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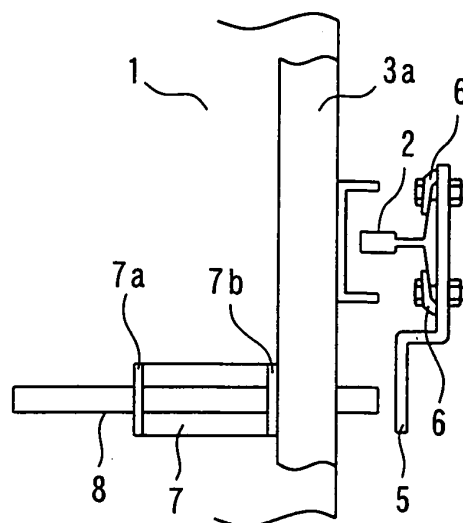
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(54) **ELEVATOR DEVICE**

(57) There is provided an elevator apparatus in which the rising of a car moving vertically in an elevator shaft to above a predetermined height is restricted mechanically by a simple method, by which a predetermined space is formed above the car at the time of elevator maintenance work, and thereby the safety of a maintenance worker can be ensured reliably. For this purpose, a locking element is provided on a shaft fixing body at the predetermined height, and an engaging portion is pro-

vided on the top of the car, the engaging portion being configured so that the arrangement thereof can be switched between a position at which the engaging portion interferes with a part of the locking element on the vertical projection plane at the time of elevator maintenance work and a position at which the engaging portion does not interfere with the locking element on the vertical projection plane at the time of the normal operation of elevator by an operation on the top of the car.

**Fig. 2**



## Description

### Technical Field

**[0001]** The present invention relates to an elevator apparatus provided with a safety device for ensuring the safety of an elevator maintenance worker.

### Background Art

**[0002]** At the time of elevator maintenance work, an elevator maintenance worker gets on the top of a car moving vertically in an elevator shaft to perform maintenance work and inspection work for elevator equipment provided in the shaft. Therefore, a space sufficient for the maintenance work is generally secured between the car and the ceiling surface of the shaft to prevent the maintenance worker from colliding with the ceiling surface of the shaft during the maintenance work even in the case where the car stops at the uppermost position. However, in some elevator apparatus that meet a recent demand for space saving as in the case of a machine room-less elevator in which the elevator equipment is arranged in the shaft, a sufficient space necessary for the maintenance work cannot be secured above the car when the car stops at the uppermost position. In such an elevator apparatus, a safety device for mechanically restricting the rising of the car at the time of elevator maintenance work is mounted to ensure the safety of maintenance worker.

**[0003]** As a conventional art of elevator apparatus provided with the safety device, a technique has been proposed in which at the time of elevator maintenance work, one end portion of a connecting member is fixedly connected to an upper part of a car guide rail for guiding the car in the elevation direction, and the other end portion thereof is fixedly connected to a car frame of the car, by which the car is fixed to the car guide rail to restrict the vertical movement of the car (for example, refer to Patent Document 1).

**[0004]** Also, as another conventional art, a technique has also been proposed in which at the time of elevator maintenance work, a counterweight inhibiting means is mounted on a counterweight buffer to inhibit the lowering of a counterweight at a predetermined position above an inhibition position at the time of normal operation, by which the rise of the car is restricted at a predetermined position below a restriction position at the time of normal operation to secure a space necessary for maintenance work between the car and the ceiling surface of the shaft (for example, refer to Patent Document 2).

Patent Document 1: Japanese Patent Laid-Open No. 2004-59216

Patent Document 2: Japanese Patent Laid-Open No. 2003-155176

## Disclosure of the Invention

### Problems to be Solved by the Invention

**[0005]** In the elevator apparatus provided with the safety device described in Patent Document 1, it is necessary to raise the car in a state in which the maintenance worker is on the top of the car until the connecting member is fixed between the upper part of the car guide rail and the car frame at the time of elevator maintenance work. In this case, the rising speed of car before the connecting member is mounted must be decreased extremely to ensure the safety of maintenance worker. Also, there arises a problem in that labor and time are required for the height adjustment of car and the work for fixing the connecting member, which decreases the work efficiency.

**[0006]** Also, in the elevator apparatus provided with the safety device described in Patent Document 2, as work of the maintenance worker before the worker gets on the top of the car, a large number of steps of entering into a shaft pit, mounting the counterweight inhibiting means in the shaft pit, and moving from the shaft pit to a floor from which the worker can get on the top of the car, and the like must be performed. Therefore, there arises a problem in that time is taken to make preparation before the maintenance work, so that the work efficiency is decreased.

**[0007]** The present invention has been made to solve the above problems, and accordingly an object thereof is to provide an elevator apparatus in which at the time of elevator maintenance work, the rising of a car to above a predetermined height is restricted by a simple operation, by which the safety of maintenance worker can be ensured reliably.

### Means for Solving the Problems

**[0008]** An elevator apparatus related to the present invention comprises a safety device which mechanically restricts the rising of a car moving vertically in an elevator shaft to above a predetermined height to secure a predetermined space above the car when elevator maintenance work is performed, and the safety device comprises a locking element provided on a shaft fixing body at the predetermined height; and an engaging portion which is provided on the car and is arranged, by an operation on a top of the car, at a position at which the engaging portion interferes with a part of the locking element on the vertical projection plane when elevator maintenance work is performed and at a position at which the engaging portion does not interfere with the locking element on the vertical projection plane when the normal operation of elevator is performed.

### Effect of the Invention

**[0009]** The present invention provides an elevator ap-

paratus comprising a safety device which mechanically restricts the rising of a car moving vertically in an elevator shaft to above a predetermined height to secure a predetermined space above the car when elevator maintenance work is performed, configured so that the safety device comprises a locking element provided on a shaft fixing body at the predetermined height; and an engaging portion which is provided on the car and is arranged, by an operation on a top of the car, at a position at which the engaging portion interferes with a part of the locking element on the vertical projection plane when elevator maintenance work is performed and at a position at which the engaging portion does not interfere with the locking element on the vertical projection plane when the normal operation of elevator is performed. Therefore, when elevator maintenance work is performed, the rising of the car to above the predetermined height is restricted by a simple operation, so that the safety of maintenance worker can be ensured reliably.

#### Brief Description of the Drawings

##### [0010]

Figure 1 is a plan view of an elevator apparatus in Embodiment 1 of the present invention.

Figure 2 is a plan view of an essential portion of an elevator apparatus in Embodiment 1 of the present invention.

Figure 3 is a side view of an essential portion of the elevator apparatus shown in Figure 2.

Figure 4 is a plan view corresponding to Figure 2, for illustrating the operation of the safety device in Embodiment 1 of the present invention.

