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(71) Applicant: OTIS ELEVATOR COMPANY
10 Farm Springs
Farmington, CT 06032(US)

(72) Inventor: Nakai, Keiichiro
Sumida 4-18-1, Sumida-Ku
Tokyo(JP)
Inventor: Suganuma, Manabu
Karabe 5-3-7-404,
Narita-City, Chiba Prefecture(JP)

(74) Representative: Klunker . Schmitt-Nilson . Hirsch
Winzererstrasse 106
D-8000 München 40(DE)

(54) **A support structure for a linear motor drive type of elevator.**

(57) A support structure for a linear motor drive type of elevator consisting of a stator functioning as a primary side or a secondary side of a linear motor and a moving element functioning as a secondary side or a primary side to said stator, the structure thereof is characterized in that one end of the stator is fastened to a building side through a first support means constituted as allowing the vibration of the stator and the other end of the stator is fastened to the building side trough the secondary support means providng a pre-determined tension to the stator and absorbing the vibration acted on the stator.

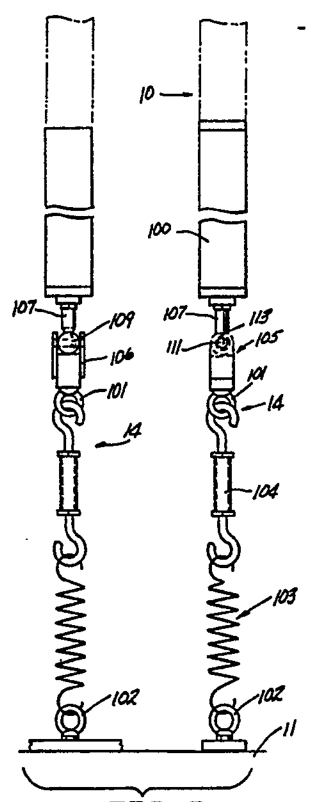


FIG-2

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# A SUPPORT STRUCTURE FOR A LINEAR MOTOR DRIVE TYPE OF ELEVATOR

Conventionally, as an elevator a traction type of elevator has widely prevailed. This type of elevator is so constituted as a machine room is provided above the lift, in which a traction machine is installed and thereon a rope is hung, on one end thereof a car and on the other end a counterweight are hung respectively.

However, the dimension of this winch is relatively large and at the same time in the machine room are installed a brake apparatus and other control apparatus, so that the machine room needs a capacity therefor, especially in the building such as a mansion which needs a more living space, it is a big problem that the building is largely occupied by a machine room. Further, as the weight of the apparatuses settled in the machine room increases to some extent, the structure of the machine room has to be expensive due to the necessary strength.

Accordingly, in order to solve the above problem, an elevator having a linear motor as its power source has recently received footlights. As this linear motor has such a structure as the motor itself as well known in a linear direction, there is of no need of a motor which needs a traction machine or reduction device and the pulleys, to make the whole structure quite lightweighted. As the result, a machine room for a traction machine is not necessary any more and a big advantage such that an elevator system as a whole is obtained.

However, the above linear motor type of elevator has still many technical problems to be solved. Particularly, from a view point of safety there are the problems to be solved in the stator fastened to the building and functioning as a primary side or a secondary side of a linear motor. This stator is said to need a corresponding length in proportion to the number of floors of the building, the supporting method of which is a problem.

Particularly in Japan, which has frequent earthquakes, as the breakage of the stator is anticipated due to the vibration and shock by earthquake, it is to be considered under the aspect of safety.

Therefore, one object of the present invention is to provide a structure of a linear motor driving elevator which is quite safely operated.

In accordance with the present invention, in order to solve the afore-said problem, a structure for a linear motor type of functioning as a primary side or a secondary side of a linear motor and a moving element functioning as a secondary side or primary side to the stator, one end of the stator being fastened to a building through the first support means constituted for allowing the vibration of the stator and the other end thereof being fastened to the building through the second support means to supply a pre-determined tension to the stator and to absorb the vibration acted on the stator.

