

EMERGENCY STOP DEVICE AND ELEVATOR HAVING THE SAME

Background of the invention

(1) Field of the invention

The present invention relates to emergency stop device that is actuated by pulling a lever up and elevators having the same.

5 (2) Description of related art

Double-deck elevators having upper and lower cages in a cage frame include driving means above the upper cage and pulleys provided under the upper cage and the lower cage. Such double-deck elevators are configured so that ropes are wound and hung around the driving means and the pulleys to drive the upper cage and the lower cage by the driving means.

10 One example of conventionally available device to operate an emergency stop device for such double-deck elevators includes a detection roller below the cages to be in contact with a rope driving the upper cage and the lower cage to detect the drop of cages due to a break in the rope, the detection roller being configured to move in accordance with abnormal loosening of the rope and a break in the rope, thus operating an emergency stop device (see for example,
15 JP-A-2007-331871, paragraphs [0021] to [0023] and Fig. 4). Another example includes a governor configured to detect a speed and a governor rope to operate an emergency stop device.

Brief summary of the invention

However, in the case of an extremely short stroke as in upper and lower cages of a double-deck elevator, for example, a governor might not be able to detect the drop of a cage due
20 to a break in the driving rope and operate the emergency stop device before the cage collides with a buffer.

It is very favorable even for typical elevators to improve the response speed of a governor thereof when a cage moves at an abnormal speed.

In view of the aforementioned states of the conventional techniques, it is an object
25 of the present invention to provide an emergency stop device operable in accordance with an acceleration of the motion of a cage when a rope breaks, for example, without the need of a special device.

In order to fulfill the above-stated object, an emergency stop device of the present invention is provided in a cage and operates when a pull-up lever is pulled up. The emergency
30 stop device includes: a brake that applies a brake to the cage; a brake operating mechanism that

is actuated when the pull-up lever is pulled up to operate the brake; and deterrent application means provided at the brake operating mechanism and applying, to the pull-up lever, a force in a direction opposite to a pulling-up direction of the pull-up lever. The pull-up lever is rotatable about a fulcrum and is configured to receive, at one end, a rotation force to rotate about the fulcrum, and the pull-up lever is held in a normal state at a position below a horizontal position where the fulcrum and the one end receiving the rotation force become horizontal by a predetermined angle, and the brake operates in a range until the pull-up lever is pulled up to reach the horizontal position where the fulcrum and the one end receiving the rotation force become horizontal.

The present invention can provide an emergency stop device operable in accordance with acceleration of the motion of a cage when a rope breaks, for example, and an elevator having such an emergency stop device.

Brief description of the drawing

Fig. 1 schematically illustrates the overall configuration of a double-deck elevator of the present embodiment,

Fig. 2 illustrates the overall configuration of cages in a double-deck elevator of the present embodiment,

Fig. 3 is a front view illustrating the outline configuration of a tension pulley in a double-deck elevator of the present embodiment,

Fig. 4 is a side view illustrating the outline configuration of a tension pulley in a double-deck elevator of the present embodiment, and

Fig. 5 is a front view illustrating the outline configuration of the periphery of an emergency stop device in a double-deck elevator of the present embodiment.

Detailed description of the invention

The following describes an embodiment of an elevator and an emergency stop device according to the present invention, with reference to the drawings.

An elevator of the present embodiment is configured as a double-deck elevator, and Fig. 1 schematically illustrates the overall configuration of a double-deck elevator of the present embodiment. As illustrated in Fig. 1, the elevator includes: a cage frame 2 moving up and down in a shaft 1; a main rope 3 having one end coupled with the cage frame 2; a counterweight 4 coupled with the other end of the main rope 3 to move up and down in the shaft 1; a driving device 6 provided in a machine room 5 at the upper part of the shaft 1, around which

a mid part of the main rope 3 is wound and hung to drive the main rope 3; a deflector wheel 7 provided near the driving device 6 in the machine room 5, around which the main rope 3 is wound and hung; and a controller 8 provided in the machine room 5 to control the operation of the double-deck elevator. The controller 8 is connected to the driving device 6 via a cable 9.

