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(54) Levelling for double deck elevator car

(57) The double deck elevator car possesses a first elevator car (**23a**) and a second elevator car (**23b**) positioned in the vertical direction inside an outer frame (**11**). The car frame (**11**) is raised and lowered via suspension cables (**16**). Transmission members (**19**) possessing first screw shafts (**19a**), which engage with a car frame (**22a**) that supports the first elevator car (**23a**), and second screw shafts (**19b**), which engage with a car frame (**22b**) that supports the second elevator car (**23b**), are provided on the outer frame (**11**) so that they are free to rotate. The first screw shafts (**19a**) and the second screw shafts (**19b**) are formed with threads that are mutually opposite, and are driven by drive motors (**17**). The gap between the two elevator cars (**23a**) and (**23b**) is adjusted by rotating the transmission members (**19**).

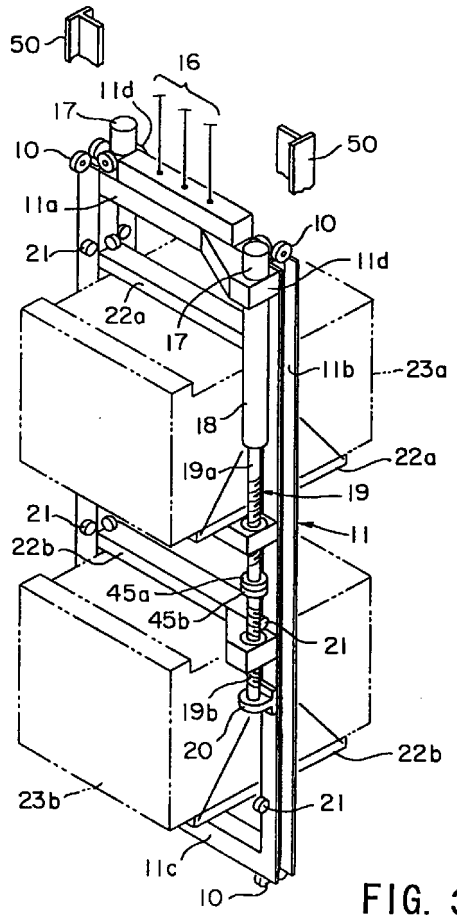

FIG. 3

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a double deck elevator car that has two elevator cars, one above the other, and may vary the gap between the elevator cars.

2. Description of the Related Art

[0002] In recent years, the need has intensified for elevator cars having two elevator cars provided in the vertical direction (double deck elevator cars) in order to increase transport capability in the vertical direction of ultra-high-rise buildings. Also, when it comes to ultra-high-rise buildings, the first floor height is often higher than that of normal floors because the first floor is an entrance hall or a lobby and the first floor is often used for ventilation, and so it is not possible to use a double deck elevator car in which the gap between the upper and lower elevator cars is fixed.

[0003] Therefore, there have been several proposals relating to double deck elevator cars that may vary the gap between the upper and lower elevator cars to respond to such a need. As an example, as shown in FIG.1, outer frame **3**, that incorporates upper and lower elevator cars **4** and **5**, is raised and lowered by hoist **2** provided above hoistway **1**. One or other of elevator cars **4** and **5** is raised or lowered in relation to outer frame **3** by a drive source for motors or the like provided in this outer frame **3** (Laid-Open Patent No. Showa 48-5384).

[0004] Also, as shown in FIG.2, a mechanism has been proposed (Laid-Open Patent No. Heisei 10-279231) that varies the gap between upper and lower elevator cars **4** and **5** by pantograph mechanism **6** that has its fulcrum on central beam **3a** of outer frame **3**.

[0005] In the above-mentioned double deck elevator car shown in FIG.1, while adjustment for floor heights is possible, to raise or lower one elevator car **4** or **5** in relation to outer frame **3** requires a large capacity drive means (device). On the other hand, the variable double deck elevator car shown in FIG.2 achieves a balance between the upper and lower cars by pantograph mechanism **6**, and the capacity required for the drive is kept smaller. However, there is a requirement to strengthen outer frame **3** and, even within it, central beam **3a** that supports the fulcrum of pantograph mechanism **6** must be strongly-built to support the combined weight of upper and lower car compartments **4** and **5**. Thus the overall outer frame becomes larger and space efficiency becomes poorer.

SUMMARY OF THE INVENTION

[0006] Accordingly, taking such points into consideration, one object of the present invention is to provide a novel double deck elevator car that, being a double deck elevator car having two elevator cars, may easily and simply vary the gap between the elevator cars.

[0007] To achieve the above object, the present invention has the following composition.

[0008] That is to say, in a double deck elevator car having a first elevator car and a second elevator car arranged in the vertical direction, the present invention is a double deck elevator car that has the characteristic of being equipped with:

a carrier (supporting member) that is raised and lowered via suspension cables passing over a hoist; transmission members that comprises:

first screw shafts that are provided in this supporting body so that they are free to move and that engage with engagement units on the first elevator car;
and
second screw shafts that are coupled to the first screw shafts and engage with engagement units on the second elevator car and, at the same time, of which the screw threads are cut in the opposite direction to those of the first screw shafts; and

drive mechanisms (devices) that are secured to the carrier and drive these transmission members in rotation.

[0009] When using the present invention, since the loads of both elevator cars are supported by the carrier, the car itself as a whole may be lightened and made smaller by strengthening the carrier alone. Also, since the screw thread direction of the first screw shafts for supporting the weight of the first elevator car and the screw thread direction of the second screw shafts for supporting the weight of the second elevator car are opposite, the first elevator car and the second elevator car play the roles of mutual counterweights. Thus, the capacity of the driving mechanisms may be made smaller.

[0010] The present invention is a double deck elevator car that has the characteristic of, at least, the first elevator car engagement units or the second elevator car engagement units having:

nuts that engage with the first screw shafts or the second screw shafts;
and
couplings that restrain the rotational movement of the nuts but permit horizontal transfer of the nuts.