Preferably, a linear motor is supported by one end of the stator which functions as a primary side or a secondary side of the linear motor and is fastened to a hoist way of the lift mounted on a building, being fastened to a upper support channel mounted above the hoist way through a revolving, coupling member allowing the stator to rotate within a certain range, and the other end thereof being fastened to the floor as a base of the hoist way through a support member consisting of a tension supplying means which allows the stator to swing within a certain range and supplies a predetermined tension to the stator. Accordingly, if the displacement of the stator is allowed by the movement of the coupling means and by the tension supply means the vibration etc is reduced and absorbed, so that the stator is protected from the breakage.

The followings are the explanation of the embodiment of the present invention referring to the drawings attached.

Fig. 1 is a schematic diagram of a linear motor drive type of elevator according to the present invention, especially as to cylindrical linear motor, it is described as follows.

A cylindrical linear motor consists of a cylindrical moving element 1 and a column 10 as a stator. This cylindrical moving element 1 functions as a primary side, on both sides of which are provided with counterweights 2, and those two are installed in the casing consisting of a channel member to form as a whole a counterweight 3 for a car 4. This counterweight 3 is usually set in its weight as 1.5 times of the car 4. The car 4 and the counterweight 3 are connected by four ropes 6 through four sheaves 5 provided above. Further, both of the car and the counterweight have a guide rail 8 on both sides thereof respectively, and those are constituted as going up and down on the rail via slide members 9. The column 10 of the stator side is made of aluminum alloy, which goes through the cylindrical moving element 1 at the middle portion between the guide rails for the counterweights and the lower end portion of which is fastened through a support member 14 to the lower support portion consisting of a support frame 11 provided on the lower portion of the guide rails 8 and the upper end portion of which is fastened through a support member 13 to the upper support portion consisting of a support channel 12. Incidentally, the desired length of column 10 in a elevator of 600 kg loading capacity, is obtained practically by connecting a plurality of columns having 1,500 mm in length and 100 mm in diameter.

In the cylindrical linear motor, as well known, a predetermined gap has to be provided between the primary side and the secondary side, and in order to maintain the gap the linear motor of the present invention is supported by the rollers 15 provided on both upper side and lower side of the motor by 4 pieces each. Further, considering the change of this gap due to the vibration , the shock to the linear motor or the wearing of the rollers 15, gap sensors 16 are provided on the upper and lower portions of the casing frame 17. Moreover, in Fig. 1, a linear motor is provided as being installed in the counterweight, on the other hand it is also possible to install the linear motor in the car to go up and down.

Next, Fig. 2 is explained. This figure shows the structure of the lower support member 14 provided on the column 10. As mentioned above, normally the column is made of aluminum alloy, and the total length is adjusted by connecting the extension 100 on one end thereof. On one end of the extension is connected by a ball joint 105 as a coupling means having an eyebolt 101. On the other hand, on the floor an eyebolt 102 is fastened to the support frame 11 joined to the lower ends of guide rails at both sides of the linear motor, and the column 10 is kept vertical by connecting the eyebolts 101 and 102 with the coil spring 103 and turnbuckle 104, both of which have the hooks on both ends thereof respectively. This turnbuckle 104 is well known, which can add a specific tension to the column 10 by regulating the distance between the spring and the joint. Further, the provision of the turnbuckle 104 causes an easy regulation of the tension to the colum 10 and easy assembly of the spring 103.

The ball joint 105 has a structure that it holds a ball by a pair of yokes 106 which are connected to the the eyebolt 101 and the ball is kept therein by a pin penetrating the pair of yokes and the ball. On the other hand, the end of column has a shaft 107 having a ring which accepts the ball. Accordingly, due to this construction, the yoke portion can rotate approximately 36° Around the pin, further, in the plane perpendicular to the above rotating plane, it can rotate within a certain angles. These structures may allow the column itself to vibrate within a certain angles.

Fig. 3 shows a structure of the upper support member 13 of the column 10. As to the upper support structure, although it is possible to connect the column 10 to the upper support channel 12 by using the same structure with the lower support structure, in this embodiment, because it is enough for either upper or lower support member to bear a spring to damp the vibration or the shock of the column, the support structure has merely a ball joint 110. This ball joint can also rotate within a certain range, and function to allow the displacement of the column due to the vibration with the lower support member.

