

## ELEVATOR

### Background of the invention

#### (1) Field of the invention

The present invention relates to elevators and more particularly relates to elevators including a counter chain coupled between a cage and a counterweight.

#### 5 (2) Description of related art

In general, weight applied to cages of elevators having a long hoisting stroke greatly changes between the state where the cage is at the highest floor and at the lowest floor because the lengths of a main rope and a control cable suspended change therebetween.

Traction of a traction machine and a motor load accordingly change with the hoisting stroke. In order to reduce such a change in traction of a traction machine and a motor load and make them substantially uniform across the overall hoisting stroke, a counter chain is coupled and suspended between the cage and a counterweight.

JP-A-04-20481, for example, already has proposed a technique of adjusting a space of the counter chain suspended between the cage and the counterweight so as to avoid the interference with a device provided in a shaft.

According to the invention disclosed in the aforementioned JP-A-04-20481, in order to adjust the space of the counter chain suspended from the cage and the counterweight, the counter chain suspended from the cage side is pushed to the counterweight side or is retracted to be away from the counterweight side.

20 The aforementioned conventional technique, however, includes a chain pushing arm in the vicinity of the suspension position of the counter chain from the cage so as to protrude downward while being pivotally supported to be adjustable in the angle, and further needs a support to adjust and fix the angle of the chain pushing arm. Additionally, the elevator of this conventional technique has to be configured so as to prevent the counter chain, which swings during the hoisting of the cage, from becoming detached from the chain pushing arm. Therefore, such a technique has a problem that the overall configuration of the elevator becomes complicated.

The aforementioned conventional technique has another problem that the chain pushing arm protruding downward of the cage requires a deep pit so as to avoid the interference between a device in the pit and the chain pushing arm when the cage is at the lowest floor.

30 These problems become notable especially in elevators including a traction

machine and a counterweight provided on one side of the width direction of the cage in the plan view and so having an increased space between the cage and the counterweight.

#### Brief summary of the invention

It is an object of the present invention to provide an elevator enabling easy  
5 adjustment of a space of a counter chain with a simple configuration and such an operation without deepening a pit.

In order to fulfill the above stated object, an elevator of the present invention includes: a traction machine on one side of the width direction of a cage in the plan view, a counterweight on the side of the traction machine opposite from the cage, pulleys pivotally  
10 supported at target positions on both sides of the width direction of the cage, a main rope wound and hung around these pulleys to suspend the counterweight via the traction machine, and a counter chain to be coupled between the cage and the counterweight for suspension. In the elevator, a chain support to be coupled with the counter chain is provided at a position on the extended line extending in the radial direction of the pulleys where a vertical projection plane  
15 thereof overlaps the pulleys, and the chain support is configured displaceably on the extended line in the radial direction of the pulleys in the plan view.

In the aforementioned configuration, the chain support is provided at a position where a vertical projection plane thereof overlaps the pulleys and is provided displaceably on the extended line extending in the radial direction of the pulleys. This configuration allows easy  
20 adjustment of the space of the counter chain suspended from the cage and the counterweight by shifting the chain support along the extended line extending in the radial direction of the pulleys in the plan view without providing a member protruding below the cage. As a result, the elevator can be free from a member protruding below the cage, and therefore there is no need to deepen a pit of the shaft.

25 Further, the counter chain on the cage side is coupled to the chain support, and therefore even when the counter chain swings during hoisting of the cage, the counter chain will not be detached from the chain support.

Further, since the counter chain is drawn from the cage side at a position overlapping the pulleys in the plan view, i.e., at a position where a vertical projection plane  
30 overlaps the pulleys, there is no device interfering with the pulleys, i.e., with the counter chain across the overall hoisting stroke in the shaft. Therefore, the drawing position of the counter chain from the cage side does not impose limitations on the layout design of devices to be installed in the shaft.

In this way, the present invention can provide an elevator enabling easy adjustment of a space of a counter chain with a simple configuration and such an operation without deepening a pit.