[0011] When using the present invention, no excessive force will operate on the transmission members during movement of the first elevator car and the second elevator car in the vertical direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG.1 is a drawing showing a prior art elevator car;
FIG.2 is a drawing showing a prior art elevator car;
FIG.3 is an overall block diagram showing a first embodiment of an elevator car according to the present invention.
FIG.4 is an illustration of the operation of the elevator;
FIG.5 is a detail drawing of the vicinity of the upper beam of the elevator car;
FIG.6 is a detail drawing showing a drive mechanism (device) of the elevator car;
FIG.7 is a detail drawing showing a nut and coupling of the elevator car;
FIG.8 is a block diagram showing a second embodiment of an elevator car according to the present invention;
FIG.9 is a drawing showing a modification of the second embodiment of an elevator car according to the present invention; and
FIG.10 is a block diagram showing a third embodiment of an elevator car according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

[0013] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG.3 thereof, one embodiment of the present invention will be described.

[0014] FIG.3 to FIG.7 are drawings showing a first embodiment of a double deck elevator car according to the present invention.

[0015] As shown in FIG.3 to FIG.5, the double deck elevator car possesses first elevator car **23a** and second elevator car **23b** that are consecutively arranged in the vertical direction inside hoistway **1**. When first elevator car **23a** in the upper position stops at upper floor **41**, second elevator car **23b** in the lower position stops at lower floor **42**. Also, so that it may respond to cases where the distance between upper floor **41** and lower floor **42** varies, the double deck elevator car may vary the gap between first elevator car **23a** and second elevator car **23b**.

[0016] That is to say, with the double deck elevator car, outer frame (carrier or supporting member is sometimes used) **11** and balance weight **15** are suspended via suspension cables **16** that pass over traction sheave **13** of hoist **12** and deflector sheave **14**, and are raised and lowered by the rotational drive of hoist **12**. Of these, outer frame **11** and balance weight (counterweight) **15** are arranged inside hoistway **1**, while hoist **12**, having traction sheave **13**, and deflector sheave **14** are positioned in machinery room **2** provided above hoistway **1**.

[0017] Also, above-mentioned first elevator car **23a** and second elevator car **23b** are supported in the vertical direction, so that they are free to move, in outer frame **11**.

[0018] Next, outer frame **11** and the support structures for first elevator car **23a** and second elevator car **23b** will be described. Outer frame **11** has upper beam **11a** that is connected via pitch springs (not shown) to the ends of suspension cables **16**, vertical beams **11b** that are connected to upper beam **11a** and extend perpendicularly downward, and lower beam **11c** that connects the lower ends of vertical beams **11b**. Furthermore, it has a pair of support beams **11d** that are secured to upper beam **11a** and protrude in mutually opposite directions. A drive motor (driving mechanism) **17** is supported on each of the pair of support beams **11d** out of the above.

[0019] A transmission member **19**, having first screw shaft **19a** that is protected by housing **18** secured to support beam **11d** and second screw shaft **19b** connected to this first screw shaft **19a**, is provided for each drive motor **17**. First screw shaft **19a** and second screw shaft **19b** are connected via respective flanges **45a** and **45b**. Also, the lower end of second screw shaft **19b** is supported, so that it is free to rotate, by support **20** secured to vertical beam **11b**.

[0020] Also, first screw shafts **19a** and second screw shafts **19b** are formed by cutting their respective screw threads in opposite directions, and compose inverse helical relationships with each other. Moreover, nuts **25a** of car frame **22a** that supports first elevator car **23a** engage with first screw shafts **19a**, and nuts **25b** of car frame **22b** that supports second elevator car **23b** engage with second screw shafts **19b**. In this way, first elevator car **23a** and second elevator car **23b** are respectively supported via car frames **22a** and **22b** by first screw shafts **19a** and second screw shafts **19b**.

[0021] Also, guidance devices **10**, having guide rollers that engage with a pair of main guide rails **50** provided in hoistway **1**, are mounted at four places at the upper and lower left and right of outer frame **11**. Guidance of outer frame **11** is performed by guidance devices **10** engaging with main guide rails **50**. Moreover, guidance devices **21**, that engage with each vertical beam **11b** of outer frame **11**, are mounted at four places

at the upper and lower left and right of each of car frames **22a** and **22b**. Furthermore, counter-weight **15** also has guidance devices that engage with a pair of sub-guide rails (not illustrated).

[0022] Next, the drive mechanisms for first elevator car **23a** and second elevator car **23b** will be explained, using FIG.6 and FIG.7. In FIG.6, output shaft **17a** of drive motor **17**, which is secured to support beam **11d**, is connected to first screw shaft **19a** via tie shaft **26**. In this case, first screw shaft **19a** is protected by housing **18** secured to support beam **11d**, and is also supported in housing **18** via bearing **28**, so that it is free to rotate. Moreover, flange **45b** of second screw shaft **19b**, on which the screw thread is cut in the reverse direction to that of first screw shaft **19a**, is coupled to flange **45a** on the lower end of screw shaft **19a**. The lower end of screw shaft **19b** is supported via bearing **48**, so that it is free to rotate, in support **20** provided on vertical beam **11b**.

[0023] Also, nuts **25a** and **25b** that engage with first screw shaft **19a** and second screw shaft **19b** are coupled to couplers **46** that have translation freedom. These couplers **46** are composed by rectangular blocks **29** in which nuts **25a** and **25b** are anchored; sliders **30** with rectangular external shapes and having rectangular holes that give sliding support to rectangular blocks **29** in one direction; mounting members **31** having rectangular holes that give sliding support to sliders **30** in the direction orthogonal to the sliding direction of rectangular blocks **29** and covers **32** provided in the vertical direction of mounting members **31**. Couplers **46** are provided on each of car frame **22a** of first elevator car **23a** and car frame **22b** of second elevator car **23b**. The design is that, should slight displacement occur in the horizontal direction between first elevator car **23a** and second elevator car **23b** and transmission members **19**, that displacement may be absorbed by couplers **46**. The engagement units of first elevator car **23a** and second elevator car **23b** are composed by couplers **46** and nuts **25a** and **25b**.

[0024] Next, the operation of an embodiment with this composition will be described. First, when hoist **12** is driven, outer frame **11** ascends or descends along guide rails **50** by means of suspensions cable **16** that pass over sheaves **13** and **14**. At this time, for example, right-hand torques are applied to first screw shafts **19a** via nuts **25a** by the weight of first elevator car **23a** and car frame **22a**. At the same time, left-hand torques are applied to screw shafts **19b**, which are directly coupled to first screw shafts **19a**, via nuts **25b** by the weight of second elevator car **23b** and car frame **22b**. At this time, when the weights of the two elevator cars **23a** and **23b**, the weights of the two car frames **22a** and **22b** and the screw pitches of the screw shafts **19a** and **19b** are respectively equal, then the torques on first screw shafts **19a** and second screw shafts **19b** cancel each other, and the positions of the two elevator cars **23a** and **23b** may be kept constant, even without outputting torques from drive motors **17**.