Therefore, according to the support structure of the column 10 mentioned above, even if the vibration and shock acted on the column 10, it is possible to protect the column 10 effectively. Moreover, in the lower support structure of column 10, the structure consisting of a ball joint and coil spring without a turnbuckle is enough for effecting the functions thereof.

Fig. 4 shows how to connect the column 10. This column 10 obtains its desired length, as mentioned above, by connecting a plurality of columns molded integrally.

However in this kind of linear motor, because of the requirement of a seriously precise linearity along the whole length of the column 10, it s a matter how to connect each column. Practically it is needed to connect two columns in such a manner that the difference in level between those columns is within 0.1 mm.

Therefore, a connecting member 200 shown in Fig. 5 is used. This connecting member 200 has the structure machined integrally by a lathe with a flange 201 formed in the middle portion of it and both ends thereof being threaded 202. On the other hand, the end portions of the column to be connected are reeled and a female screw is threaded therein so as to receive the flange 201.

As to the machining of the end portions of the column also, it is possible to do relatively easily with a lathe to form a female screw sufficiently concentrically.

Accordingly, it becomes possible to connect the columns in such a manner that the allowable linearity of the whole columns is satisfied by screwing one male screw portion of the above connecting member 200 into a female screw threaded on one end of a column, the other male screw portion of the member 200 is screwed into another female screw of other column.

Figs 6 and 7 show a gap sensing system to detect the abnormality of the distance between the column and the moving element of the linear motor.

As mentioned above, normally in a linear motor, it is necessary to provide a certain gap between the stator of the primary side and the moving element of the secondary side (in this embodiment between the moving element of the primary side and the stator of the secondary side) and in order to maintain this gap a support mechanism becomes necessary.

Thus, as shown in Fig. 1, in this embodiment the support mechanism consists of the rollers 15.

However, these rollers have the problem that the gap between the stator and the moving element is changed due to the wearing of the surface of the rollers by frequent up-down travelling of the elevator, the breakage or the dropping out.

So as to detect the abnormal change of the gap, the gap sensors 16 are provided on both of the upper and lower sides of the linear motor.

This gap sensor system consists of a hollow casing 300, a conductive strip 301, a conductive strip fastening screw 302, a regulator screw 303 and a detecting circuit 310. One end of the conductive strip 301 is fastened to the inner side of the casing 300 by a fastening screw 302 and the other end thereof sets a change of the allowable gap between the column 10 and the moving element 1 of the linear motor through a regulator screw 303.

Further, the fastening screw 302 and the column 10 are connected to a DC source through a lead wire 304 respectively. The conductive strip 301 is preferably installed at each of 4 positions of the quarter inner circumference of the casing 300, but it may be at 3 positions or a plurality of positions over 5.

Furthermore, this conductive strip does not limit to the shape of strip, but it may be changed to the ring shape.

The detecting circuit 310 has a structure as shown in Fig. 7.

As mentioned above, if a change is generated in the gap due to the wearing of the rollers, the conductive strip 301 of the gap sensor 16 provided on both of the upper and lower sides of the linear motor touches the surface of the column, by which a relay coils $X_1$ and $X_2$ are energized and the contacts of $Y_1$ and $Y_2$ which are normally open are closed. Because those relay coils and the contacts constitute a self holding circuit, the warning lamps $l_1$ and $l_2$ continue to light.

Further, a safety means may be provided, which reads the signal generated when the conductive strip 301 contacts the column 10 and operates the brake apparatus to stop the car 4.

In the above described embodiment, a support structure for a cylindrical type of linear motor, particularly a support structure of the column of the stator side is described, but the structure according to the present invention is not limited to the application to the cylindrical type of linear motor; but it is sufficiently applicable for instance to a support structure of a conductive plate of a plate type of linear motor.

(Effects of the Invention)

According to the present invention, since the stator functioning as a primary side or a secondary side of a linear motor is provided on a building by being mounted on a hoist way of a elevator through a coupling members allowing relative movement provided on the upper and the lower portions of the stator, even if a shock or vibration was acted on the stator, the movement of the stator itself is appropriately allowed, particularly the vibration etc is reduced or absorbed by the spring provided on the lower portion of the stator to protect the stator effectively from the damages such as breaking.