#### Brief description of the drawing

5 Fig. 1 schematically illustrates a transversal plan view of an elevator of Embodiment 1 according to the present invention,

Fig. 2 schematically illustrates an enlarged side view of the elevator of Fig. 1 illustrating the suspending state of a counter chain,

10 Fig. 3 is a front view illustrating a chain support for the counter chain of Fig. 2 on the cage side,

Fig. 4 is a front view illustrating a modification example of the chain support of Fig. 3,

Fig. 5A is a side view illustrating the state before the chain support for the counter chain on the cage side is adjusted, and

15 Fig. 5B is a side view illustrating the state after the chain support for the counter chain on the cage side is adjusted.

#### Detailed description of the invention

The following describes an elevator of the present invention, with reference to Fig. 1 to Fig. 3.

20 In a shaft 1 formed in a building, a cage 3 is placed so as to move up and down while being guided by a pair of left and right guide rails 2A and 2B for cage. On one side of the width direction of the cage 3 in the plan view is provided a traction machine 4, and on the opposite side of the traction machine 4 from the cage 3 is provided a counterweight 5.

25 These guide rails 2A, 2B for cage are provided at horizontally symmetrical positions when viewing the cage 3 from an entrance 3A direction, i.e., symmetrically on both sides of the width direction of the cage 3, and they are supported by rail brackets RB1 provided at the shaft 1.

The traction machine 4 is provided close to one side of the width direction of the cage 3 in the plan view, and as illustrated in Fig. 2, the traction machine 4 is fixed in the shaft 1  
30 below the stop position of the cage 3 at the lowest floor. Note here that since the vertical installation position of the traction machine 4 in the shaft 1 is decided by the driving method of the cage 3 and the layout in the shaft 1, the vertical position is not limited. The horizontal

position of the traction machine 4, however, is limited to one side of the width direction of the cage 3.

Meanwhile, the counterweight 5 has a rectangular shape extending in the depth direction of the cage 3 in the plan view, and both-end sides of the counterweight 5 in the longitudinal direction in the plan view are guided by a pair of guide rails 6A and 6B for weight  
5 supported by a rail bracket RB2 at the shaft 1.

At the cage 3, a pair of pulleys 7A and 7B are pivotally supported at horizontally symmetrical positions when viewed from the entrance 3A direction, i.e., at target positions on both sides of the width direction and below of the cage. Around these pulleys 7A and 7B is  
10 wound and hung a main rope (not illustrated) having one end fixed at a fixing part at the top of the shaft 1.

The other end of the main rope wound and hung around the pulleys 7A and 7B is extended upward to a pulley (not illustrated) pivotally supported at the top of the shaft 1 and then is extended downward to be wound and hung around a driving sheave 4D of the traction machine  
15 4, and thereafter is extended upward again to another pulley (not illustrated) pivotally supported at the top of the shaft 1 and is extended downward to be coupled to the counterweight 5. Herein, the main rope extended downward may be wound and hung around a pulley (not illustrated) pivotally supported at the counterweight 5 without being coupled to the counterweight 5 and be extended upward thrice, and thereafter may be fixed to a fixing member  
20 of the shaft 1. As already described, since the winding/hanging order and the fixing position of the main rope is decided by the driving method of the cage 3 and the layout in the shaft 1, they are not limited to those stated above.

In this configuration, as the traction machine 4 is driven to make the driving sheave 4D move the main rope move up and down, the cage 3 and the counterweight 5 can move  
25 up and down in the mutually opposite directions.

Meanwhile, the cage 3 and the counterweight 5 are coupled via a counter chain 8 so as to minimize a change in weight of the main rope and a control cable not illustrated during hoisting and to eliminate a change of traction of the traction machine 4 and a motor load.

The following specifically describes the coupling structure of the counter chain 8  
30 with the cage 3 and the counterweight 5 in the present embodiment.

As illustrated in Fig. 2 and Fig. 3, below the cage 3 is provided and fixed a pulley beam 9 to pivotally support the pulleys 7A and 7B and the pulley beam 9 is extended in the width direction of the cage 3. The pulleys 7A and 7B are pivotally supported at this pulley beam 9 so as to slightly protrude from the side part of the cage 3.

This pulley beam 9 has an inverted-hat shape in the cross section, and on an end of this pulley beam 9 is outwardly overlaid a chain attachment beam 10 having a slightly smaller inverted-hat shape in the cross section. These pulley beam 9 and chain attachment beam 10 are coupled for fixing at brims 9F and 10F using well-known coupling means 11 such as a bolt and a nut.