[0025] Also, the weights of the two elevator cars **23a** and **23b** and of the two car frames **22a** and **22b** are all applied to support beam **11c**, which is secured to upper beam **11a**, via first screw shafts **19a** and second screw shafts **19b**. Therefore, no structural problems will arise if only upper beam **11a** of outer frame **11** is strengthened.

[0026] Next, the operation of varying the gap between first elevator car **23a** and second elevator car **23b** will be described. First, when each driving motor **17** is rotated, each transmission member **19** rotates and, for example, car frame **22a**, having nuts **25a** that engage with first screw shafts **19a**, ascends while car frame **22b**, having nuts **25b** that engage with second screw shafts **19b**, descends. At this time car frames **22a** and **22b** move in vertical directions guided along vertical beams **11b** of outer frame **11** by guidance devices **21**.

[0027] First elevator car **23a** and second elevator car **23b** move in vertical directions in accompaniment to the movements in the vertical direction of car frames **22a** and **22b**. Thus, the gap between the two car s **23a** and **23b** varies from **h** to **h'** and it becomes possible for each of car s **23a** and **23b** to arrive at floors **41** and **42** that have differing floor heights.

[0028] Also, when the weights of first elevator car **23a** and second elevator car **23b**, or of car frames **22a** and **22b**, are unequal, or when it is desired to alter the movement distances of upper and lower car s **23a** and **23b**, these situations may be coped with by changing the pitches of first screw shafts **19a** and second screw shafts **19b**.

[0029] For example, by reducing the pitch of first screw shafts **19a** and making the pitch of second screw shafts **19b** greater, it is possible to narrow the overhead dimension when the two elevator cars **23a** and **23b** are brought close to each other.

[0030] Also, should a slight deviation (displacement) in the horizontal direction occur between screw shafts **19a** and **19b** and elevator cars **23a** and **23b** when causing ascent or descent by rotating screw shafts **19a** and **19b**, no excessive transverse load will be applied to screw shafts **19a** and **19b** because, even though there may be a slight change within the horizontal plane in the positions of car frames **22a** and **22b** in relation to nuts **25a** and **25b**, sliding will occur in the horizontal plane in two mutually orthogonal directions between rectangular blocks **29** and sliders **30** and between sliders **30** and mounting members **31**. Moreover, drive with little friction and good efficiency becomes possible if ball threads are used in screw shafts **19a** and **19b** and nuts **25a** and **25b**. Furthermore, by arranging the positions of drive motors **17** and screw shafts **19a** and **19b** in point symmetry in relation to the centers of gravity of first elevator car **23a** and second elevator car **23b**, well-balanced drive becomes possible.

[0031] When using this embodiment, by driving first

elevator car **23a** and second elevator car **23b** in relation to outer frame **11**, which is guided by guide rails, using screw shafts **19a** and **19b**, which are directly coupled on the same axis but of which the respective threads are cut in different directions, it is possible easily and simply to adjust the gap between elevator cars **23a** and **23b**.

Second Embodiment

[0032] Next, a second embodiment of an elevator car according to the present invention will be described using FIG.8 and FIG.9.

[0033] The embodiment shown in FIG.8 and FIG.9 is one in which, in the first embodiment shown in FIG.3 to FIG.7, reduction gears **33** are provided between each drive motor **17** and screw shafts **19a** and **19b** (FIG.8), or only a single drive motor **17** is provided and the motive power of this drive motor **17** is transmitted to the other drive mechanism **51** via toothed belt **34** (FIG.9). In FIG.8 and FIG.9, parts that are identical to those of the first embodiment shown in FIG.3 to FIG.7 have been assigned identical reference numerals and their detailed descriptions have been omitted.

[0034] In FIG.8, since the speed of revolution of screw shafts **19a** and **19b** may be kept low by providing reduction gears **33**, it is easy to avoid the critical speed that becomes a problem when long screwed rods **19** are used.

[0035] Also, in FIG.9, since there is only one drive motor **17**, there is no need to consider controls such as guaranteeing the synchronization of two drive motors.

Third Embodiment

[0036] Next, a third embodiment of an elevator car according to the present invention will be described using FIG.10. This embodiment provides suspension beam **35** as the carrier in place of outer frame **11**. In FIG.10, parts that are identical to those of the first embodiment shown in FIG.3 to FIG.7 have been assigned identical reference numerals and their detailed descriptions have been omitted.

[0037] In FIG.10, suspension beam **35** is provided at the end of suspension cables **16**, and guidance devices **10** that guide it on guide rails **50** are provided at the upper and lower, left and right four corners of suspension beam **35**. Also, supports **36** project in mirror-image directions to the left and right at the two ends of suspension beam **35**, and each supports a drive motor **17**. First screw shafts **19a** are supported below the two supports **36** protected in housings **18**. Second screw shafts **19b**, with their threads cut in the opposite direction to those of first screw shafts **19a**, are coupled to first screw shafts **19a** by flanges **45a** and **45b**. Stoppers **37** are secured at the lower ends of second screw shafts **19b**. Also, first car frame **22a** supports first elevator car **23a** and, at the same time, has nuts **25a** that engage with first screw shafts **19a**. Guidance devices **21** that guide it on main guide rails **50** are provided on the upper and lower four corners of car frame **22a**. Moreover, second car frame **22b** supports first elevator car **23b** and, at the same time, has nuts **25b** that engage with second screw shafts **19b**. Guidance devices **21** that guide it on main guide rails **50** are provided on the upper and lower four corners of car frame **22b**.

[0038] The drive mechanisms for elevator cars **23a** and **23b** are the same as in the first embodiment (see FIG.6), and output shafts (drive shafts) **17a** of drive motors **17** are coupled, via tie shafts **26**, to first screw shafts **19a**, which are supported so that they are free to rotate by bearings **28** in housings **18**. Moreover, second screw shafts **19b**, of which the screw threads are cut in the opposite direction, are coupled to first screw shafts **19a** via flanges **45a** and **45b**, and stoppers **37** are provided at the lower ends of second screw shafts **19b**.

