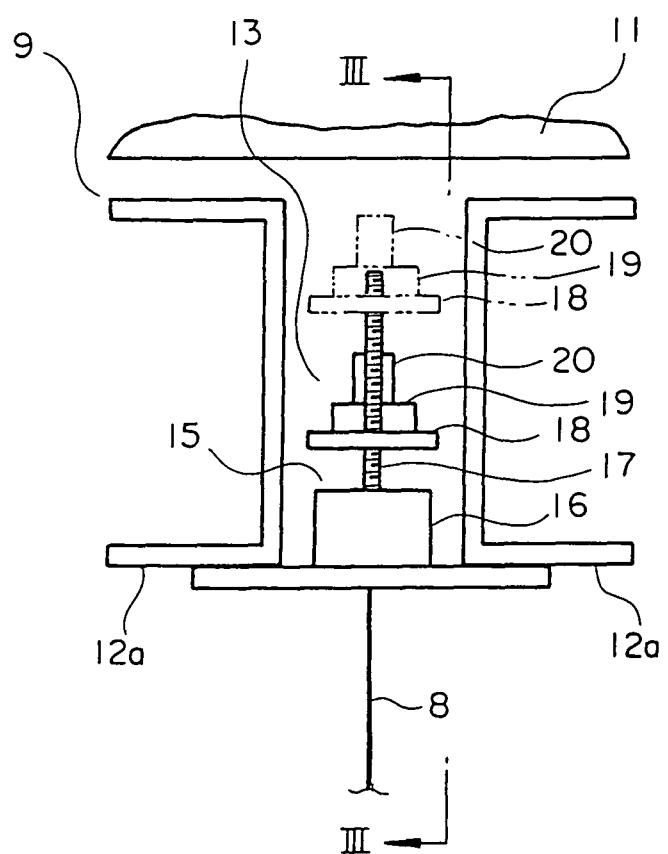


FIG. 3

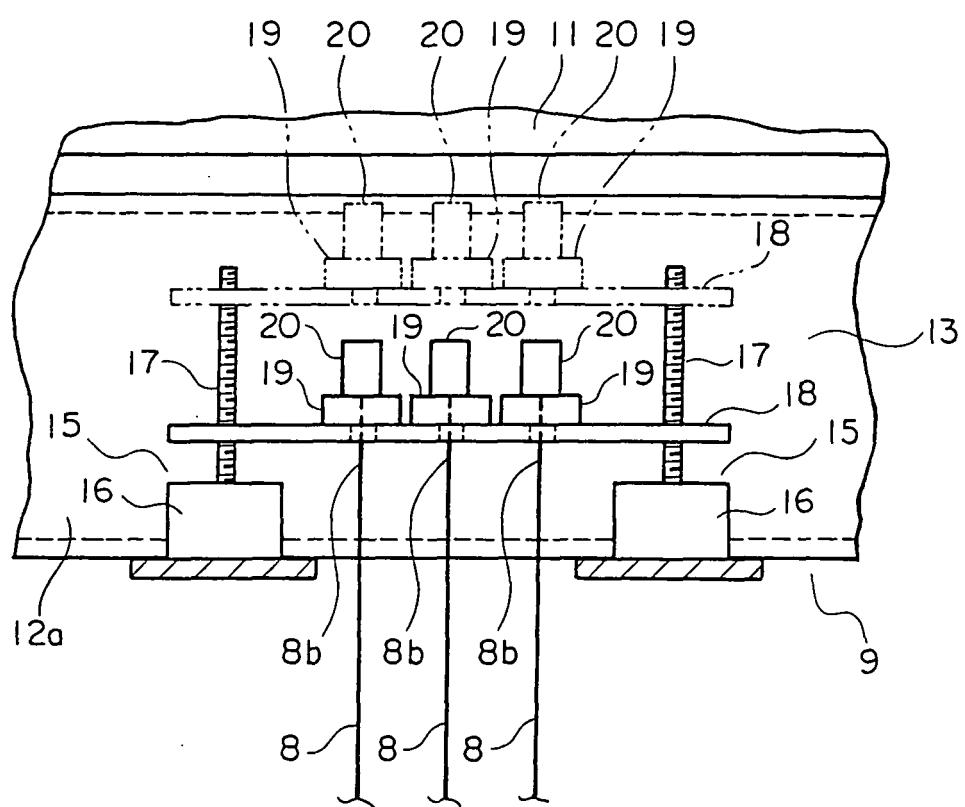


FIG. 4

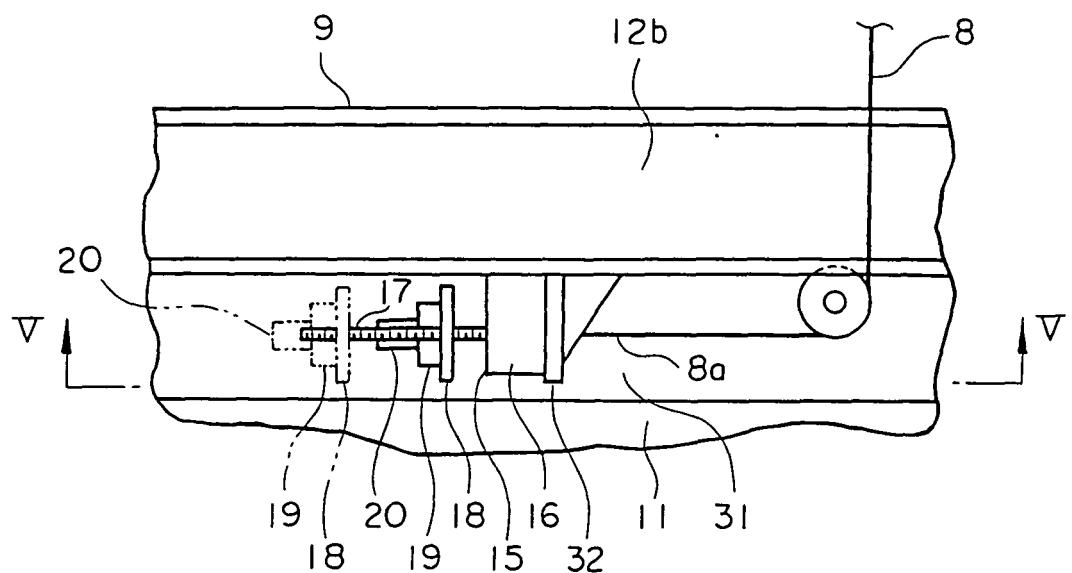
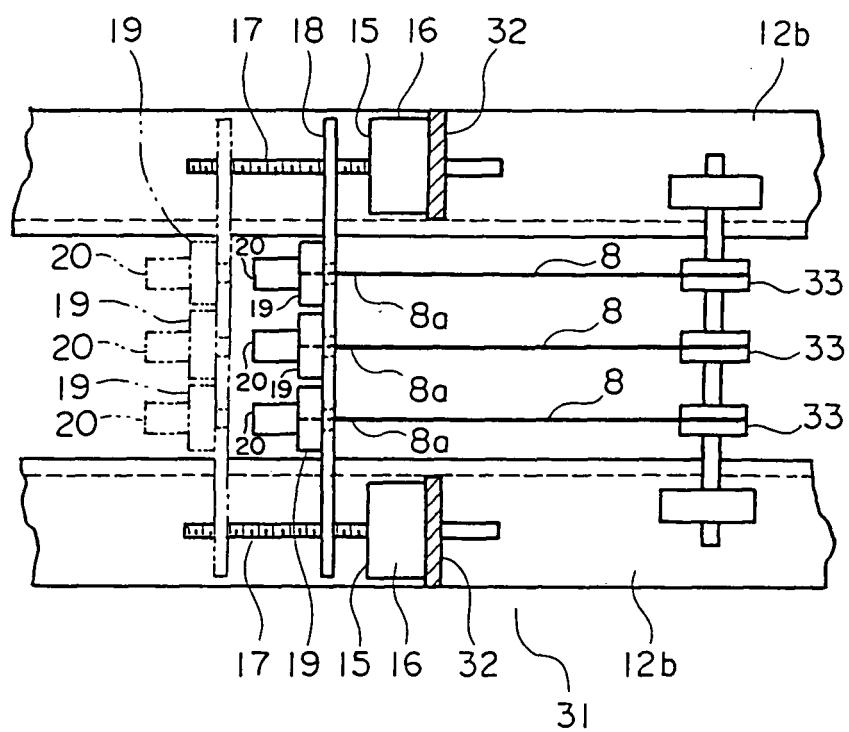


FIG. 5



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/014833

A. CLASSIFICATION OF SUBJECT MATTER  
Int.Cl<sup>7</sup> B66B7/10

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<sup>7</sup> B66B7/00-B66B7/12Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005  
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-67365 A (Otis Elevator Co.), 04 March, 2004 (04.03.04), Par. Nos. [0009] to [0010], [0013]; Figs. 1 to 2, 7 (Family: none)	1-3 4
Y A	JP 7-206319 A (Mitsubishi Electric Building Techno-Service Co., Ltd.), 08 August, 1995 (08.08.95), Par. Nos. [0020] to [0028], [0048]; Figs. 1 to 2, 7 (Family: none)	1-3 4

 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 07 July, 2005 (07.07.05)	Date of mailing of the international search report 26 July, 2005 (26.07.05)
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2004/014833

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3-98976 A (Mitsubishi Electric Corp.), 24 April, 1991 (24.04.91), Page 2, lower right column, line 18 to page 3, lower left column, line 18; Figs. 1 to 2 & GB 2236301 A	4

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2004067365 A [0003]