Figure 5 is a side view corresponding to Figure 3, for illustrating the operation of the safety device in Embodiment 1 of the present invention.

Figure 6 is a plan view of an essential portion of an elevator apparatus in Embodiment 2 of the present invention.

Figure 7 is a side view of an essential portion of the elevator apparatus shown in Figure 6.

Figure 8 is a plan view corresponding to Figure 6, for illustrating the operation of the safety device in Embodiment 2 of the present invention.

Figure 9 is a side view corresponding to Figure 7, for illustrating the operation of the safety device in Embodiment 2 of the present invention.

Figure 10 is a plan view of an essential portion of an elevator apparatus in Embodiment 3 of the present invention.

Figure 11 is a side view of an essential portion of the elevator apparatus shown in Figure 10.

Figure 12 is a plan view of an essential portion of an elevator apparatus in Embodiment 4 of the present invention.

Figure 13 is a plan view corresponding to Figure 12, for illustrating the operation of the safety device in

Embodiment 4 of the present invention.

Figure 14 is a front view of an essential portion of an elevator apparatus in Embodiment 5 of the present invention.

Figure 15 is a front view corresponding to Figure 14, for illustrating the operation of the safety device in Embodiment 5 of the present invention.

#### Description of Symbols

[0011] 1 car, 2 car guide rail, 3 car frame, 3a upper frame, 4 safety device, 5 locking element, 6 rail clip, 7 support, 7a parallel plate, 7b parallel plate, 8 engaging element, 9 support, 9a parallel plate, 9b parallel plate, 10 engaging element, 11a pin, 11b pin, 12 slit, 13 buffer element, 14 switch cam, 15 detection switch, 15a detector, 16 collapsible maintenance work handrail, 16a vertical frame, 17 engaging element, 18 connecting bracket, 19 connecting pin

#### Best Mode for Carrying Out the Invention

[0012] To describe the present invention in more detail, the present invention will be explained with reference to the accompanying drawings. In the drawings, the same symbols are applied to the same or corresponding elements, and the duplicated explanation thereof is simplified or omitted appropriately.

##### Embodiment 1

[0013] Figure 1 is a plan view of an elevator apparatus in Embodiment 1 of the present invention. In Figure 1, a car 1 that moves vertically in an elevator shaft is guided in the elevation direction by a pair of car guide rails 2 erected in the shaft in such a way that the car guide rails 2 are opposed to each other with the car 1 interposed between them while the horizontal movement of the car 1 is restricted. Also, the car 1 is supported by a car frame 3 formed of a steel material etc. provided so as to surround the periphery of the car 1, and is suspended by a main rope (not shown) via a suspension sheave (not shown) provided on the car frame 3. On the other hand, the car guide rail 2 for guiding the car 1 is arranged in the elevation range of the car 1 from a pit portion to a top portion of the shaft, and is fixed firmly to a shaft wall and a shaft beam via a support bracket and a rail clip (neither shown). In an upper part of the car 1 and in an upper part of each of the car guide rails 2, a safety device 4 is provided. The safety device 4 mechanically restricts the rising of the car 1 to above a predetermined height, thereby securing a predetermined space necessary for maintenance work above the car 1, namely, between the car 1 and the ceiling surface of shaft at the time of elevator maintenance work. Hereunder, the safety device 4 is explained in detail.

[0014] Figure 2 is a plan view of an essential portion of the elevator apparatus in Embodiment 1 of the present

invention, and Figure 3 is a side view of an essential portion of the elevator apparatus shown in Figure 2; these figures show a configuration of the safety device 4. In Figures 2 and 3, on the car guide rail 2 erected in the shaft, a locking element 5 is provided at a position of a predetermined height. This locking element 5 has a plate shape. One end portion of the locking element 5 is firmly fixed on the back surface side of the guide rail 2 so that the flange portion of the car guide rail 2 is held between the locking element 5 and a rail clip 6, and the other end portion thereof is arranged so as to project to the side of the car guide rail 2. The other end portion of the locking element 5 projecting to the side of the car guide rail 2 is bent appropriately to the car 1 side, and a predetermined clearance is formed between the other end portion of the locking element 5 and the vertically moving car 1 on the vertical projection plane.

**[0015]** Also, on the top of the car 1 moving vertically in the shaft, an engaging device is provided on the car frame 3 adjacent to the car guide rail 2 to which the locking element 5 is fixed. This engaging device is provided with an engaging portion configured so that the arrangement position thereof can be switched from a position at which the engaging portion interferes with the other end portion of the locking element 5 on the vertical projection plane (hereinafter called an "interference position") to a position at which the engaging portion does not interfere with the locking element 5 on the vertical projection plane (hereinafter called a "non-interference position") and vice versa by the operation from on the car 1. When the elevator is operated normally, the engaging portion of the engaging device is arranged at the non-interference position. In this state, the engaging portion of the engaging device does not come into contact with the locking element 5 when the car 1 moves vertically, and the configuration of the car 1 is made such that the engaging portion can pass through the height of the locking element 5 and can move to above and below the locking element 5. That is to say, the locking element 5 is arranged in the elevation range of the car 1 at the time of the normal operation of elevator.

**[0016]** On the other hand, at the time of elevator maintenance work, the engaging portion of the engaging device is arranged at the interference position below the locking element 5. If the car 1 continues to rise in this state, the engaging portion collides with the other end portion of the locking element 5 from the downside to mechanically restrict the rising of the car 1. That is to say, when the engaging portion of the engaging device is arranged at the interference position, the engaging portion does not move to above the locking element 5. Therefore, by appropriately setting the installation height of the locking element 5, the position to which the car 1 can be raised at the time of elevator maintenance work is made lower a predetermined distance than the position to which the car 1 can be raised at the time of normal operation, so that a sufficient space necessary for maintenance work can be secured between the car 1 and the ceiling

surface of the shaft. Thereupon, the present invention can be easily applied to a machine room-less elevator in which a predetermined space cannot be secured between the car 1 and the ceiling surface of the shaft when the car 1 of the elevator stops on the uppermost floor or the like elevators. It is a matter of course that even if the engaging portion of the engaging device is arranged at the interference position, the car 1 can be moved freely in the shaft until the engaging portion comes into contact with the locking element 5 from the downside.