[0039] Also, nuts **25a** and **25b** that engage with screw shafts **19a** and **19b** are coupled by couplers **46** that have translation freedom and are composed by rectangular blocks **29** in which nuts **25a** and **25b** are anchored; sliders **30** with rectangular external shapes and having rectangular holes that give sliding support to rectangular blocks **29** in one direction; mounting members **31** having rectangular holes that give sliding support to sliders **30** in the direction orthogonal to the sliding direction of rectangular blocks **29** and covers **32** provided in the vertical direction of mounting members **31**. Couplers **46** are coupled to car frame **22a** of first elevator car **23a** and car frame **22b** of second elevator car **23b**.

[0040] In FIG.10, suspension beam **35** is provided in place of outer frame **11** as the carrier. Therefore, outer frame **11** becomes unnecessary, and, in the case of the same size of hoistway, larger-sized elevator cars **23a** and **23b** may be provided.

[0041] When using the present invention as described above, by driving the first elevator car by means of first screw shafts that are driven in rotation and driving the second elevator car by means of second screw shafts that are co-axially coupled to, and of which the screw threads are cut in the opposite direction to, the first screw shafts, it becomes possible to adjust the gap between the upper and lower elevator cars with an energy-saving and space-saving construction.

[0042] Also, by using ball threads for the first screw shafts and the second screw shafts, it becomes possible very efficiently to drive the elevator cars.

[0043] Moreover, by driving the respective elevator cars with screw shafts of different pitches, in cases where the weights of the upper and lower elevator cars are not equal, or when it is not possible uniformly to move the upper and lower elevator cars due to hoistway shaft dimensions or the like, it is possible efficaciously to adjust the gap between the elevator cars.

[0044] Furthermore, by supporting the nuts that engage with the screw shafts with couplings that are restricted only in the direction of rotation but may move

horizontally, no excessive force is applied to the transmission members.

[0045] Still further, by arranging the transmission members in positions that are in point symmetry with the centers of gravity of the first elevator car and the second elevator car, it is possible stably to drive the elevator cars.

[0046] Yet further, by providing a single drive mechanism, it is possible to drive a pair of transmission members in synchronization, and it is possible stably to drive the elevator cars.

[0047] Again, by guiding the elevator cars along the outer frame, it is possible stably to drive the elevator cars.

[0048] Yet again, by providing a suspension beam in place of an outer frame, it is possible to provide larger-sized elevator cars.

[0049] Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the present invention may be practised otherwise than as specifically described herein.

Claims

1. A double deck elevator car having a first elevator car and a second elevator car that are arranged in the vertical direction, comprising:

a carrier that is suspended via suspension cables that pass over a hoist;
transmission members that comprises:

first screw shafts that are provided in said carrier so that said first screw shafts are free to move and that engage with first engagement units on said first elevator car;
second screw shafts that are coupled to said first screw shafts and engage with second engagement units on said second elevator car and, at the same time, of which screw threads are cut in the opposite direction to directions of said first screw shafts; and drive mechanisms that are secured to the carrier and

that drive these transmission members in rotation.

2. A double deck elevator car according to Claim 1, wherein:

said first engagement units of said first screw shafts and said first elevator car are ball thread construction; and
said second engagement units of said second screw shafts and said second elevator car are ball thread construction.

3. A double deck elevator car according to Claim 1, wherein:

pitches of said first screw shafts and said second screw shafts are different from each other.

4. A double deck elevator car according to Claim 1, at least, said first elevator car engagement units or said second elevator car engagement units further comprising:

nuts that engage with said first screw shafts or said second screw shafts; and
couplers that restrict rotational movement of said nuts, but permit horizontal movement of said nuts.

5. A double deck elevator car according to Claim 1, wherein:

a pair of said transmission members are arranged in point symmetry with the center of gravity of said first elevator car and said second elevator car when seen in plan view.

6. A double deck elevator car according to Claim 5, wherein:

said pair of transmission members being driven by a single drive mechanism.

7. A double deck elevator car according to Claim 1,

said carrier further comprising:
an outer frame that surrounds said first elevator car and said second elevator car, wherein said first elevator car and said second elevator car are guided in the vertical direction along said outer frame.

8. A double deck elevator car according to Claim 1,

said carrier further comprising:
a suspension beam that is positioned above said first elevator car and said second elevator car.

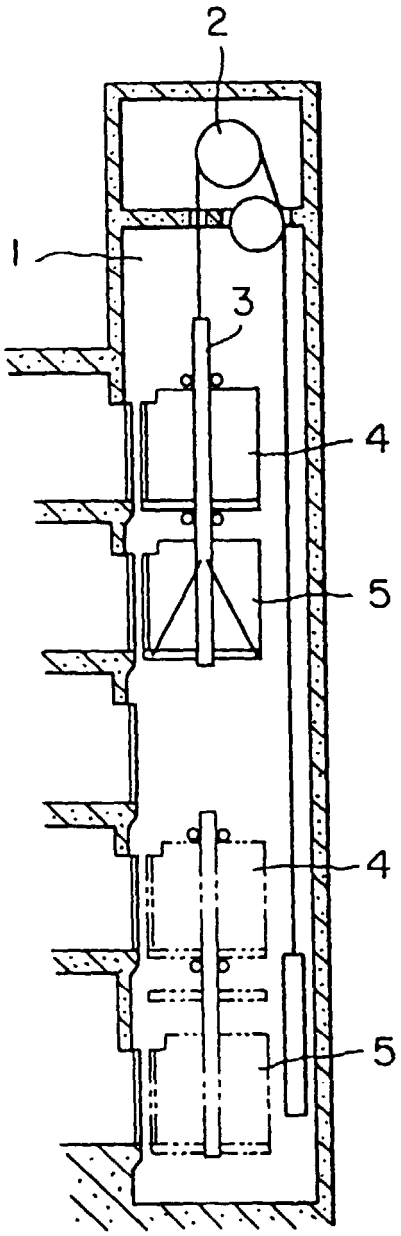

FIG. 1 (PRIOR ART)