5 Fig. 2 illustrates the overall configuration of cages in a double-deck elevator of the present embodiment. As illustrated in Fig. 2, the cage frame 2 includes an upper frame 2a, a middle frame 2b, a lower frame 2c and vertical frames 2d, and is guided by guide rails 11 vertically provided in the shaft 1 via guide members 10 provided at four corners thereof. The cage frame 2 is provided with an upper cage 12 and a lower cage 13 that can move in the
10 mutually opposite directions vertically in the cage frame 2, guide rails 14 to guide the travelling of the upper cage 12 and the lower cage 13, and driving means 15 to drive the upper cage 12 and the lower cage 13.

The driving means 15 includes, for example, a motor 151, a plurality of below-cage pulleys 152 provided below each of the upper cage 12 and the lower cage 13, a sheave 151a
15 of the motor 151 and a plurality of ropes 153 hung around the below-cage pulleys 152 and having one end fixed to the upper frame 2a and the other end fixed to the middle frame 2b.

As illustrated in Fig. 2, the double-deck elevator of the present embodiment further includes governors 16a and 16b and tension pulleys 17a and 17b provided thereunder, respectively, in the cage frame 2, and the governors 16a and 16b and tension pulleys 17a and 17b
20 are coupled with governor ropes 18a and 18b, respectively. The governor ropes 18a and 18b are coupled with pull-up levers 19a and 19b, respectively, of emergency stop devices provided in the upper cage 12 and the lower cage 13, whereby the governor ropes 18a and 18b are coupled with the upper cage 12 and the lower cage 13, respectively, to transmit the motion of the upper cage 12 and the lower cage 13 to the governors 16a and 16b, respectively.

25 Referring to Fig. 2, the following describes a basic operation when the ropes 153 break and the upper cage 12 or the lower cage 13 drops. The pull-up lever 19a, 19b coupled with the upper cage 12 or the lower cage 13 tries to pull the governor rope 18a, 18b down.

The governor rope 18a, 18b tends to rotate the governor 16a, 16b as well as the tension pulley 17a, 17b. At this time, a rotation inertial mass added to the tension pulley 17a,
30 17b generates an inertial force against the rotation of the tension pulley 17a, 17b to stop the rotation of the tension pulley 17a, 17b. As a result, tension is applied to the governor rope 18a, 18b, resulting in the pull-up lever 19a, 19b to be pulled up because of relative motion with the upper cage 12 or the lower cage 13 moving downward, thus operating the emergency stop device. This rotation inertial mass may be added to the rotation members of the governors 16a

and 16b, leading to a similar effect. The rotation inertial mass may be added to both of the tension pulley 17a and the governor 16a and to both of the tension pulley 17b and the governor 16b.

Fig. 3 is a front view illustrating the outline configuration of a tension pulley in a double-deck elevator of the present embodiment. The tension pulley 17 is rotatably fixed to a cage frame member 30 making up the cage frame 2 via a lever 33, thus allowing vertical motion due to elasticity of a rope. At a front end of the lever 33 is fixed an additional mass 32 to give tension to the governor rope 18. This mass generates friction between the tension pulley 17 and the governor rope 18 so as to prevent the governor rope 18 from slipping even when the drop acceleration of cages occurs.

Fig. 4 is a side view illustrating the outline configuration of a tension pulley in a double-deck elevator of the present embodiment. A rotation inertial mass 21 is a metal disk and is fixed to the tension pulley 17 from a side face thereof. At this time, the rotation inertial mass 21 is made coaxial with the tension pulley 17 so as not to generate vibration during rotation. The number of the disk(s) of the rotation inertial mass 21 can be from single to multiple to adjust the rope tension and the inertial force. This allows the rotation inertial mass suitable to the mass of the cages to be added, whereby an inertial force acting on the governor ropes 18a and 18b can be adjusted. Such a configuration is applicable also to the case where the rotation inertial mass is added to the rotation members of the governors 16a and 16b or to the case where the rotation inertial mass is added to both of the tension pulley 17a and the governor 16a and to both of the tension pulley 17b and the governor 16b.

Fig. 5 is a front view illustrating in general the configuration of the periphery of an emergency stop device in a double-deck elevator of the present embodiment. This drawing illustrates the upper cage 12 as an example. Below the upper cage 12 is provided a cage frame member 53. The cage frame member 53 fixes an upper cabin 60 via a vibration-insulating rubber 54. The pull-up lever 19a coupled with the governor rope 18a in the present embodiment is configured to be rotatable around a fulcrum 58b and to receive, at an end thereof, a rotation force for rotation around the fulcrum 58b.