The brims 9F and 10F of the pulley beam 9 and the chain attachment beam 10 are provided with a plurality of holes for coupling such as bolt holes along the longitudinal direction of the beam, and these holes for coupling are displaced for coupling in the beam longitudinal direction, whereby the protrusion dimension of the chain attachment beam 10 from the end of the pulley beam 9 can be adjusted.

Below the front end of the chain attachment beam 10 is coupled and fixed a support 12 using well-known coupling means 13, and further below this support 12 is fixed a U-bolt 14 using a nut 15, to which an end of the counter chain 8 is coupled.

Meanwhile, as illustrated in Fig. 2, below the counterweight 5 is coupled and fixed a support 16 using well-known coupling means, and to the support 16 is fixed a U-bolt 17 to which an end of the counter chain 8 is coupled.

As described above, according to the present embodiment, an elevator includes the traction machine 4 on one side of the width direction of the cage 3 in the plan view, the counterweight 5 on the side of the traction machine 4 opposite from the cage 3, the pulleys 7A and 7B pivotally supported at target positions on both sides of the width direction of the cage 3, a main rope wound and hung around these pulleys 7A and 7B to suspend the counterweight 5 via the traction machine 4, and the counter chain 8 to be coupled with the cage 3 and the counterweight 5 for suspension. In such an elevator, the support 12 and the U-bolt 14 as a chain support to be coupled with the counter chain 8 are provided at positions on the extended line extending in the radial direction of the pulleys 7A and 7B where a vertical projection plane thereof overlaps the pulleys 7A and 7B, and the chain support (12, 14) is configured displaceably on the extended line (the longitudinal direction of the pulley beam 9) extending in the radial direction of the pulleys 7A and 7B in the plan view.

In the aforementioned configuration, the support 12 and the U-bolt 14 to be coupled with the counter chain 8 are provided at the positions on the extended line extending in the radial direction of the pulleys 7A and 7B where a vertical projection plane thereof overlaps the pulleys 7A and 7B. This configuration allows the counter chain 8 to be provided away from not only the traction machine 4 but also a device provided in the shaft such as a traction machine inspection stage 19 provided below the traction machine. Since the chain support (support 12,

U-bolt 14) is configured displaceably on the extended line (the longitudinal direction of the pulley beam 9) extending in the radial direction of the pulleys 7A and 7B in the plan view, the suspension radius of a below-suspended part of the counter chain 8 in a U-letter shape can be easily adjusted, thus avoiding the interference of the counter chain 8 with devices provided in the shaft 1 across the overall hoisting stroke of the cage 3.

Additionally, according to the present embodiment, since the counter chain 8 is suspended below in a straight manner from below the cage 3, the suspension structure can be simplified as compared with conventional elevators having a mechanism to push a suspended counter chain outside to adjust the space of the counter chain suspended between the cage and the counterweight. Further, problems occurring due to pushing the counter chain outside can be solved, such as the possibility of the counter chain pushed outside to be detached.

In the aforementioned embodiment, since the support 12 and the U-bolt 14 are attached below the chain attachment beam 10 integral with the pulley beam 9, extra structures will be added below the cage 3. However, these structures are small enough to be considered as a part of the counter chain 8, and therefore there is no need to deepen a pit of the shaft 1 due to these structures.

In the aforementioned embodiment, the protrusion dimension of the counter chain 8 from the cage 3, i.e., the protrusion dimension of the chain attachment beam 10 from the pulley beam 9 is adjusted by removing the well-known coupling means 11 such as a bolt and a nut from the plurality of coupling holes provided in the pulley beam 9 and the chain attachment beam 10, displacing the coupling holes and then inserting the coupling means into the coupling holes again for fastening. The workability of such adjustment operation, however, is somewhat troublesome because the coupling means 11 is removed from the coupling holes and then the coupling holes are displaced and the coupling means 11 is inserted into the coupling holes again for fastening. Further, since the adjustment position is decided by a space between the plurality of coupling holes, the adjustment of positions can only be preformed in a step-by-step manner.

To cope with this, a modification example of the present embodiment is described below, with reference to Fig. 4, 5A and 5B. In the modification example illustrated in Figs. 4, 5A and 5B, the same reference numerals as those in Figs. 1 to 3 denote the same elements, and the detailed description thereon are omitted.