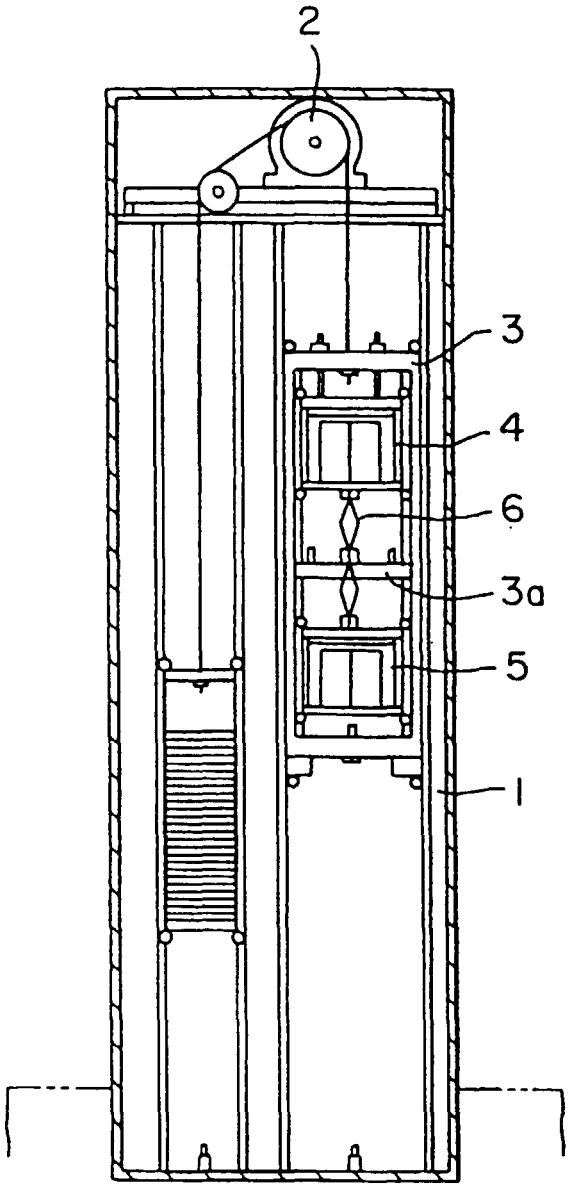

FIG. 2 (PRIOR ART)

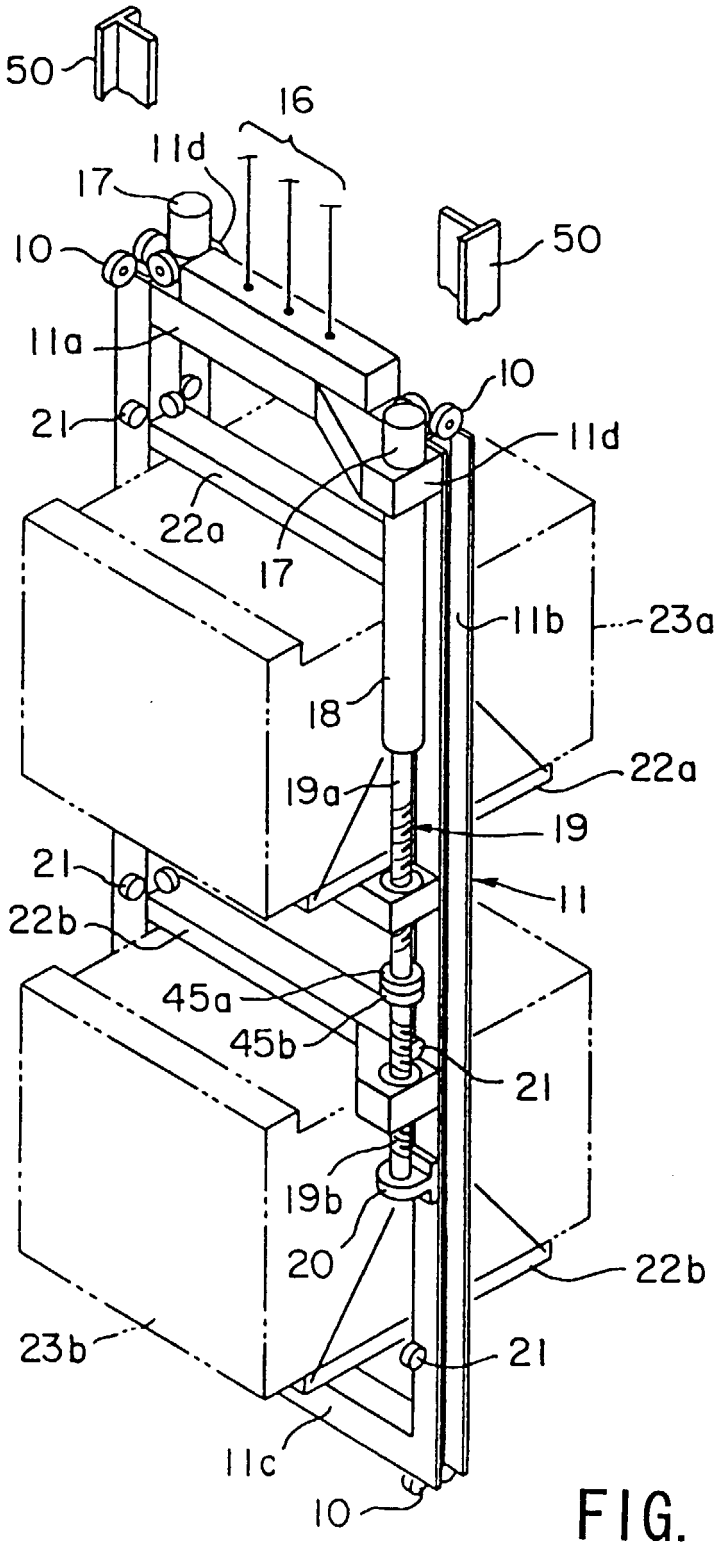
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FIG. 3