The pull-up lever 19a is further coupled with an actuating arm 57b, and the actuating arm 57b also is configured to rotate around the fulcrum 58b while the pull-up lever 19a is pulled up. The actuating arm 57b holds a brake actuating rod 56b. When the rotation of the actuating arm 57b pulls the brake actuating rod 56b up by a predetermined pulling-up amount, a brake 52b operates, and when the brake 52b operates, the brake 52b catches the guide rail 14 not illustrated in Fig. 5 but illustrated in Fig. 2 to apply a brake force thereto, thus applying a brake

to the upper cage 12.

As illustrated in Fig. 5, also on a guide rail 14 facing the guide rail 14 provided with the actuating arm 57b coupled with the pull-up lever 19a of the upper cage 12 is provided a brake 52a to catch the guide rail 14 to apply a brake force thereto so as to apply a brake to the upper cage 12, a brake actuating rod 56a to operate the brake 52a in accordance with the predetermined pulling-up amount and an actuating arm 57a that holds the brake actuating rod 56a and rotates around a fulcrum 58a to pull the brake actuating rod 56a up. Then, the upper end of the actuating arm 57a and the lower end of the actuating arm 57b are coupled via a coupling rod 55.

With this configuration, when the pull-up lever 19a is pulled up to rotate the actuating arm 57b around the fulcrum 58b counterclockwise, the actuating arm 57b pulls the brake actuating rod 56b up gradually while pulling the coupling rod 55. The pulled coupling rod 55 rotates the actuating arm 57a around the fulcrum 58a clockwise to pull the brake actuating rod 56a up. The present embodiment is configured so that, when the pull-up lever 19a reaches a position where the fulcrum 58b and an end of the pull-up lever 19a coupled with the governor rope 18a to which a rotation force is given become horizontal (hereinafter called a horizontal position 62), the brake actuating rods 56a and 56b are pulled up by a predetermined amount to operate the brakes 52a and 52b. That is, the brake actuating rods 56a and 56b, the actuating arms 57a and 57b and the coupling rod 55 make up a brake operating mechanism.

Herein the coupling rod 55 is provided with a deterrent spring 51 as a deterrent application means, and this deterrent spring 51 is held at one end by a deterrent spring holding piece 59a fixed to the cage frame member 53. The other end of the deterrent spring 51 is held by a deterrent spring holding piece 59b fixed to the coupling rod 55. With this configuration, since when the pull-up lever 19a is pulled up, the coupling rod 55 is pulled so that the deterrent spring 51 is compressed between the deterrent spring holding pieces 59a and 59b, therefore, the pull-up lever 19a is pulled higher, the spring force of the deterrent spring 51 acts more strongly to pull the pull-up lever 19a down. That is, the pull-up lever 19a actuates the brake when the pull-up lever 19a is pulled up to overcome the spring force of the deterrent spring 51.

In this way, the emergency stop device of the present embodiment includes the pull-up lever 19a, the brakes 52a and 52b, a brake operating mechanism having the brake actuating rods 56a and 56b, the actuating arms 57a and 57b and the coupling rod 55, and the deterrent spring 51 as a deterrent application means. This configuration prevents the emergency stop device from operating in response to the vibration and swing without the necessity of actuating the emergency stop device.

