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Device and Method for Preventing Vertical Displacements and
Vertical Vibrations of the Load Carrying Means of Vertical
5 Conveyors

Description

The present invention relates to a device and a method for
10 preventing vertical displacements and vertical vibrations
of the load carrying means of vertical conveyors while they
are stopped at landings, achieving the desired effect by
the load carrying means being held fast on its guiderails
during landing stops by means of frictional engagement,
15 this frictional engagement being released in the presence
of a corresponding control command.

The following description relates to passenger- or freight-
elevators which represent a special type of vertical
20 conveyors. The designations of the components therefore
correspond to the technical terms pertinent to the elevator
field. For example the load carrying means is designated as
elevator car or car.

25 EP 0 346 195 discloses an electromagnetically actuated
caliper brake which is designed inter alia to bind the car
or counterweight of an elevator to its respective guiderail
by means of frictional engagement. The brake has two
double-arm levers with a common joint at their mid-point
30 whose shaft is fastened to the car or counterweight. The
gripping arms of the levers are lined with brake linings
and embrace the tongue of the guiderail of the car or
counterweight. The opposite, driving arms of the levers are
held apart by a compression spring which gives rise to the
35 gripping force between the brake linings and the tongue of
the guiderail at the other end of the levers. Concentric to

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the compression spring which pushes the ends apart there is a pull-type electromagnet which, when current flows through it, overcomes the force of the compression spring and thereby opens the brake.

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The disclosed braking device is particularly intended as a holding brake for counterweights or cars of elevators driven by linear motors, and the patent claims relate mainly to the embodiment of an integral damping element to prevent switching jolts and switching noises being caused by the pull-type magnet.

In elevator installations with large travel heights, cars hanging on suspension means such as, for example, wire ropes or flat belts have the disadvantage that when stopping at a landing they undergo relatively large vertical displacements whose cause is the stretching or contraction of the elastic suspension means due to changes in load. Such changes in load in the car are caused by passengers entering or leaving, or by transportation equipment being put into or taken out of the car. If the vertical displacements exceed a variable limit value, the drive usually executes a compensating movement until the surfaces of the car floor and landing floor are again at the same level. Depending on the type of change in load, several such compensating procedures may be necessary during a stop at a landing.

Furthermore, while stopped at a landing, such elevator cars are susceptible to vertical vibrations caused by the stopping process, changes in load, or the level-compensating procedures described above. Vertical displacements and vibrations of the car can cause passengers to experience unpleasant sensations or even alarm. Moreover, if the surfaces of the car floor and hoistway door sill are not at exactly the same level, this

can lead to accidents caused by passengers stumbling as they enter or leave the car.

5 The situation described can be improved by holding the elevator car fast on its guiderails by frictional engagement.

10 The purpose of the present invention is to create a car braking device which solves the problems concerning vertical displacement and car vibrations described above without impairing the quality of ride, and particularly without causing a jerk when the brake opens for the car to continue its travel.

15 To ensure that there is no jerk when travel commences, when using a car braking device for the purpose described, the car-side suspension means (suspension ropes, suspension and driving belts, or similar elements) should be pre-tensioned to the load which will occur after the brake is opened,
20 which is the case if a drive unit which can be regulated with respect to torque and rotational speed pre-tensions the car-side suspension means via the traction sheave each time before travel commences, so that the braking device is completely relieved before it is opened. For optimal
25 fulfillment of this requirement the drive regulator must have suitable information concerning the load status on the car braking device.

30 In the present invention this is achieved by the devices and measures as described in the characterizing portions of the independent claims 1, 5 and 7.

35 Measuring the holding forces directly on the car braking device is advantageous because this makes it possible to register and compensate the holding forces actually present and because all indirect methods of relieving the brakes are subject to a number of sources of error.

Installation and use of the car braking device with integrated registering of the holding forces according to the invention has a number of important advantages. The
5 first is that perfect relief of the brake before further travel commences is not effected by a pre-tensioning torque being generated by regulation of the drive unit and calculated from the torque registered when stopping and the difference in load measured during the landing stop;
10 instead, it is effected by this torque being continuously increased by the drive unit before travel commences until a measuring bridge formed by the load-measuring sensors of the car braking device is in balance, i.e. the car braking device is perfectly relieved. With this method, deviations
15 due to frictional effects, or resulting from errors in measuring the load in the car, and from inaccuracies in generating a torque corresponding to a calculated reference value, are ruled out.

20 Secondly, its use makes it possible to dispense with the relatively costly measurement of the load in the car, because the load in the car can be sufficiently accurately calculated from the torque on the drive unit before stopping and the change in load on the car braking device
25 during the landing stop, the weights of the car, counterweight, and - depending on the position of the car - ropes being included in this calculation.