**[0017]** The engaging device in Embodiment 1 is made up of a support 7 substantially having a U shape and an engaging element 8 having a function of the engaging portion. The support 7 is provided on an upper frame 3a provided in the shaft depth direction on both sides of the upper part of the car 1, and is arranged so that the U-shaped opening portion is directed upward and parallel plates 7a and 7b facing to each other are parallel with the lengthwise direction of the upper frame 3a. Also, the substantially cylindrical rod-shaped engaging element 8 penetrates, with a play, through holes (not shown) formed in the parallel plates 7a and 7b of the support 7 and the upper frame 3a substantially in a straight line form, and is provided so as to be capable of advancing and retreating freely in the lengthwise direction thereof by being guided by these through holes. The engaging element 8 is arranged so that one end portion thereof projects from the side surface of the car 1 to the adjacent car guide rail 2 side on which the locking element 5 is fixed, and is configured so that the projection length of one end portion thereof can be adjusted by sliding the engaging element 8 in the lengthwise direction thereof.

**[0018]** Figures 2 and 3 show a state in which the engaging element 8 of the engaging device is arranged at the non-interference position. That is to say, the engaging element 8 is slid to the other end portion side so that the projection length of one end portion projecting from the side surface of the car 1 is short, and the end face of one end portion is arranged within a clearance formed between the car 1 and the locking element 5 on the vertical projection plane.

**[0019]** Figure 4 is a plan view corresponding to Figure 2, for illustrating the operation of the safety device in Embodiment 1 of the present invention, and Figure 5 is a side view corresponding to Figure 3; these figures show a state in which the engaging element 8 of the engaging device is arranged at the interference position. In Figures 4 and 5, the engaging element 8 is slid to the one end portion side so that the projection length of one end portion projecting from the side surface of the car 1 is longer than that in the state shown in Figures 2 and 3, and the one end portion is arranged so as to cross the other end portion of the locking element 5 on the vertical projection plane.

**[0020]** Next, the operation of the elevator apparatus provided with the safety device 4 at the time of maintenance work is explained. When the elevator is operated normally, the engaging element 8 of the engaging device

is arranged at the non-interference position, and therefore the car 1 stops on any floor based on the destination floor information registered by the user. In this state, a space sufficient for the maintenance worker to perform maintenance work on the top of the car 1 is not secured between the car 1 stopping on the uppermost floor and the ceiling surface of the shaft. Therefore, when the elevator maintenance work is performed, the maintenance worker first stops the car 1 at a predetermined position, and moves from a predetermined floor onto the top of the car 1. When the maintenance worker gets on the top of the car 1, the car 1 has been stopped so that the engaging element 8 of the engaging device is positioned below the locking element 5. The maintenance worker having gotten on the top of the car 1 arranges the engaging element 8 of the engaging device at the interference position before moving the car 1 vertically. After making sure that the engaging element 8 is surely arranged at the interference position, the maintenance worker performs the elevating operation of the car 1 on the top of the car 1, and stops the car 1 at an arbitrary position in the shaft for performing the maintenance work.

**[0021]** According to the elevator apparatus in Embodiment 1, at the time of elevator maintenance work, even if the maintenance worker raises the car 1 without becoming aware that the worker is coming close to the ceiling surface of the shaft, one end portion of the engaging element 8 projecting to the side of the car 1 collides with the other end portion of the locking element 5 from the downside, by which the rising of the car 1 can be restrained compulsorily at a predetermined position. That is to say, at the time of elevator maintenance work, a predetermined space necessary for maintenance work on the top of the car 1 is secured reliably, so that an accident such that the maintenance worker on the top of the car 1 collides with the ceiling surface of the shaft can be prevented. The maintenance worker can arrange the engaging element 8 at the interference position immediately after the worker has gotten on the top of the car 1 regardless of the stop position of the car 1. Also, since this operation is easy, the preparation time before maintenance work can be reduced significantly, and hence the work efficiency can be improved.

**[0022]** Also, in the above-described elevator apparatus, since the locking element 5 and the engaging device corresponding to the locking element 5 are provided on both sides of the car guide rail 2 and the car 1, respectively, symmetrically in the right-and-left direction, even if the engaging element 8 collides with the locking element 5, the shock at the time of collision is distributed evenly, so that a load imposed on the car guide rail 2 and the car frame 3 can be alleviated.

**[0023]** In Embodiment 1, the case where the locking element 5 is fixed to the car guide rail 2 for guiding the vertical movement of the car 1 has been explained. However, it is a matter of course that if the locking element 5 can be arranged so that a predetermined space is secured above the car 1 at the time of elevator maintenance

work, the same effect can be achieved even when the locking element 5 is provided on another shaft fixing body such as the shaft beam. However, by fixing the locking element 5 to the car guide rail 2 as in Embodiment 1, the locking element 5 can be arranged close to the engaging device, so that the strength of the locking element 5 can be kept to a minimum. Also, there is no need for providing, in advance, a fixing means for the locking element 5, such as an anchor bolt, on the shaft fixing body such as the shaft wall, and the present invention can be applied to various types of elevator apparatus.

## Embodiment 2

**[0024]** Figure 6 is a plan view of an essential portion of an elevator apparatus in Embodiment 2 of the present invention, and Figure 7 is a side view of an essential portion of the elevator apparatus shown in Figure 6; these figures show a configuration of the safety device 4. In Figures 6 and 7, the engaging device provided on the top of the car 1 is provided with a position holding means for holding the engaging portion at the non-interference position at the time of normal operation of elevator and at the interference position at the time of elevator maintenance work. That is to say, at the time of normal operation of elevator, the engaging portion of the engaging device is arranged at the non-interference position, and the engaging portion is always held at the non-interference position by the position holding means so that the engaging portion does not move to the interference position during the elevator operation. On the other hand, at the time of elevator maintenance work, the engaging portion of the engaging device is arranged at the interference position, and the engaging portion is always held at the interference position by the position holding means so that the engaging portion does not move to the non-interference position during the maintenance work.

**[0025]** The engaging device in Embodiment 2 is made up of a support 9 substantially having a U shape and an engaging element 10 having a function of the engaging portion, and the position holding means is provided on the support 9 and the engaging element 10. The support 9 is provided on the upper frame 3a so that the U-shaped opening portion is directed upward and parallel plates 9a and 9b facing to each other are parallel with the lengthwise direction of the upper frame 3a. Also, the engaging element 10 penetrates, with a play, through holes (not shown) formed in the parallel plates 9a and 9b of the support 9 and the upper frame 3a substantially in a straight line form, and is provided so as to be capable of advancing and retreating freely in the lengthwise direction thereof by being guided by these through holes. The engaging element 10 is arranged so that one end portion thereof projects from the side surface of the car 1 to the adjacent car guide rail 2 side on which the locking element 5 is fixed, and is configured so that the projection length of one end portion thereof can be adjusted by sliding the engaging element 10 in the lengthwise direction

thereof.