Preferably, the brakes 52a and 52b of the emergency stop device operate, in response to the operation of the governor, beyond the spring force of the deterrent spring 51 within a range from the horizontal position 62 to a lower position 61 of the pull-up lever 19a. This is because the spring force of the deterrent spring 51 becomes the maximum when the
5 brakes 52a and 52b are actuated within the pulling-up range of the pull-up lever 19a because the pull-up lever is pulled the most upward. In the present embodiment, the pull-up lever 19a is held in a normal state at the position 61 below the horizontal position 62 by a predetermined angle. Let that the held angle in this state is θ and that the force that the governor rope 18a pulls the pull-up lever 19a up is F , the force corresponding to $F\sin\theta$ does not contribute to the
10 pulling-up of the pull-up lever 19a. That is, the brakes 52a and 52b are actuated within the range from the position 61 to the horizontal position 62 before the spring force of the deterrent spring 51 increases gradually to the maximum deterrence where the brakes 52a and 52b are actuated, whereby the efficiency of the governor rope 18a pulling up the pull-up lever 19a can increase gradually. Especially, the brakes 52a and 52b are configured to be actuated at the
15 horizontal position 62 where the efficiency for the force pulling up the pull-up lever 19a is the best or in the vicinity thereof, whereby the maximum force can be exerted when the brakes are actuated. Thereby, prompt operation can be performed when the ropes break. Then, the emergency stop device can be configured to prevent malfunction in response to the vibration or swing g without the necessity of actuating the emergency stop device, and to operate correctly in
20 emergency actually requiring the stopping operation. The vicinity of the horizontal position 62 refers to 20 degrees or less, preferably, where the value of $\sin\theta$ is 0.35 or less, and below 5 degrees where the value of $\sin\theta$ is 0.1 or less leads to excellent efficiency of the force.

Typical governors can cope with the operation even when the spring force increases because a rope thereof is caught. In the configuration of the present embodiment,
25 however, since the governor rope 18a is not caught and the rotation inertial mass is used to convert large acceleration into a force pulling the pull-up lever 19a up, and therefore the present embodiment is required to minimize the pulling-up force. The aforementioned configuration can meet such a requirement.

In Fig. 5, the tension of the governor rope 18 in a normal state is as follows,
30 where $T1$ denotes the tensile on the pulling-up side and $T2$ denotes the tension on the counter-pulling-up side:

$$T1=T2 \dots (1)$$

On the other hand, when the ropes 153 break, a difference occurs in the tensile between $T1$ and $T2$. However, friction generated between the tension pulley 17a and the

governor rope 18a and the rotation inertial mass 21a function to stop a sudden change of the rotation speed of the tension pulley 17a, and therefore when the upper cage 12 descends suddenly, the pull-up lever 19a is pulled upward relatively. The normal position 61 of the pull-up lever 19a at this time is below the horizontal position 62, and the spring force of the deterrent
5 spring 51 increases gradually with the pulling up of the pull-up lever by the angle θ .

Meanwhile, the decrease amount of the pulling-up force decreases because θ approaches 0 degree, and therefore the pull-up lever can be pulled up promptly. When the difference in the tensile this time is too small, malfunction may occur because of vibration of the cages, and therefore the difference is preferably set within the following range by adjusting the rotation
10 inertial mass.

$$T1=(1.2 \text{ to } 1.8) \times T2 \dots (2).$$

In this way, an elevator with less operation delay of the emergency stop device can be provided even for an elevator with a short stroke.

In the present embodiment, the actuating arms 57a and 57b have a T-letter shape and they are provided so that a vertical straight part of the letter T is extended outwardly of the
15 upper cage 12, and the brake actuating rods 56a and 56b are held at this vertical straight part. Instead, the actuating arms 57a and 57b may have a L-letter shape having a vertical straight part to hold these brake actuating rods 56a and 56b, an upper end of the actuating arm 57a and a lower end of the actuating arm 57b coupled via the coupling rod 55. In this case, the actuating arms 57a and 57b are not provided horizontally-symmetrically as in the present embodiment, but
20 are provided symmetrically about a point.

In the present embodiment, the lower cage 13 is configured in a similar manner to Fig. 5.

As described above, the present embodiment is configured so that a rotation inertial mass is added to tension pulleys provided at an upper cage and a lower cage movable in
25 the vertical opposite directions in a cage frame, a pull-up lever operates in a range from a horizontal position to a position below the horizontal position and the rope tension can be adjusted in a range from 1.2 times to 1.8 times by the friction of the tension pulleys with a rope. With this configuration, the emergency stop device of the present embodiment can operate quickly using an inertial force generated in accordance with the acceleration of the drop of cages
30 exceeding normal elevator acceleration when a rope driving the upper cage and the lower cage breaks.

In the thus configured emergency stop device and elevator of the present embodiment, when a rope breaks because of some reason and acceleration of the drop occurs in

the cages, an inertial force is applied to the governor rope coupled to the emergency stop device of the cages because of the effect of the rotation inertial mass added to the tension pulleys of the governor. The aforementioned range of rope tension can avoid malfunction of the emergency stop device because of small acceleration.