Thirdly, the car braking device according to the invention
30 can replace the usual holding brake on the drive unit, although operation with both braking devices is possible.

By means of the measures stated in the dependent claims, advantageous further developments of, and improvements to,
35 the invented objects stated in the independent claims are possible.

Because the car braking device registers the holding forces in the upward and downward direction, the regulable drive unit has enough information available in all possible load situations to completely relieve the car braking device
5 before travel continues and thereby to enable jerk-free starting. Registering the holding forces in the upward and downward direction is necessary for two reasons. If the elevator is operated with a holding brake on the drive unit, the car braking unit is loaded in opposite directions
10 depending on whether passengers enter or leave. If operation is without a holding brake on the drive unit, the direction of load on the car braking device depends on whether the weight of the car and its momentary load is greater or less than that of the counterweight.

15 Integration of the measuring elements into the car braking device itself permits this device to be fastened onto the car in a simple, sandwich-like manner in combination with other car components, and to be electrically connected
20 without problem.

Actuation of the brake levers of the car braking device by a stroke-imparting mechanism acting via a toggle mechanism has the advantage that the force of the stroke-imparting
25 mechanism is amplified many times by simple means, and that in the braked status a continuation of the holding force of the stroke-imparting mechanism is not required. For this reason, and even taking account of power outages, stroke-imparting mechanisms can be used which have no pre-
30 tensioned springs and operate with briefly activated closing and opening strokes such as, for example, a solenoid acting in both directions and having limited switch-on time.

35 An important advantage of this invention is that in the future, when use is made of suspension means made of synthetic fibers (e.g. aramide fiber ropes or flat belts),

the problems in relation to vertical displacements and vibrations during stops at landings which are then expected to occur to a greater extent can be avoided by using the car braking device according to the invention.

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An exemplary embodiment of the invention is illustrated in Figures 1 to 5 and described below.

10 Fig. 1 shows the construction of a car braking device according to the invention, and its interaction with a guiderail;

Fig. 2 shows a cross-section through a car braking device having integral means of registering the holding forces by measuring the deformation of a
15 component;

Fig. 3 shows a cross-section through a car braking device having integral means of registering the holding forces by means of piezoelectric force sensors;

20 Fig. 4 shows a normal elevator installation with two car braking devices built onto it;

Fig. 5 shows a variant in which two car braking devices are actuated by a common stroke-imparting mechanism.

25 Fig. 1 shows a plan view of a car braking device 1 according to the invention. Recognizable on the left is a guiderail 2 of the sort normally used in elevator construction and on which the braking device acts.

30 The car braking device 1 consists essentially of a rectangular block-shaped casing 3 which has fixed inside it a brake arm support 4 with two brake arm swivel bolts 5, the brake arm hub 6.1 and brake shoes 6.2, the brake linings 7, a toggle mechanism 8, a stroke-imparting device
35 9 taking the form of a solenoid, a hydraulic cylinder, or a spindle motor, and a compression spring 10. It also has

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wire-resistance strain gages 11 with which the holding forces of the brake levers are registered.

The holding effect of the car braking device is achieved by the compression spring 10 acting via the toggle mechanism 8 to push the brake arms, which are pivoted on the brake arm swivel bolt 5, apart thereby pressing the brake ends of the arms together and the brake linings 7 against the running surface of the guiderail. In the process, the toggle mechanism greatly amplifies the force of the spring. The position of the car braking device shown in the drawing corresponds to the situation in which it holds the car fast on the guiderails 2 by means of frictional engagement. The car braking device is released by the controllable stroke-imparting mechanism 9 overcoming the pre-tensioned force of the compression spring 19, bringing the toggle mechanism 8 into its flexed position, thereby relieving the brake arms 6 and moving the brake linings to a sufficient distance from the guiderail 2. Not shown in the drawing is a device which uses screws to adjust the effective length of the extended toggle mechanism.

Fig. 2 shows a vertical cross section through the car braking device 1. Shown in the drawing are the car guiderail 2, the baseplate 12 and the cover plate 13 of the casing 3, the brake arm support 4 with the brake arm swivel bolt 5, the brake arm 6 with brake arm hub 6.1 and brake shoe 6.2, and a cross-section through the toggle mechanism 8, the stroke-imparting mechanism 9, and the compression spring 10.