**[0026]** The position holding means includes two pins 11a and 11b provided on the engaging element 10, the parallel plate 9a of the support 9, and a slit 12 formed in the through hole of the parallel plate 9a. The pins 11a and 11b are provided so as to be at right angles to the engaging element 10, and are arranged in parallel with each other at positions separating a predetermined distance from the end face of one end portion of the engaging element 10 projecting to the side of the car 1. Also, the width and direction of the slit 12 are set so that when the engaging element 10 is slid in the lengthwise direction thereof by being guided by the through holes formed in the parallel plates 9a and 9b, the pins 11a and 11b can be moved to the locking element 5 side and the side opposite to the locking element 5 of the parallel plate 9a via this slit 12.

**[0027]** Figures 6 and 7 show a state in which the engaging element 10 of the engaging device is held at the non-interference position. That is to say, the engaging element 10 is slid to the other end portion side, and the end face of one end portion thereof is arranged in a clearance formed between the car 1 and the locking element 5 on the vertical projection plane. The pin 11b provided on the locking element 5 side of the engaging element 10 is arranged in the direction substantially perpendicular to the slit 12 on the side opposite to the locking element 5 of the parallel plate 9a formed with the slit 12. In this state, the pin 11b is locked to the parallel plate 9a, so that the movement of the engaging element 10 to the locking element 5 side is restricted. Therefore, the engaging element 10 is always held at the non-interference position.

**[0028]** Also, Figure 8 is a plan view corresponding to Figure 6, for illustrating the operation of the safety device in Embodiment 2 of the present invention, and Figure 9 is a side view corresponding to Figure 7; these figures show a state in which the engaging element 10 of the engaging device is held at the interference position. In Figures 8 and 9, the engaging element 10 is slid to the one end portion side as compared with the state shown in Figures 6 and 7, and one end portion of the engaging element 10 is arranged so as to cross the other end portion of the locking element 5 on the vertical projection plane. The pin 11a on the side opposite to the locking element 5 of the engaging element 10 is arranged in the direction substantially perpendicular to the slit 12 on the locking element 5 side of the parallel plate 9a formed with the slit 12. In this state, the pin 11a is locked to the parallel plate 9a, and thereby the movement of the engaging element 10 to the side opposite to the locking element 5 is restricted. Therefore, the engaging element 10 is always held at the interference position.

**[0029]** According to the elevator apparatus in Embodiment 2, at the time of elevator maintenance work, the engaging element 10 of the engaging device is always held at the engaging position. Therefore, the engaging element 10 does not move to the non-engaging position

before the maintenance worker becomes aware, so that the safety of maintenance worker can be ensured reliably. Also, at the time of normal operation of elevator, the engaging element 10 of the engaging device is always held at the non-engaging position. Therefore, the engaging element 10 is not moved to the engaging position by vibrations etc. caused at the time of normal operation, and therefore there is no fear of hindering the vertical movement of the car 1. Other configurations and effects are the same as those of Embodiment 1.

### Embodiment 3

**[0030]** Figure 10 is a plan view of an essential portion of an elevator apparatus in Embodiment 3 of the present invention, and Figure 11 is a side view of an essential portion of the elevator apparatus shown in Figure 10; these figures show a configuration of the safety device 4. In Figures 10 and 11, on the lower surface of the other end portion of the locking element 5 provided in the upper part of the car guide rail 2, a buffer element 13 formed of rubber or the like is provided at a position just above the engaging portion of the engaging device arranged at the interference position at the time of maintenance work. By providing such a configuration, even if the engaging portion of the engaging device, namely, one end portion of the engaging element 8 collides with the locking element 5 from the downside when the elevator maintenance work is performed, one end portion of the engaging element 8 collides with the buffer element 13. Therefore, the shock at the time of collision is eased, and hence the safety of maintenance worker can be ensured. Other configurations and effects are the same as those of Embodiments 1 and 2.

### Embodiment 4

**[0031]** Figure 12 is a plan view of an essential portion of an elevator apparatus in Embodiment 4 of the present invention, showing a configuration of the safety device 4. In Figure 12, the engaging device provided on the top of the car 1 is provided with a detecting means for checking which of the interference position or the non-interference position is the position at which the engaging portion is arranged. The detecting means in Embodiment 4 includes a switch cam 14 which is provided on the engaging element 8 consisting of the engaging portion and moves in association with the slide of the engaging element 8, a detection switch 15 arranged so that a detector 15a engages with the switch cam 14 when the engaging element 8 is arranged at the interference position, and a judging means (not shown) for judging, based on a detection signal sent from the detection switch 15, whether the engaging element 8 is arranged at the interference position or at the non-interference position.

**[0032]** Figure 13 is a plan view corresponding to Figure 12, for illustrating the operation of the safety device in Embodiment 4 of the present invention. This figure shows

a state in which the engaging element 8 of the engaging device is arranged at the interference position. In Figure 13, the engaging element 8 is slid from the non-interference position shown in Figure 12 to the one end portion side, and one end portion thereof is arranged so as to cross the other end portion of the locking element 5 on the vertical projection plane. At this time, the switch cam 14 provided on the engaging element 8 is moved to the adjacent car guide rail 2 side together with the engaging element 8, and engages with the detector 15a of the detection switch 15 provided on the upper frame 3a etc. By the engagement of the switch cam 14 with the detector 15a, a detection signal is sent from the detection switch 15 to the judging means. The judging means that has received the detection signal judges, based on this detection signal, that the engaging element 8 has been arranged at the interference position.

**[0033]** By this configuration, which of the interference position or the non-interference position is the position at which the engaging portion 8 of the engaging device is arranged can be checked easily. Based on the judgment result of the judging means, switching is performed between the normal operation of elevator and the maintenance operation at the time of maintenance work. Thereby, misoperation etc. of the safety device 4 is prevented, so that a safer elevator apparatus can be provided. That is to say, when the judging means judges that the engaging element 8 is arranged at the non-interference position, only the normal operation of elevator is made valid, and the maintenance operation is made invalid. On the other hand, when the judging means judges that the engaging element 8 is arranged at the interference position, only the maintenance operation of elevator is made valid, and the normal operation is made invalid. By providing a control means having such a configuration, the maintenance operation can be prevented from being performed in the state in which the engaging element 8 is arranged at the non-interference position, so that the safety of maintenance worker can be ensured reliably. Also, the normal operation can be prevented from being performed in the state in which the engaging element 8 is arranged at the interference position, so that an inadvertent contact of the engaging element 8 with the locking element 5 at the time of normal operation can be prevented. Other configurations and effects are the same as those of Embodiments 1 to 3.