5 Therefore, the present embodiment has a configuration to detect the acceleration of the drop of cages to operate the emergency stop device by an inertial force applied to the governor rope even before the governor main body operates and to avoid malfunction of the emergency stop device with acceleration during normal traveling.

10 In this way, according to the present embodiment, the acceleration of the drop of cages can be detected securely when a rope driving an upper cage and a lower cage of a double-deck elevator breaks, whereby safety of passengers can be secured.

15 For the description of the present invention, the present embodiment exemplifies a double-deck elevator. The emergency stop device of the present embodiment is very effective for the upper cage 12 and the lower cage 13 in the cage frame 2 having an extremely short stroke because typical governors cannot cope with the drop of such cages. However, the emergency stop device of the present embodiment is not limited to double-deck elevators but is applicable also to normal elevators because it is effective to improve the responsivity of the emergency stop device during abnormality.

Claims:

1. An emergency stop device provided in a cage and operating when a pull-up lever is pulled up; comprising:
 - a brake that applies a brake to the cage;
 - a brake operating mechanism that is actuated when the pull-up lever is pulled up to operate the brake; and
 - deterrent application means provided at the brake operating mechanism and applying, to the pull-up lever, a force in a direction opposite to a pulling-up direction of the pull-up lever,wherein
 - the pull-up lever is rotatable about a fulcrum and is configured to receive, at one end, a rotation force to rotate about the fulcrum, and
 - the pull-up lever is held in a normal state at a position below a horizontal position where the fulcrum and the one end receiving the rotation force become horizontal by a predetermined angle, and the brake operates in a range until the pull-up lever is pulled up to reach the horizontal position where the fulcrum and the one end receiving the rotation force become horizontal.
2. The emergency stop device according to claim 1, comprising a governor rope connected to the one end of the pull-up lever receiving the rotation force, the governor rope being wound and hung around a governor and a tension pulley, wherein the pull-up lever receives a rotation force to rotate about the fulcrum via the governor rope.
3. The emergency stop device according to claim 2, comprising a disk-shaped rotation inertial mass coaxially added to a part of the governor around which the governor rope is wound and hung or the tension pulley or to both of the part of the governor around which the governor rope is wound and hung and the tension pulley.
4. The emergency stop device according to claim 3, wherein a plurality of pieces of the rotation inertial mass can be added to the part of the governor around which the governor rope is wound and hung or the tension pulley or to both of the part of the governor around which the governor rope is wound and hung and the tension pulley, and an inertial force acting on the governor rope is adjusted by adjusting the number of pieces of the rotation inertial mass to be added.
5. The emergency stop device according to claim 1, wherein a position to operate the brake operating mechanism is at a position where the fulcrum and the one end receiving the rotation force of the pull-up lever become horizontal or in a vicinity thereof.

6. An elevator, comprising a cage and a traction machine that hoists the cage; the cage including an emergency stop device that operates when a pull-up lever is pulled up; the emergency stop device comprising:

a brake that applies a brake to the cage;

a brake operating mechanism that is actuated when the pull-up lever is pulled up to operate the brake; and

deterrent application means provided at the brake operating mechanism and applying, to the pull-up lever, a force in a direction opposite to a pulling-up direction of the pull-up lever,

wherein

the pull-up lever is rotatable about a fulcrum and is configured to receive, at one end, a rotation force to rotate about the fulcrum, and

the pull-up lever is held in a normal state at a position below a horizontal position where the fulcrum and the one end receiving the rotation force become horizontal by a predetermined angle, and the brake operating mechanism is actuated at a position where or in a range until the pull-up lever is pulled up to reach the horizontal position where the fulcrum and the one end receiving the rotation force become horizontal.

7. The elevator according to claim 6, wherein the cage comprises an upper cage or a lower cage, or both of the upper cage and the lower cage in a double-deck elevator including a cage frame moving up and down in a shaft, the upper cage disposed in the cage frame to be vertically movable in the cage frame, the lower cage disposed below the upper cage in the cage frame to be vertically movable in the cage frame, and a cage driving device to move the upper cage and the lower cage up and down in the cage frame.