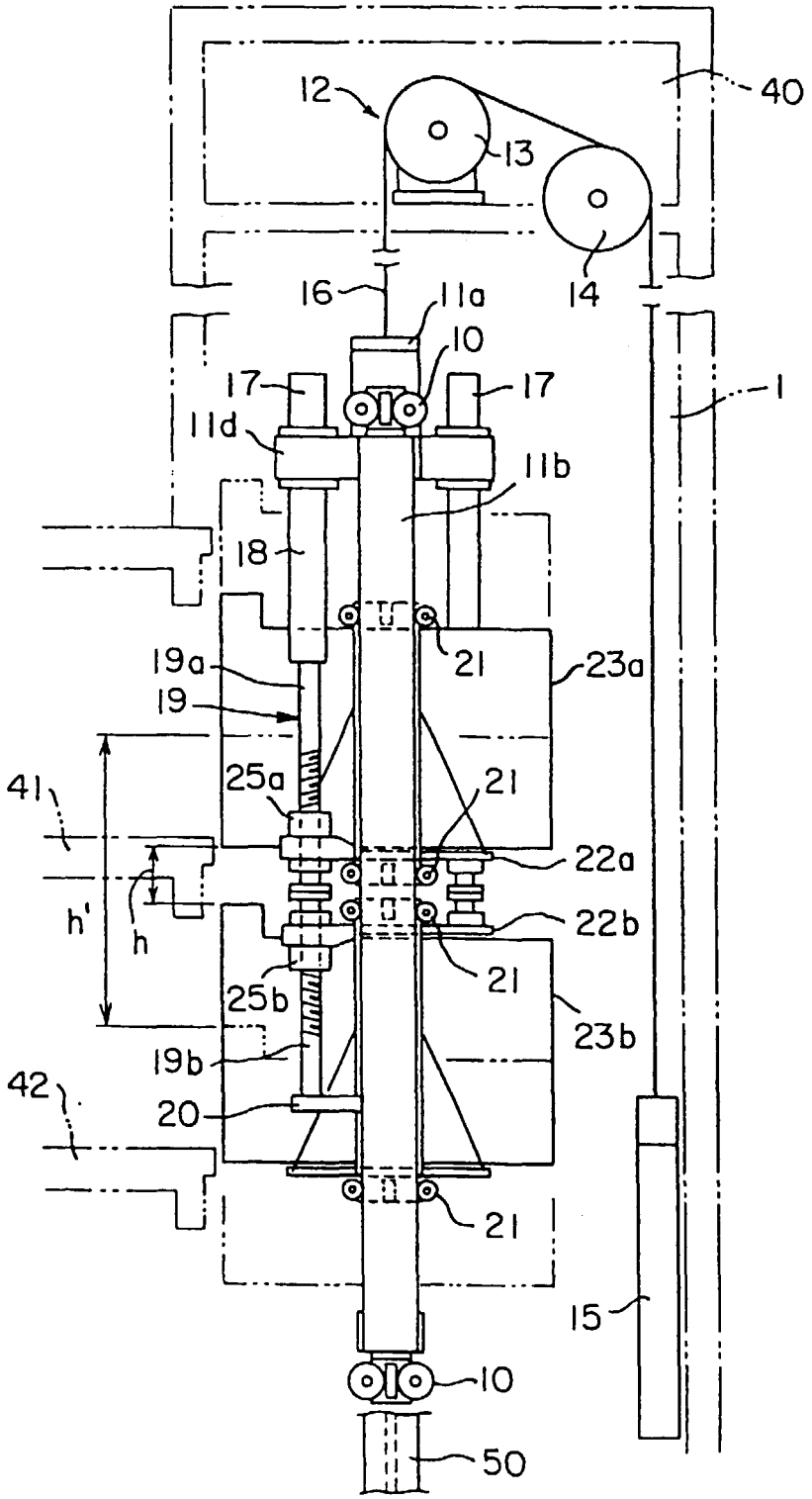
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FIG. 4