#### Embodiment 5

**[0034]** Figure 14 is a front view of an essential portion of an elevator apparatus in Embodiment 5 of the present invention, showing a configuration of the safety device 4. In Figure 14, on the top of the car 1 moving vertically in the shaft, a collapsible maintenance work handrail 16 is provided. The handrail 16 is used by being assembled at the time of elevator maintenance work, and is stored by being folded on the top of the car 1 at the time of normal operation of elevator. Also, an engaging element

17 of the engaging device is configured so as to move in association with the collapsible maintenance work handrail 16 via a link mechanism etc., and be arranged at the interference position when the handrail 16 is assembled and at the non-interference position when the handrail 16 is stored.

**[0035]** Specifically, a vertical frame 16a of the collapsible maintenance work handrail 16 is turnably provided at its lower end portion on the upper frame 3a etc. so as to be tiltable to the inside of the car 1, and a connecting bracket 18 movable in association with the turning of the vertical frame 16a is provided in a part of the vertical frame 16a. This connecting bracket 18 is formed with an elongated hole in the direction perpendicular to the lengthwise direction of the vertical frame 16a, and a connecting pin 19 provided on the engaging element 17 is arranged so as to pass through the elongated hole in the connecting bracket 18 with a play. By providing such a configuration, when the vertical frame 16a is turned, the connecting pin 19 is guided by the elongated hole in the connecting bracket 18, and hence the engaging element 17 is arranged at the interference position and the non-interference position. Figure 15 is a front view corresponding to Figure 14, for illustrating the operation of the safety device in Embodiment 5 of the present invention. This figure shows a state in which the collapsible maintenance work handrail 16 is assembled, and thereby the engaging element 17 of the engaging device is arranged at the interference position.

**[0036]** According to the elevator apparatus in Embodiment 5, the engaging element 17 can be arranged at the interference position and the non-interference position by the assembling and storing work of the collapsible maintenance work handrail 16. Therefore, misoperation etc. of the safety device 4 are prevented, by which the safety can further be improved. Other configurations and effects are the same as those of Embodiments 1 to 4.

#### Industrial Applicability

**[0037]** As described above, according to the elevator apparatus in accordance with the present invention, the engaging portion of the engaging device provided on the top of the car 1 is configured so that the arrangement thereof can be switched from the interference position to the non-interference position and vice versa on the vertical projection plane with respect to the locking element 5 fixed to the car guide rail 2 by an operation on the top of the car 1. Therefore, at the time of elevator maintenance work, the rising of the car 1 to above a predetermined height is restricted by a simple operation, and thus the safety of maintenance worker can be ensured reliably.

#### Claims

1. An elevator apparatus comprising:

a safety device which mechanically restricts the rising of a car moving vertically in an elevator shaft to above a predetermined height to secure a predetermined space above the car when elevator maintenance work is performed, the safety device comprising:

a locking element provided on a shaft fixing body at the predetermined height; and an engaging portion which is provided on the car and is arranged, by an operation on a top of the car, at a position at which the engaging portion interferes with a part of the locking element on the vertical projection plane when elevator maintenance work is performed and at a position at which the engaging portion does not interfere with the locking element on the vertical projection plane when the normal operation of elevator is performed.

2. The elevator apparatus according to claim 1, **characterized in that** the safety device comprises a position holding means for holding the engaging portion at the position at which the engaging portion interferes with a part of the locking element on the vertical projection plane and the position at which the engaging portion does not interfere with the locking element on the vertical projection plane.
3. The elevator apparatus according to claim 1 or 2, **characterized in that** the safety device comprises a detecting means for checking whether the engaging portion is arranged at the position at which the engaging portion interferes with a part of the locking element on the vertical projection plane or at the position at which the engaging portion does not interfere with the locking element on the vertical projection plane.
4. The elevator apparatus according to any one of claims 1 to 3, **characterized in that** a collapsible maintenance work handrail is provided on the top of the car; and the engaging portion of the engaging device moves in association with the collapsible maintenance work handrail and is arranged at the position at which the engaging portion interferes with a part of the locking element on the vertical projection plane when the collapsible maintenance work handrail is assembled and at the position at which the engaging portion does not interfere with the locking element on the vertical projection plane when the collapsible maintenance work handrail is stored.
5. The elevator apparatus according to any one of claims 1 to 4, **characterized in that** when elevator maintenance work is performed, the car can be moved vertically in the shaft in a state in which the

engaging portion is arranged below the locking element.

6. The elevator apparatus according to any one of claims 1 to 5, **characterized in that** when the normal operation of elevator is performed, the engaging portion can be moved to above the locking element.
7. The elevator apparatus according to any one of claims 1 to 6, **characterized in that** the locking element is provided on a car guide rail for guiding the car in the vertical direction.
8. The elevator apparatus according to claim 7, **characterized in that** the locking element is provided on each of a pair of car guide rails arranged on both sides of the car, and the engaging portion is provided on both sides on the top of the car so as to correspond to the locking element.
9. The elevator apparatus according to any one of claims 1 to 8, **characterized in that** the locking element comprises a buffer element for easing a shock produced when the engaging portion collides with a part of the locking element.