It can be seen from the drawing how registering the holding forces is effected in the car braking device according to the invention. Vertically directed holding forces on the brake shoes 6.2 generate via the brake ends of the brake arms 6 and the brake arm swivel bolt 5 a bending moment on the vertical section 4.1 of the brake arm support 4 which

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generates in it tensile and compressive stresses which are essentially proportional to the holding forces which occur. An electronic interpretation circuit detects these stresses with the assistance of metal or semiconductor wire-

5 resistance strain gages 11 which are fastened in a suitable manner onto the aforementioned vertical section 4.1 and form components of an electrical bridge circuit. For the expert, it is easy to recognize that with this arrangement a correctly signed value for upward or downward directed

10 holding forces can be determined, which serves as information for the control and the drive regulator regarding the load present in the car. On the other hand, by detecting when the bridge circuit is in balance, it can be very accurately determined when no more vertical holding

15 forces are present on the closed brake levers and the car braking device can therefore be opened without generating a jerk.

Fig. 3 illustrates an alternative solution to the method

20 described above of registering the holding forces acting on the car braking device. 18 indicates piezoelectric pressure sensors and 18.1 their connecting cables. Here the casing 3 contains, and has rigidly fastened to it, a metal guiderail support 14 which has two arms 15 in the form of plates each

25 having in it two drilled holes 16 which serve as play-free guides for the brake arm swivel bolts 5. The arms 15 act as a parallelogram guide for these bolts which at one end are rigidly fastened with a pin 17 to the brake arm hub 6.1 of the brake arms 6 and at the other end are supported axially

30 via piezoelectric pressure sensors 18 against the baseplate 12 and the cover plate 13. If there are now vertical holding forces acting on the brake shoes 6.2 they are compensated by parallel, oppositely acting supporting forces acting from the base or cover plate via the pressure

35 sensors 18 on the brake arm swivel bolt 5. The moment on the brake arm swivel bolt is absorbed by horizontal supporting forces between the arms 15 and this bolt. As a

result, only the vertical components corresponding to the holding forces are transmitted to the piezoelectric pressure sensors 18. An electronic circuit interprets their pressure-dependent electrical characteristics and generates
5 the information required by the elevator control and drive regulator.

Fig. 4 shows the application and installation in a normal elevator system of a car braking device according to the
10 invention. The drawing is of an elevator hoistway 20 having installed in it car guiderails 2, a machine room 21 containing a drive unit 22 with traction sheave 23, an elevator car 24 with car sling 25, a counterweight 26; and suspension means 27 which suspend and connect together the
15 car and the counterweight and which are themselves driven by the traction sheave 23.

Fastened to the car sling 25 are roller guide assemblies 28 to guide the car 24 on the car guiderails 2, safety gears
20 29, and the car braking device 1 according to the invention. These components are constructed in such a way that by means of suitable connecting pieces they can be flanged together one below the other in the form of a sandwich and onto the car sling. On very heavy cars, use of
25 this technique makes it possible to install two or even more car braking devices one below the other.

Fig. 5 shows a preferred arrangement of two car braking devices 1 in which a common compression spring 30 actuates
30 a connection rod 32 and the toggle mechanisms 8 of both braking devices, and a common stroke-imparting device 31 fastened to the car sling acts against the pressure spring 30 to release them, as a result of which synchronous functioning is assured and one-sided braking is ruled out.

List of Reference Numbers

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|----|------|-------------------------------------|
| | 1. | Car braking device |
| | 2. | Car guiderail |
| 5 | 3. | Casing |
| | 4. | Brake arm support |
| | 5. | Brake arm swivel bolt |
| | 6. | Brake arm |
| | 6.1 | Brake arm hub |
| 10 | 6.2 | Brake shoe |
| | 7. | Brake lining |
| | 8. | Toggle mechanism |
| | 9. | Stroke-imparting mechanism |
| | 10. | Compression spring |
| 15 | 11. | Wire-resistance strain gage |
| | 12. | Baseplate |
| | 13. | Cover plate |
| | 14. | Guiderail support |
| | 15. | Extension |
| 20 | 16. | Drilled hole |
| | 17. | Pin |
| | 18. | Piezoelectric pressure sensor |
| | 18.1 | Connecting cable to pressure sensor |
| | 19. | - |
| 25 | 20. | Elevator hoistway |
| | 21. | Machine room |
| | 22. | Drive unit |
| | 23. | Traction sheave |
| | 24. | Elevator car |
| 30 | 25. | Car sling |
| | 26. | Counterweight |
| | 27. | Suspension means |
| | 28. | Roller guide assembly |
| | 29. | Safety gear |
| 35 | 30. | Common compression spring |
| | 31. | Common stroke-imparting mechanism |
| | 32. | Connecting rod |

Patent Claims:

- 5 1. Device to prevent vertical displacements and vertical vibrations of load carrying means (24) of vertical conveyors while stopped at landings, having attached to the load carrying means (24) a braking device (1) which during halts at landings holds the load carrying means
10 (24) fast on its guiderails (2) by means of frictional engagement and releases this frictional engagement in the presence of a corresponding control command, characterized in that
hoisting of the load carrying means (24) is effected by
15 elastic suspension means (27) and the braking device (1) contains sensors (11, 18) to register the vertically directed holding forces which occur.
- 20 2. Device to prevent vertical displacements and vertical vibrations of the load carrying means of vertical conveyors while stopped at landings according to Claim 1, characterized in that
the sensors (11, 18) integrated in the braking device (1) register the vertically directed holding forces
25 which occur in the upward and downward direction.
- 30 3. Device to prevent vertical displacements and vertical vibrations of the load carrying means of vertical conveyors while stopped at landings according to Claims 1 and 2,
characterized in that
the vertically directed holding forces are registered by measuring the elastic deformations of components of the braking device (1) caused by them, or by
35 piezoelectric force sensors (18) located at suitable positions in the flow of force between the point of

braking and the load carrying means (24).

4. Device to prevent vertical displacements and vertical vibrations of the load carrying means of vertical conveyors while stopped at landings according to one or more of the foregoing claims, characterized in that it has brake arms (6) which are actuated by means of a stroke-imparting mechanism (9) (e.g. electromagnet, hydraulic cylinder, or spindle motor) via a toggle mechanism (8).
5. Vertical conveyor for persons or freight containing at least one drive unit (22), which is regulated in relation to torque and rotational speed, and a load carrying means (24) which is guided by guiderails, the load carrying means having a controllable braking device (1) which during halts at landings holds the load carrying means (24) fast on its guiderails (2) by means of frictional engagement, characterized in that hoisting of the load carrying means (24) is effected by elastic suspension means (27) and the braking device (1) contains sensors (11, 18) to register the vertically directed holding forces which occur.
6. Device to prevent vertical displacements and vertical vibrations of the load carrying means of vertical conveyors while stopped at landings according to one or more of the foregoing claims, characterized in that hoisting of the load carrying means (24) is effected by suspension means (27) of synthetic fibers.
7. Method of preventing vertical displacements and vertical vibrations of the load carrying means of vertical conveyors while stopped at landings, the

conveyor installation containing at least one drive unit (22) which can be regulated, and a load carrying means (24) with a braking device (1), and this load carrying means (24) being guided by guiderails (2),

5 characterized in that

hoisting of the load carrying means (24) is effected by elastic suspension means (27), and that while stopped at a landing the load carrying means (24) is held fast on its guiderails (2) by means of the braking device (1), and sensors integrated in the braking device (1)

10 communicate the magnitude and direction of the vertically directed holding forces to a drive regulator.

15 8. Method according to Claim 7, characterized in that

before travel continues, the drive regulator uses the magnitude and direction of the vertically directed holding forces communicated by the sensors (11, 18) to

20 adjust the torque on a traction sheave of the drive unit, and thereby the tensile force in the suspension means (27) carrying the load carrying means (24), so that the braking device can be deactivated without being under load.

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9. Method according to Claims 7 and 8, characterized in that

in a conveyor installation having a drive unit (22) without holding-brake the aforementioned adjustment of tensile force in the suspension means (27) carrying the

30 load carrying means (24) before travel continues takes place in such a manner that the regulated drive unit applies to the traction sheave (23) a varying torque, whose direction depends on the sign of the holding

35 force of the braking device (1) registered by the sensors (11, 18), and thereby develops a varying tensile force in the suspension means (27) carrying the

load carrying means (24) until a measuring bridge formed by the sensors is in balance, i.e. the holding force on the braking device (1) is zero, at which point this braking device is deactivated and the drive unit
5 (22) accelerates the load carrying means (24) in the direction of its destination.

10. Method according to Claims 7 and 8,
characterized in that

10 in a conveyor installation having a drive unit (22) with holding-brake the aforementioned adjustment of tensile force in the suspension means (27) carrying the load carrying means (24) before travel continues takes place in such a manner that, with the drive holding-
15 brake still activated, the regulated drive unit (22) first develops a torque corresponding to the load status registered before stopping at the landing, the drive holding-brake is then opened, and with the braking device (1) of the load carrying means (24)
20 still active the regulated drive unit then applies to the traction sheave an increasing or decreasing torque, whose direction depends on the sign of the holding force of the braking device (1) registered by the sensors (11, 18), until a measuring bridge formed by
25 the sensors is in balance, i.e. the holding force on the braking device (1) is zero, at which point this braking device (1) is deactivated and the drive unit (22) accelerates the load carrying means (24) in the direction of its destination.