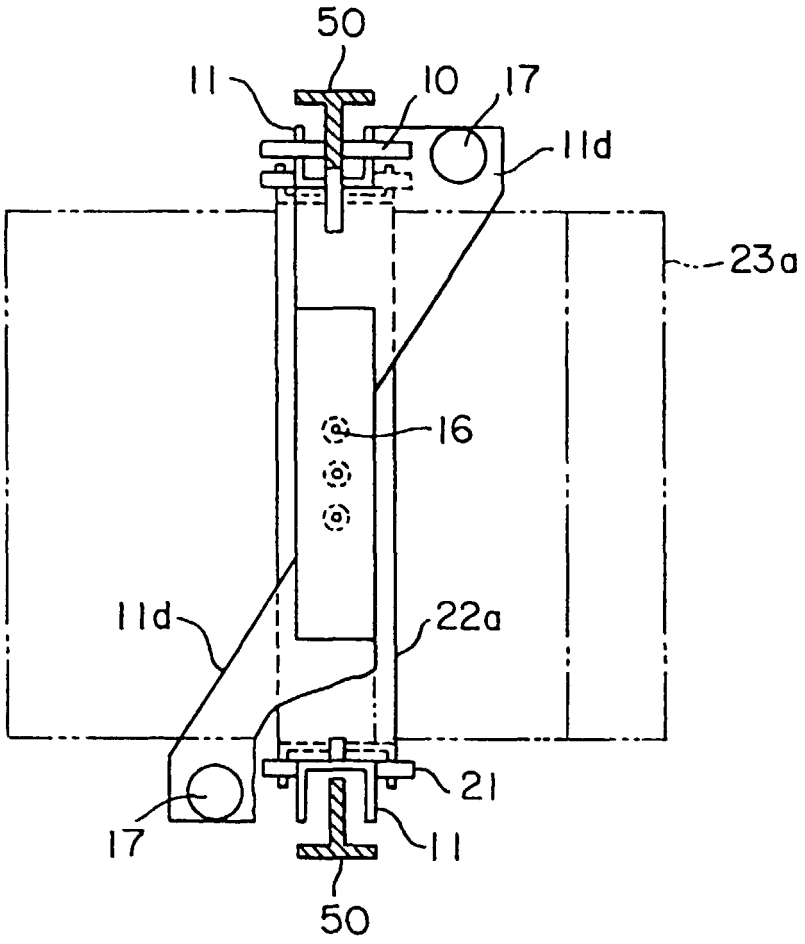

FIG. 5

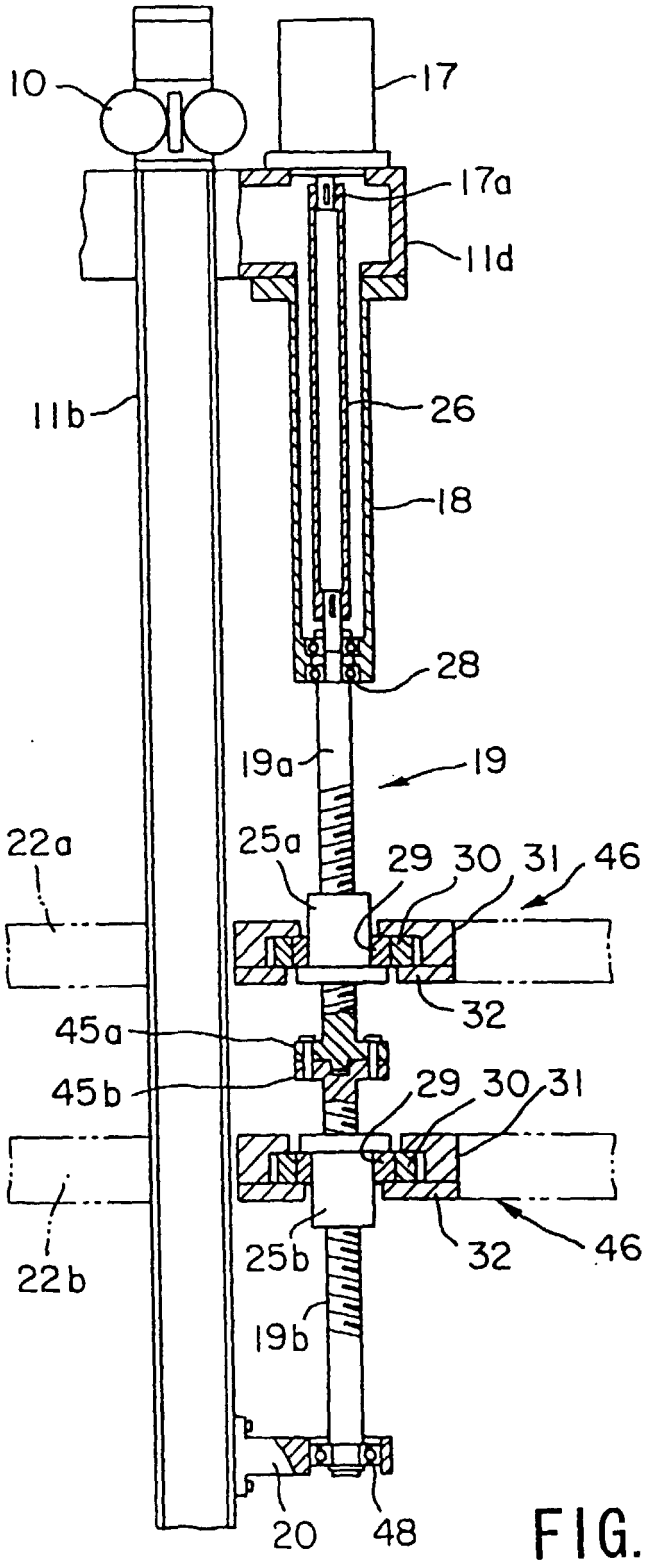
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FIG. 6

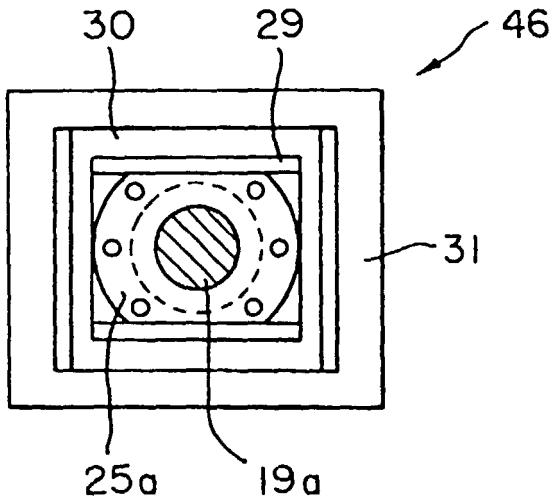
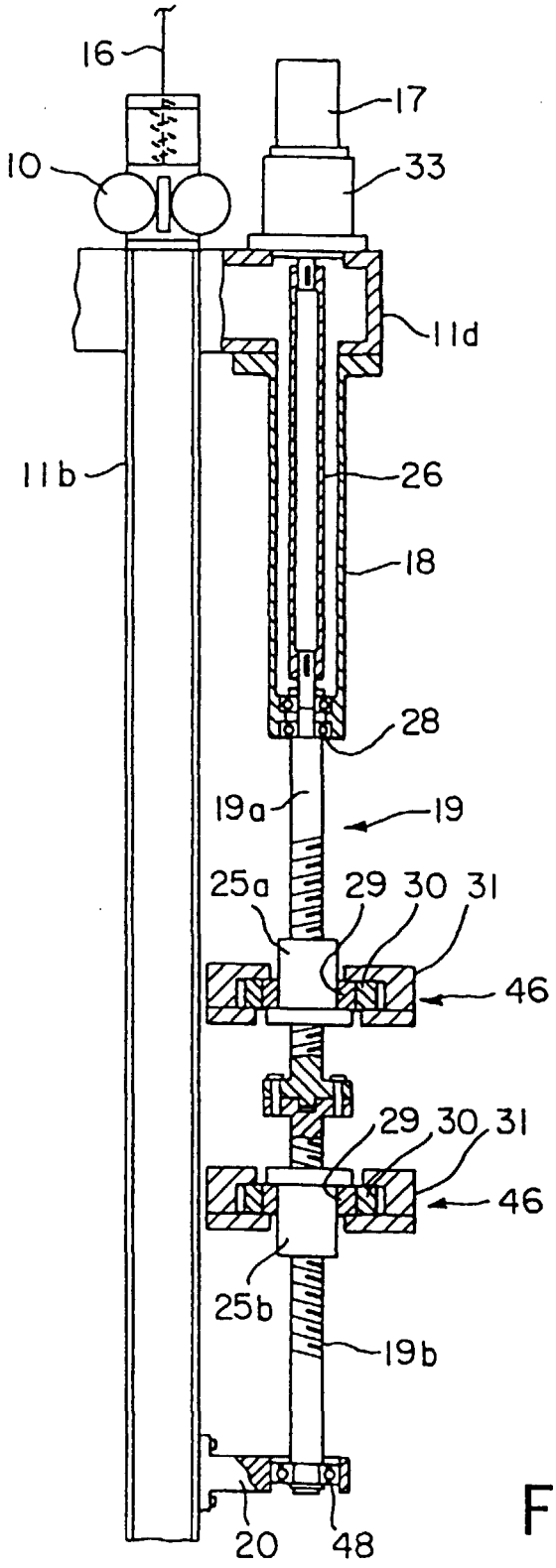