Brief Explanation of Drawings

Fig. 1 is a schematic diagram of a linear motor drive type of elevator,

Fig. 2 shows the lower support structure for a column is a stator of a linear motor,

Fig. 3 shows the upper support structure,

Fig. 4 shows how to connect columns partially in section,

Fig. 5 shows a perspective view showing a column connecting member.

Fig. 6 shows a sectional view of a gap sensor,

Fig. 7 shows a circuitry for the gap sensor.

## Claims

(1) A support structure for a linear motor drive type of elevator consisting of a stator functioning as a primary side or a secondary side of a linear motor and a moving element functioning as a secondary side or a primary side to said stator, the structure thereof is characterized in that one end of the stator is fastened to a building side through a first support means constituted as allowing the vibration of the stator and the other end of the stator is fastened to the building side through the secondary support means providing a pre-determined tension to the stator and absorbing the vibration acted on the stator.

(2) A support structure for a linear motor drive type of elevator as defined Claim 1 characterized in that the said first support means consists of a coupling means allowing relative movement and the said secondary support means consists of a coupling means allowing relative movement and a coil spring.

(3) A support structure for a linear motor drive type of elevator as defined Claim 1 or 2, characterized in that the second support means comprises a coupling allowing relative movement, a turn buckle and a coil spring.