The present modification example is different from Fig. 3 in that a chain attachment beam 10 is fixed to a pulley beam 9. That is, in the present modification example, as illustrated in Fig. 4, when the chain attachment beam 10 having an inversed hat-shape in the cross section is attached to the pulley beam 9 having an inversed hat-shape in the cross section

from the below, the extension length of a brim 9F of the pulley beam 9 is made shorter than the extension length of a brim 10F of the chain attachment beam 10, and across such a shorter brim 9F and a longer brim 10F is provided a clip 18, and this clip 18 is fixed on the brim 10F using fastening means 19 such as a bolt and a nut.

5               With this configuration, a protrusion dimension of the chain attachment beam 10 from the pulley beam 9 in the state of Fig. 5A can be adjusted as follows. Firstly, the fastening means 19 is loosened. Next, since the chain attachment beam 10 can move with reference to the pulley beam 9 in the beam longitudinal direction (width direction of the cage 3) because the fastening means 19 is loosened, the chain attachment beam 10 is shifted to the front end side of  
10 the pulley beam 9 as illustrated in Fig. 5B so that the protrusion dimension of the chain attachment beam 10 from the pulley beam 9 is increased, and thereafter the fastening means 19 is fastened for fixing to complete the adjustment operation.

              According to the present modification example, since the fastening means 19 is not removed from the chain attachment beam 10 during adjustment, the adjustment operation can  
15 be performed in a short time and can be facilitated. Further, since the fastening means 19 is kept attached to the chain attachment beam 10 during the adjustment operation, a problem such as missing of the fastening means 19 during the adjustment operation can be avoided.

              Additionally, since the pulley beam 9 is held by the clip 18 against the chain attachment beam 10, the loosening of the fastening means 19 enables continuous adjustment of  
20 the protrusion dimension of the chain attachment beam 10 relative to the pulley beam 9, and as a result the suspension position of the counter chain 8 can be optimized by the adjustment.

              The aforementioned embodiment and modification example exemplify the case where the traction machine 4 is provided on the bottom side of the shaft 1. However, the present invention is applicable also to the case where the traction machine is provided at an  
25 upper part or a mid part of the shaft as long as the traction machine 4 is provided on the side of the cage 3 in the plan view. Further, although these descriptions exemplify the case where the traction machine 4 is located on the side of the cage 3 and between the cage 3 and the counterweight 5 in the plan view, the present invention is applicable also to the case where the counterweight 5 is located on the side of the cage 3 and the traction machine 4 is located outside  
30 of the counterweight 5.

              The basic configuration of the present invention is such that the counter chain 8 is suspended below the pulleys 7A and 7B pivotally supported below the cage 3 and a chain support for the counter chain 8 is configured displaceably on the extended line extending in the radial direction of the pulleys in the plan view, and any design is possible for other configuration.

Claims:

1. An elevator including:
  - a traction machine and a counterweight located on one side of a width direction of a cage in a plan view in a shaft, wherein the counterweight is located on the side of the traction machine opposite from the cage, and the traction machine is fixed in the shaft below the stop position of the cage at the lowest floor,
  - a pulley beam fixed to below the cage to pivotally support pulleys at target positions on both sides of the width direction of the cage;
  - a main rope wound and hung around the pulleys to suspend the counterweight via the traction machine;
  - a counter chain to be coupled between the cage and the counterweight for suspension, and
  - a chain attachment beam supported by the pulley beam on an extended line extending in a radial direction of the pulleys where a vertical projection plane thereof overlaps the pulleys,
  - wherein the chain attachment beam is configured displaceably in a longitudinal direction of the pulley beam with reference to the pulley beam, and
  - the chain attachment beam includes a chain support to be coupled with the counter chain,
  - wherein the pulley beam and the chain attachment beam have an inverted-hat shape in the cross section respectively, and on an end of the pulley beam, they are overlaid each other in an integrated manner.
2. The elevator according to claim 1, wherein the pulley beam is fixed to below the cage along the width direction of the cage.
3. The elevator according to claim 1, wherein the chain attachment beam is displaceable in a step-by-step manner in the longitudinal direction of the pulley beam with reference to the pulley beam.
4. The elevator according to claim 1, wherein the chain attachment beam is continuously displaceable in the longitudinal direction of the pulley beam with reference to the pulley beam.