Fig. 1

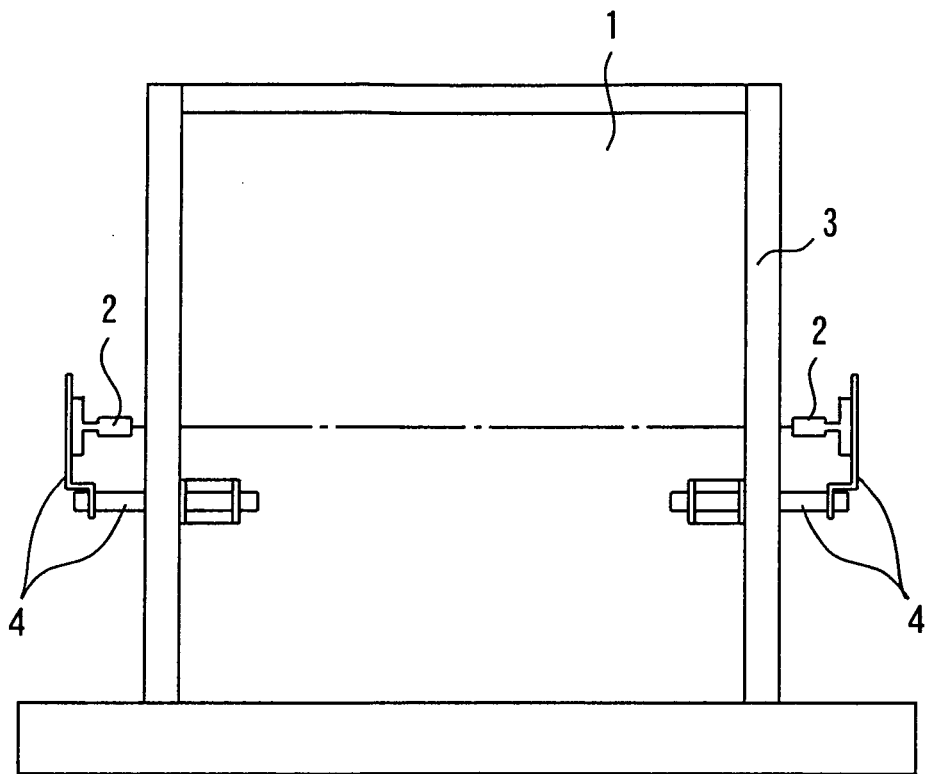


Fig. 2

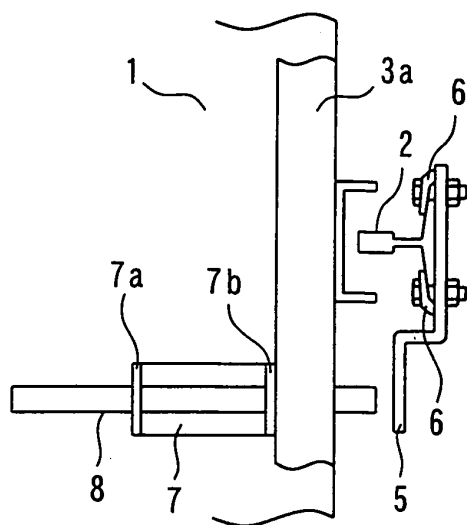


Fig. 3

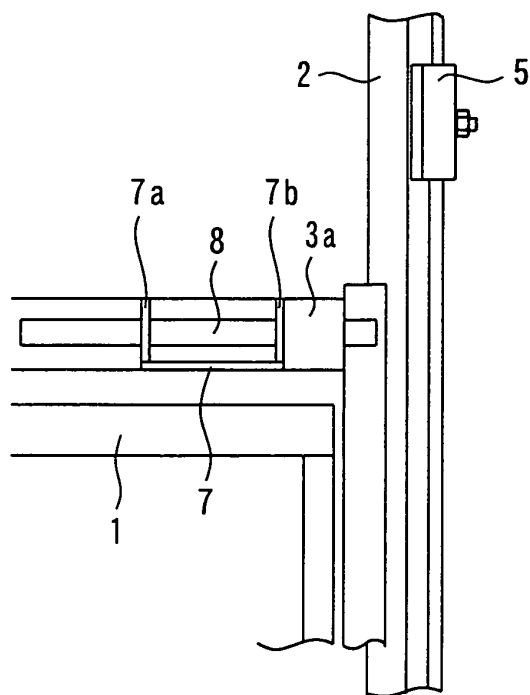


Fig. 4

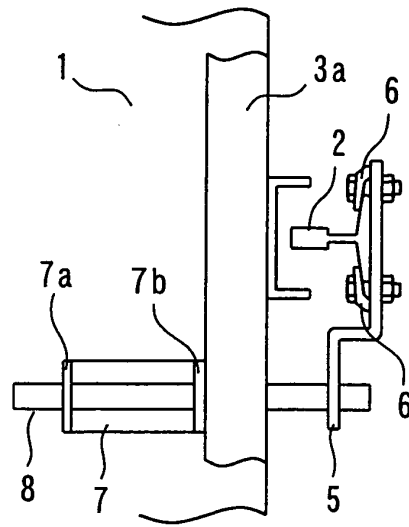


Fig. 5

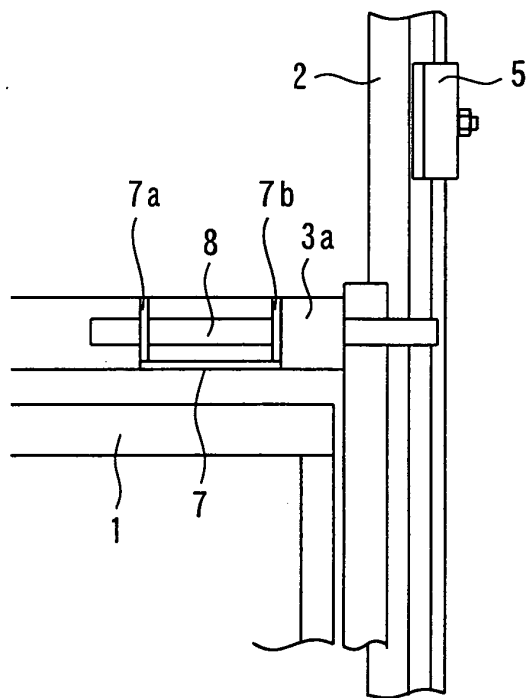


Fig. 6

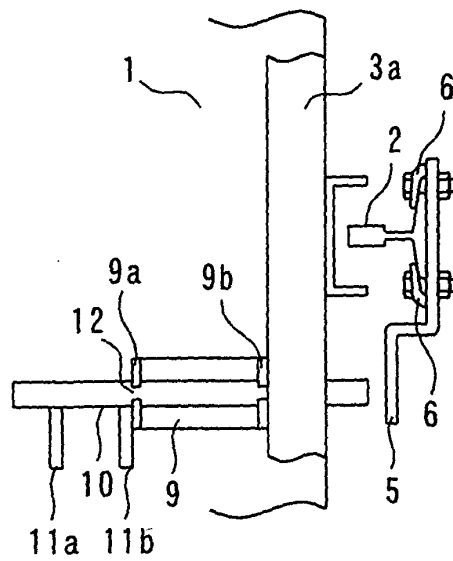


Fig. 7

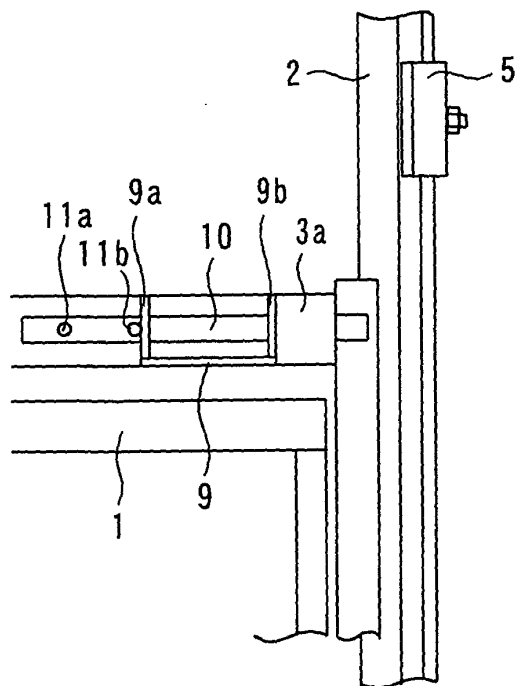


Fig. 8

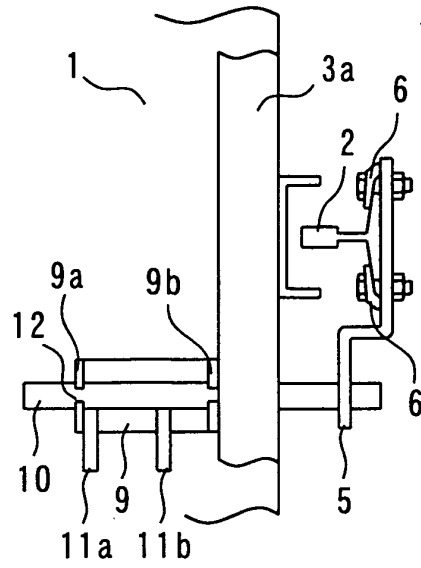


Fig. 9

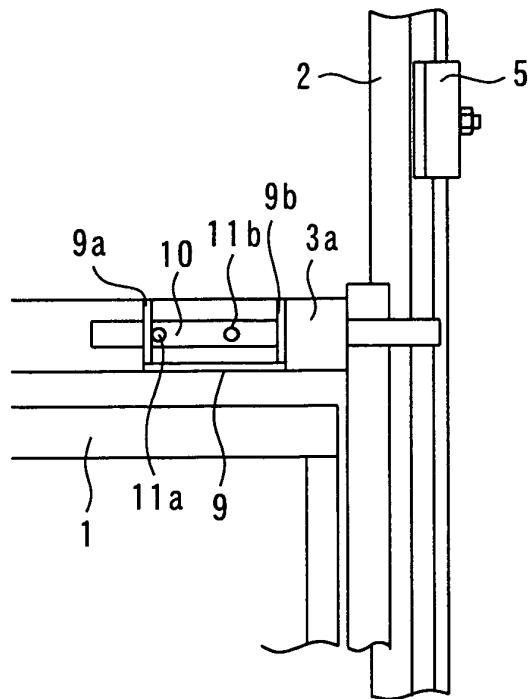


Fig. 10

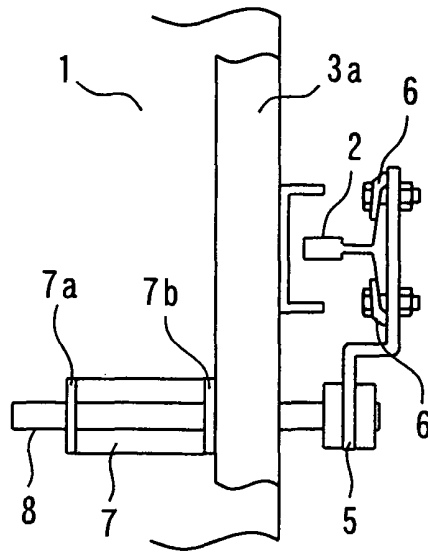


Fig. 11

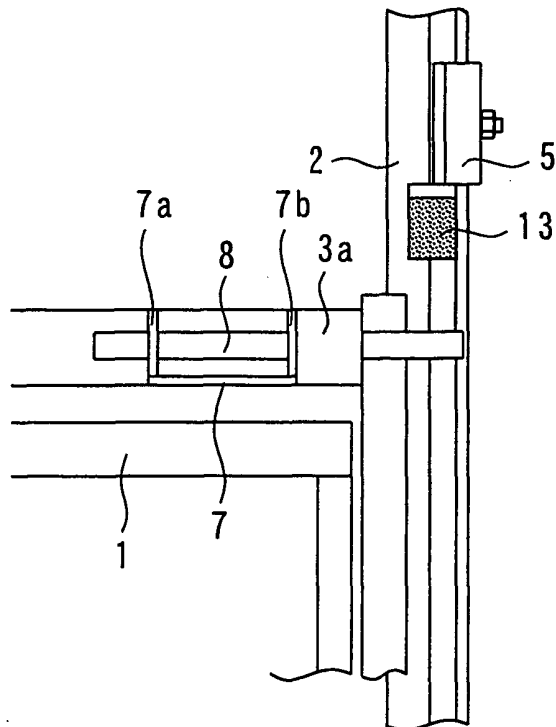


Fig. 12

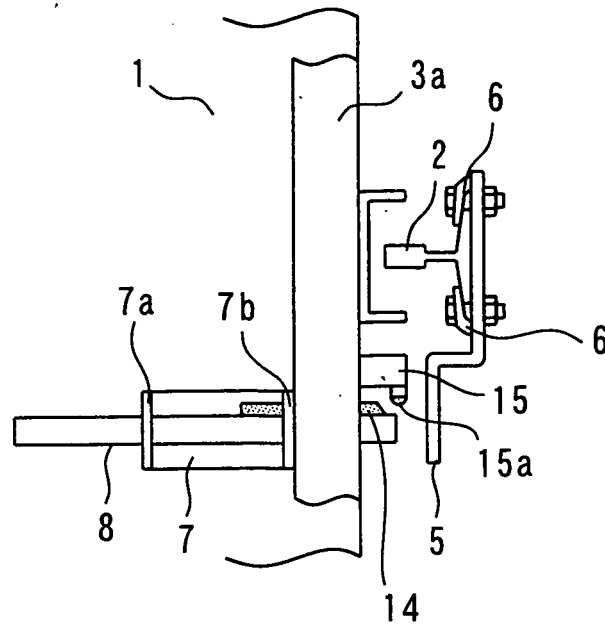


Fig. 13

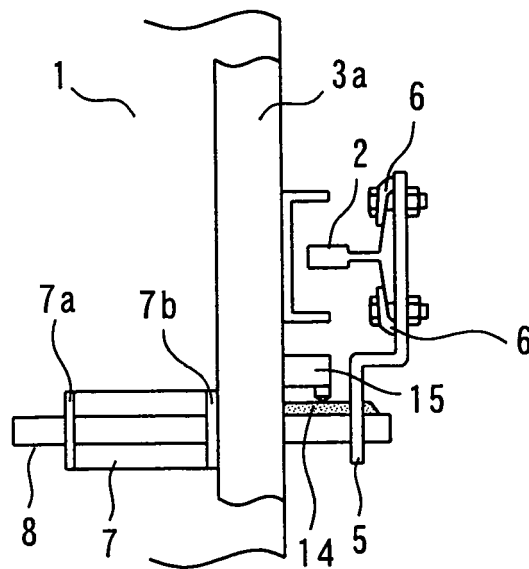


Fig. 14

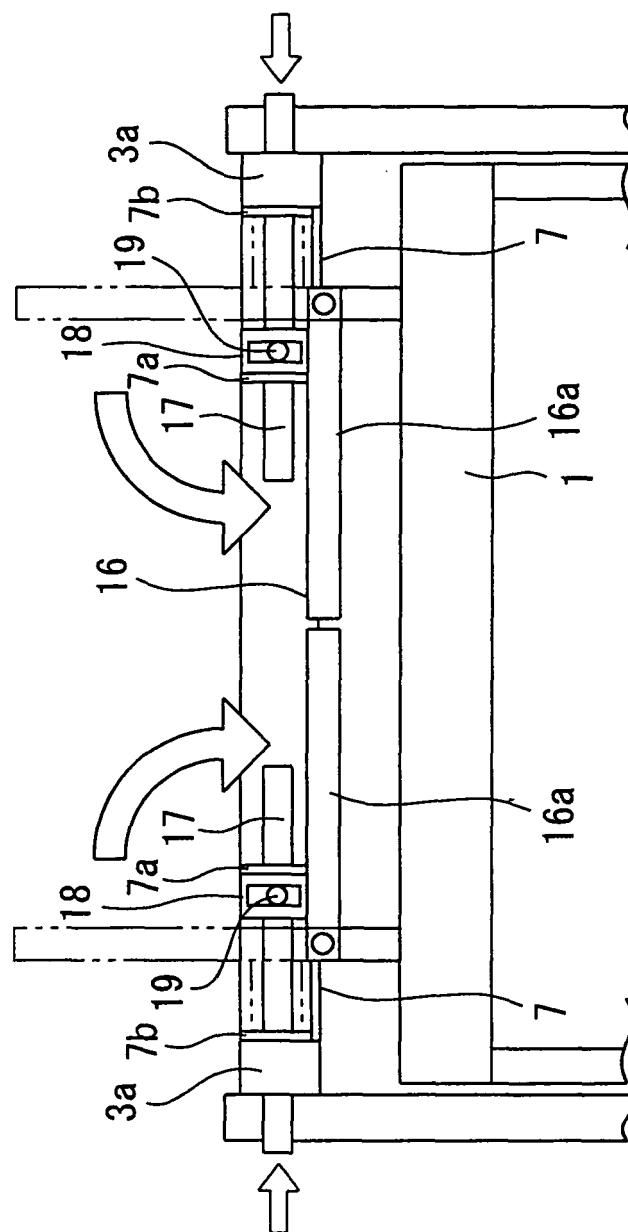