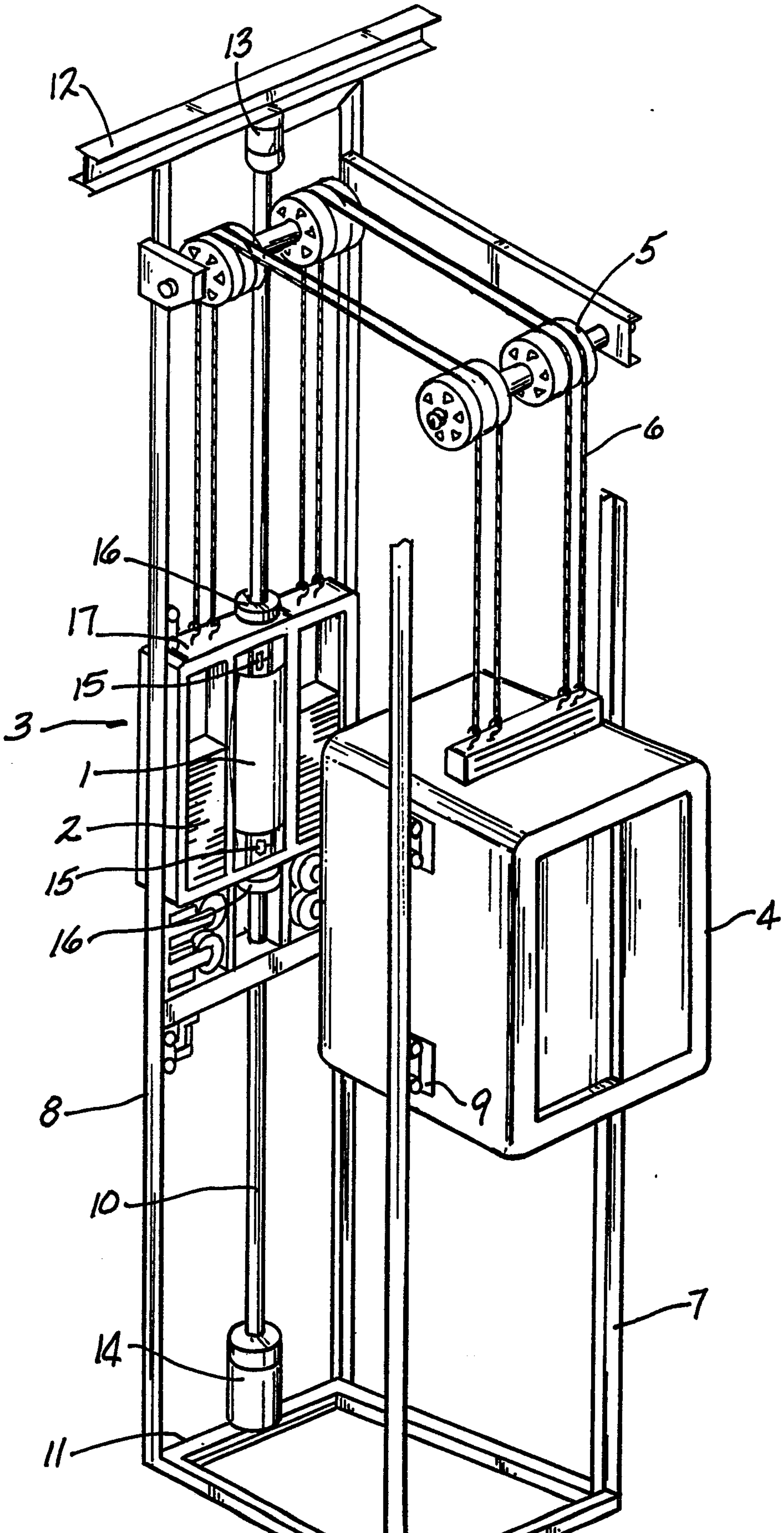


FIG-1

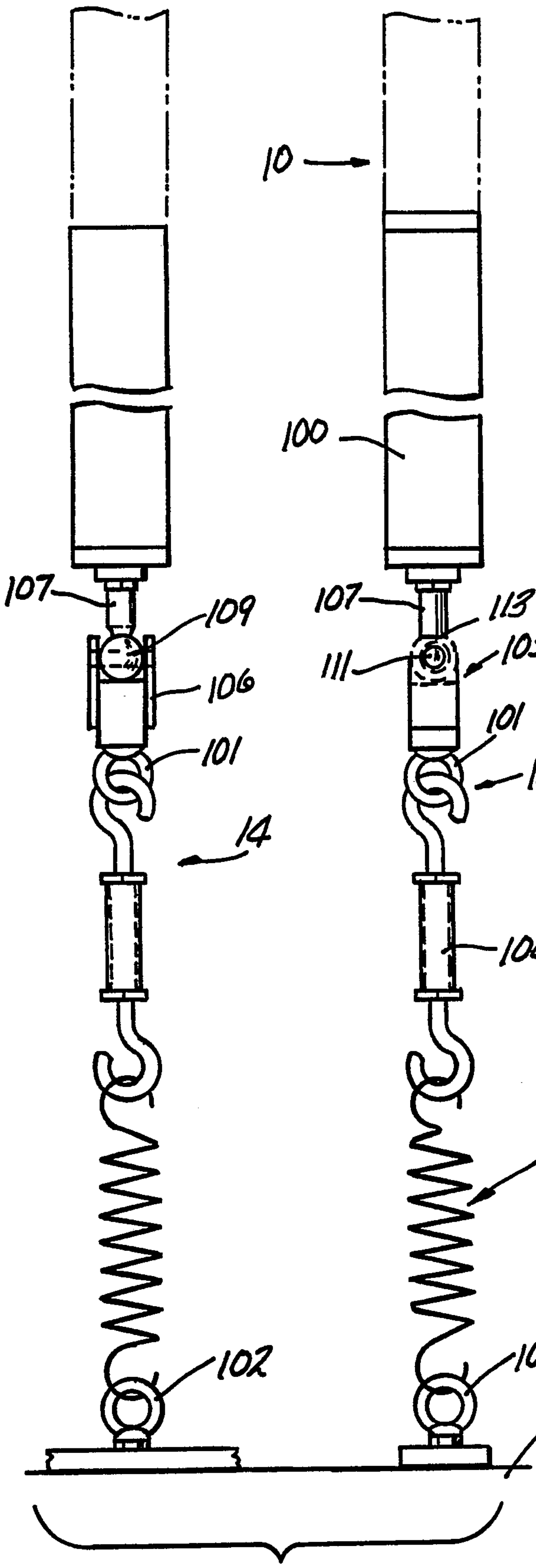
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FIG-2