FIG. 7


16
17
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33
11d
11b
26
18
28
19a
19
25a
29 30 31
46
29 30 31
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25b
19b
20
48

FIG. 8

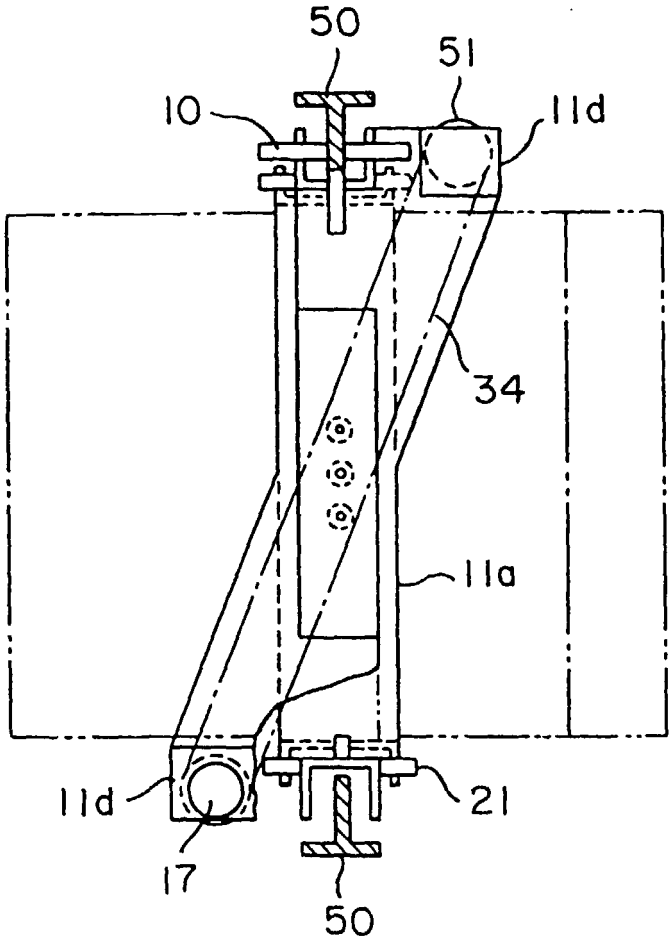
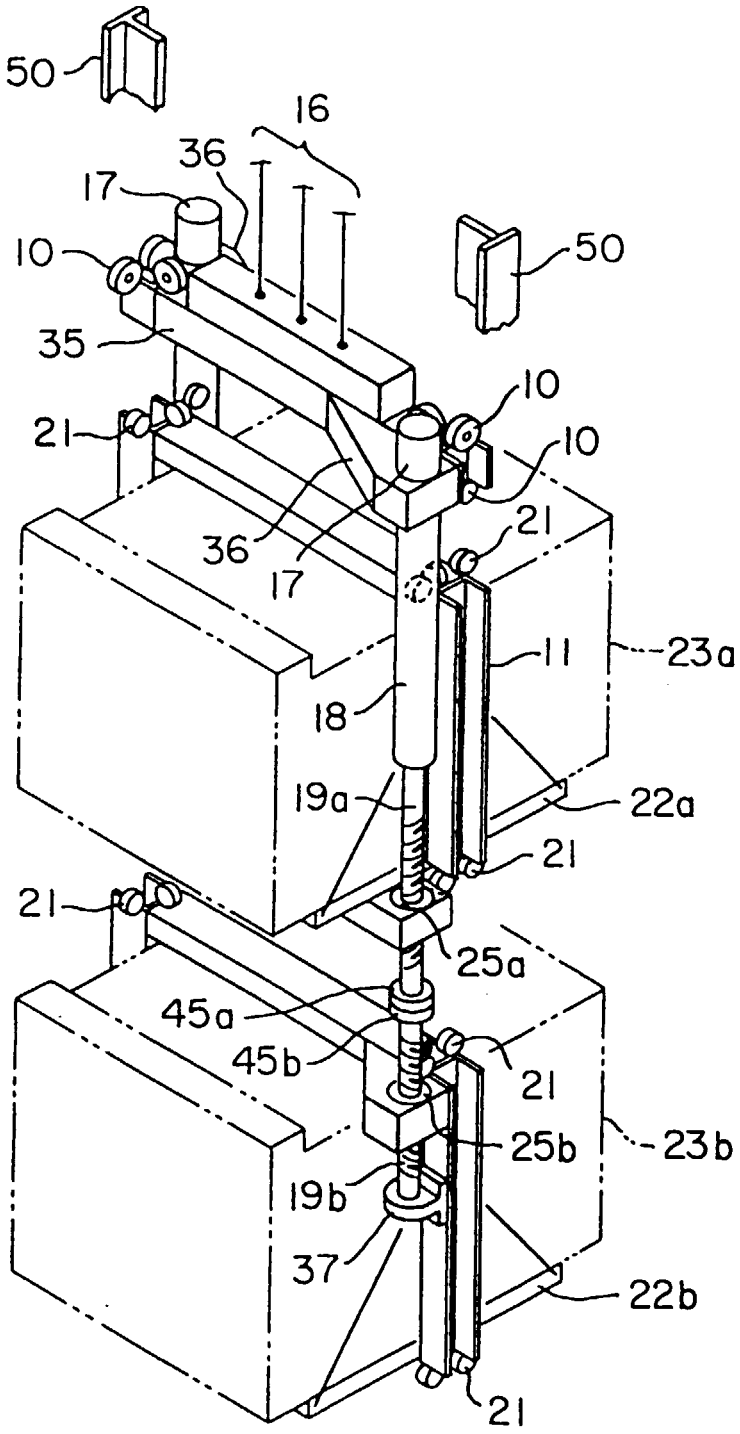


FIG. 9


50
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21
11
23a
18
19a
22a
21
21
25a
45a
45b
21
25b
23b
19b
37
22b
21

FIG. 10