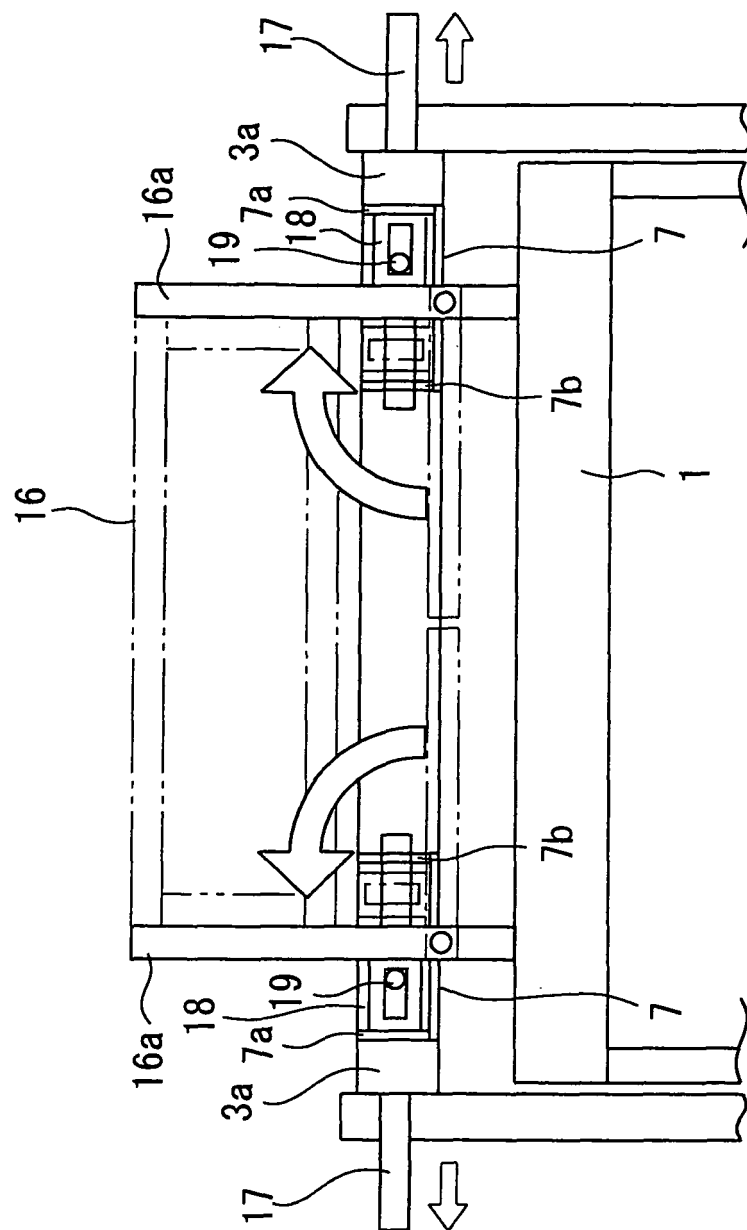




Fig. 15



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/009926

## A. CLASSIFICATION OF SUBJECT MATTER

**B66B5/00** (2006.01)

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)

**B66B5/00** (2006.01)

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 1996-2006

Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2000-203774 A (Toshiba Corp.), 25 July, 2000 (25.07.00), Claims 1 to 6; Par. Nos. [0039] to [0045]; Figs. 3 to 4 (Family: none)	1-3, 6-7 4-5, 8-9
Y	JP 2002-96979 A (Mitsubishi Electric Corp.), 02 April, 2002 (02.04.02), Claims 1 to 5 (Family: none)	4

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

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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
27 February, 2006 (27.02.06)Date of mailing of the international search report  
07 March, 2006 (07.03.06)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP2005/009926

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>JP 2004-352497 A (Inventio AG.), 16 December, 2004 (16.12.04), Claims 1 to 8; Par. Nos. [0012] to [0016]; Figs. 1 to 4</p> <p>&amp; CA 2462296 A1                      &amp; US 2004/0188184 A1 &amp; NO 20041337 A                      &amp; CN 1533977 A &amp; AU 2004201340 A1                  &amp; EP 1473264 A1 &amp; BR 0401005 A                      &amp; NZ 531912 A</p>	5, 8-9

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 2004059216 A [0004]
- JP 2003155176 A [0004]