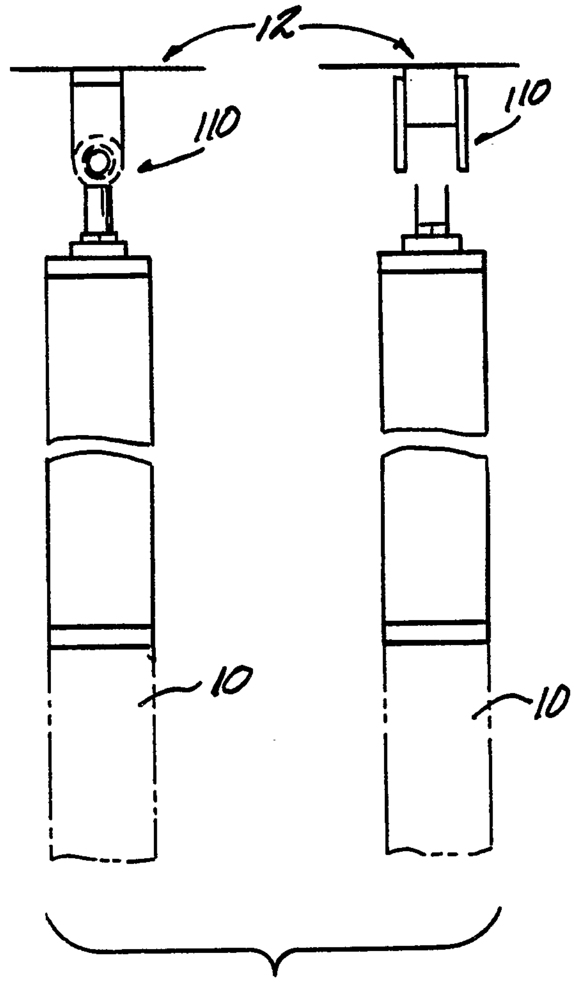
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FIG-3

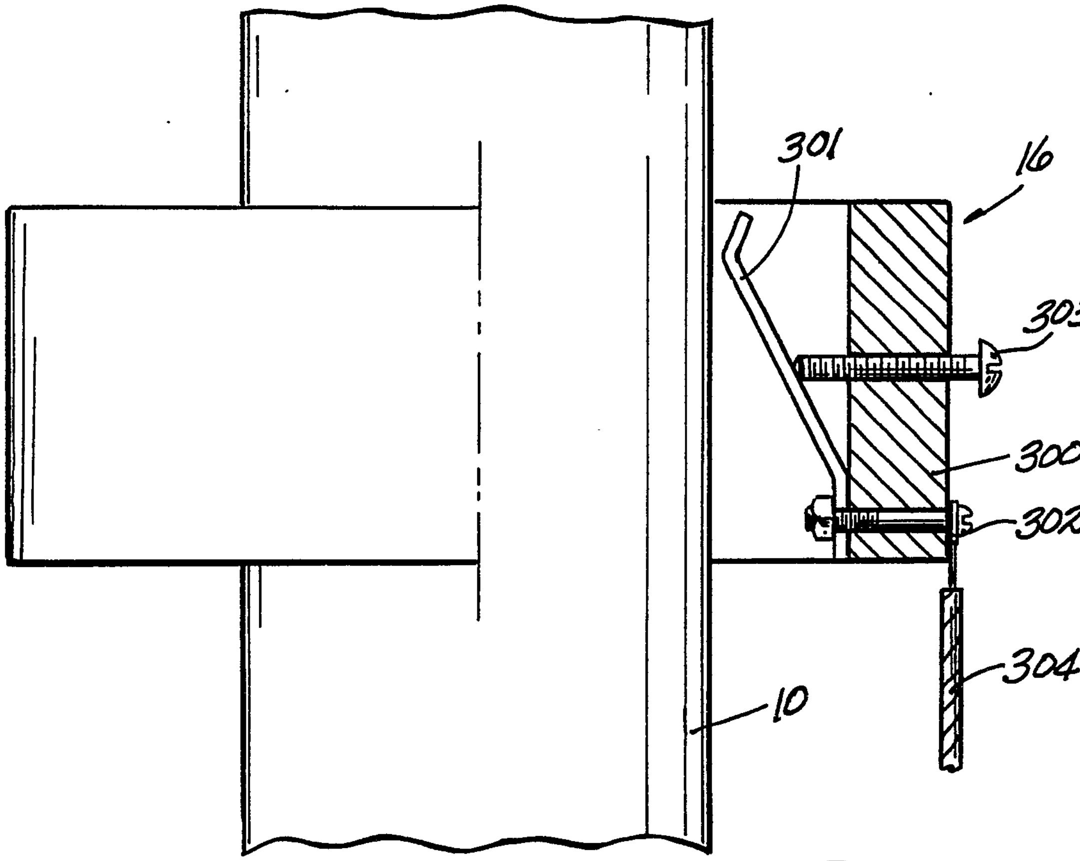


FIG-6

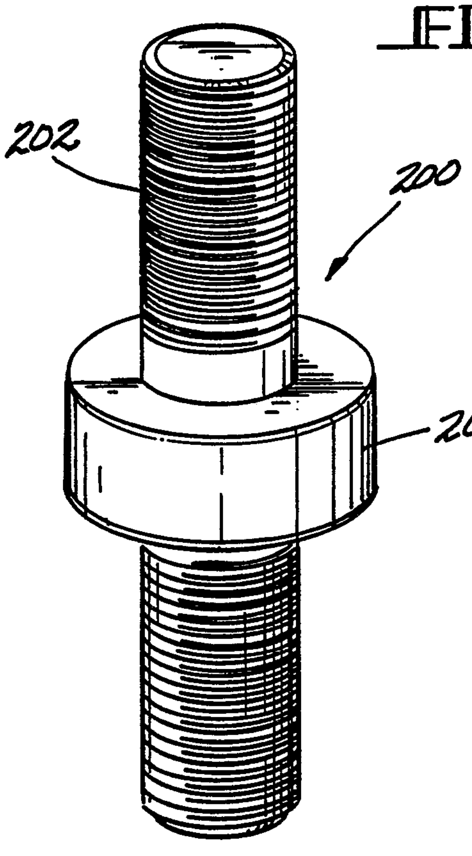


FIG-5

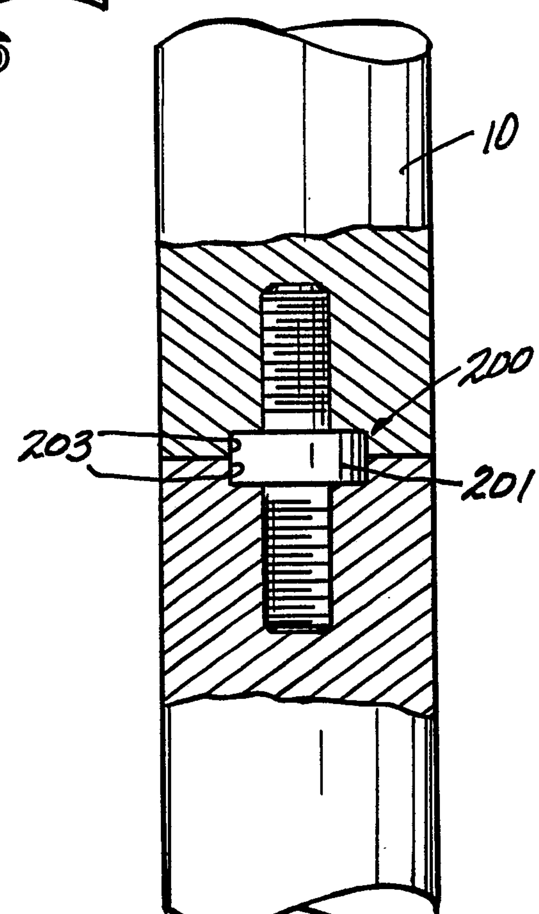


FIG-4

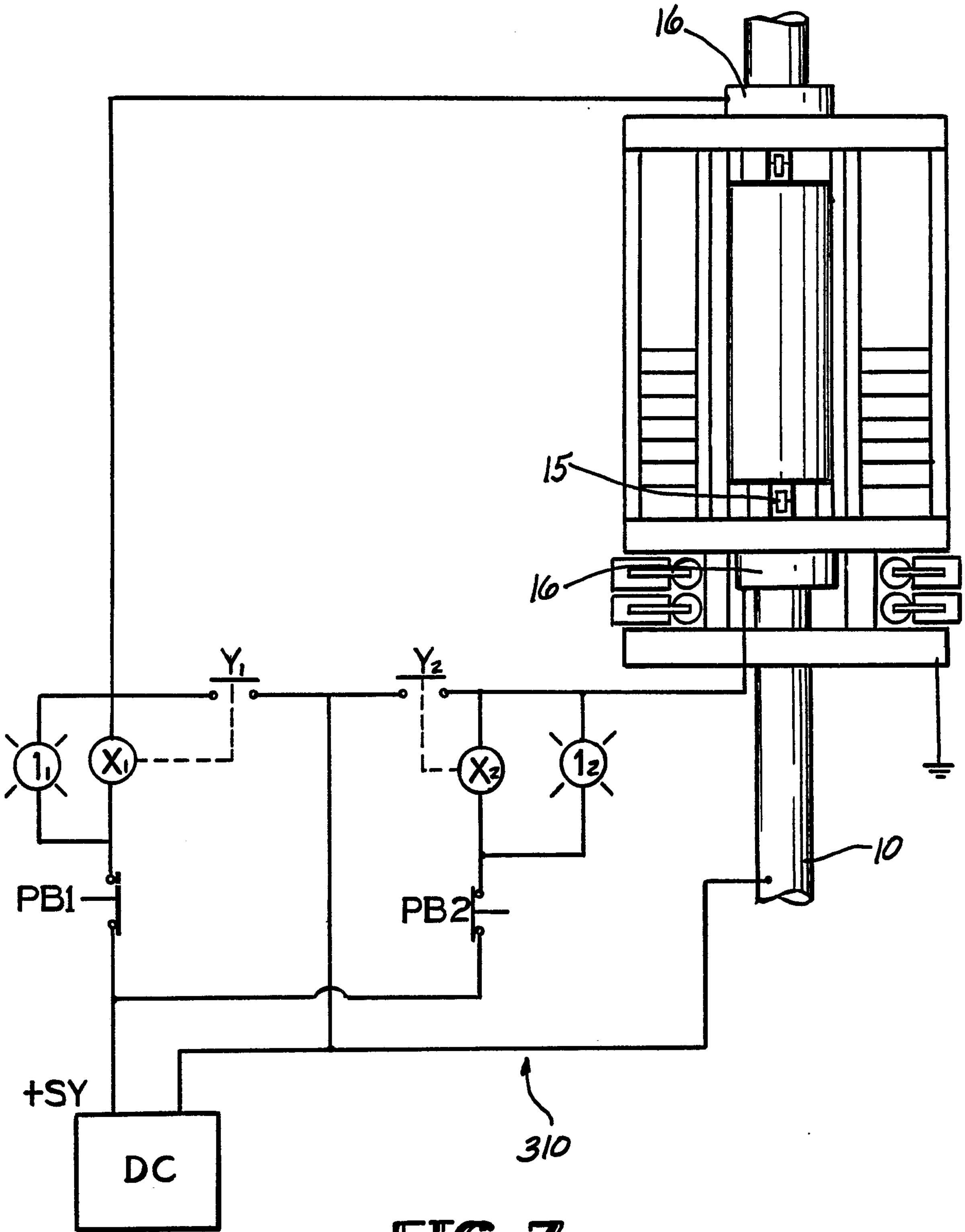


FIG-7

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# EUROPEAN SEARCH REPORT

Application Number

EP 89 12 2702

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5 ) |
|---|---|---|---|
| X | EP-A-0048847 (OTIS ELEVATOR COMPANY)<br>* page 5, lines 9 - 22; figures 1, 2 *<br>--- | 1 | B66B11/00<br>B66B11/04 |
| A | US-A-4570753 (OHTA ET AL)<br>* column 2, line 55 - column 3, line 33; figure 2 *<br>--- | 1 | |
| A | DE-A-3422374 (HEIDENREICH)<br>* page 5, lines 29 - 33 *<br>* page 6, lines 19 - 31; figures 1, 2 *<br>--- | 1 | |
| A | US-A-4012654 (MIHAILO STARCEVIC)<br>* column 1, line 9 - column 2, line 25; figure 5 *<br>--- | 1 | |
| A | US-A-3641832 (SHIGETA ET AL)<br>* column 2, line 63 - column 3, line 61; figures 5-7 *<br>----- | 1 | |
| | | | **TECHNICAL FIELDS SEARCHED (Int. Cl.5 )** |
| | | | B66B<br>H02K |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 14 MARCH 1990 | CLEARY F.M. |

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### CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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