

Description

Controllable lift brake

The invention relates to a method of controlling a lift brake comprising a housing and a brake unit which is movable in axial direction on a path between a braking position and a starting position and is disposed in operative connection with at least one pull unit and which is moved at least by means of a first spring force of at least one brake spring.

Lift brakes on the one hand have to rapidly respond in the case of emergency and stop the lift cage and the counterweight without delay and on the other hand the lift brakes have to operate as quietly as possible so that the noises arising when the lift brake responds do not have a disturbing effect in the areas adjoining the lift installation. Known lift brakes comprise at least one spring or brake spring generating a braking force, wherein an electromagnetic device with at least one electromagnetic coil operates against the spring force and in that case keeps the brake in, inter alia, a starting position. If the voltage at the coil is switched off, the magnetic field collapses and the one brake unit of the lift brake presses against, for example, a brake disc, lift rail, etc., due to the spring force of the at least one brake spring. The brake unit in that case accelerates under the action of the spring force of the brake spring and presses against the brake disc in order to achieve a braking action. The brake unit usually presses from one side and a further brake unit from the opposite side against the brake disc such as is known, for example, from WO 97/42118.

In the case of an emergency it can be necessary for a lift cage of the lift installation to be moved to an evacuation storey, for example for evacuation of persons who are trapped in the lift cage. For that purpose the lift brake has to be released. If, however, no power supply is available for the lift installation the lift brake cannot be released without consequent dropping of the lift cage. In order to prevent dropping of the lift cage, the lift brake has to be controllable so that the lift cage in the case of emergency can, for example, be safely moved to an evacuation storey.

However, even in the case of normal operation of the lift cage it can be useful for the lift brake to be regulable, for example for smoother braking.

It is an object of the invention to propose a simple and efficient possibility for regulation of a lift brake.

The invention is fulfilled by way of the features of the independent patent claims. Developments are indicated in the dependent claims.

A core of the invention consists in that for control or regulation of a lift brake by means of a stroke unit, which generates a stroke, at a pull unit of a brake unit a movement in axial direction against a first spring force is generated by means of a brake spring, wherein the first spring force of the at least one brake spring is reduced by means of a second spring force of a compensating spring stressed by the stroke of the stroke unit.

The lift brake comprises at least one housing and at least one brake unit movable in axial direction on a path between a braking position and a starting position. In addition, the lift brake comprises at least one brake spring which is disposed in operative connection with the movable brake unit and which can be arranged in the housing. The at least one brake spring exerts a first spring force on a movable brake unit. The movable brake unit is in operative connection with a pull unit. The at least one pull unit and the brake unit are either formed from one piece or connected together by way of suitable means, for example screws, by welding, by gluing, by means of a cable or similar, etc. The pull unit of the brake unit can be so arranged that it protrudes through the housing of the lift brake, wherein it can be arranged centrally, decentrally, symmetrically, asymmetrically, etc., through the housing of the lift brake. It is also possible for the pull unit to be arranged in a suitable construction outside the housing of the lift brake. The pull unit can be, for example, a rod of metal, a cable, a wire cable, etc.

In principle any unit which can generate a stroke in axial direction can be used as stroke unit. Ideally, in that case use is made of a non-self-locking stroke unit. Thus, for example, a ball cap unit, a trapezium thread unit, a non-self-locking thread, a spindle unit, etc., can be used as stroke unit. The brake unit with the pull unit is moved in axial direction against the first spring force of the at least one brake spring by means of the stroke unit. Through the second spring force of the at least one compensating spring, which can be disposed or arranged in or near the stroke unit, the amount of the first spring force of the at least one brake spring is reduced by the amount of the second spring force of the compensating spring.

The movement of the stroke unit and thus the axial movement of the brake unit can be carried out by means of at least one actuator connected with the stroke unit. However, the actuator can also be integrated in the stroke unit. In that case, a manually operable lever, a motor-spindle unit, a spindle unit, a motor, a hydraulic unit, a stroke magnet, etc., can be used as at least one actuator. The at least one actuator can according to the invention be controlled or regulated by way of a control unit connected with the at least one actuator. It is thus possible for the stroke of the stroke unit to be regulated or controlled by way of the at least one actuator with the help of the control unit. The control unit can be, for example, a lift control unit which is connected with the at least one actuator by way of a suitable communications network, whether by way of a line or not by way of a line. The control unit could obviously also be represented by a separate unit. The control unit can regulate or control the stroke of the stroke unit by way of the at least one actuator by means of analysis, evaluation or comparison of obtained data or parameters, for example position data, speed data, acceleration data, etc., which are transmitted from at least one sensor unit to the control unit by way of a communications network. It is thus possible for the lift brake to be able to be regulated or controlled. As sensor unit in a lift installation any unit can be used which can make available data or parameters necessary for regulation or control of the lift brake. By way of example, an acceleration sensor, an incremental transmitter, an incrementing motor, a position sensor, a speed sensor, etc., comes into consideration as sensor unit.

A lift brake frequently comprises at least one electromagnetic coil, wherein the at least one electromagnetic coil can be arranged in the housing. The electromagnetic coil is in that case used for holding the brake unit in a starting position. In the starting position no braking action by the lift brake takes place. An additional possibility for reducing the first spring force of the at least one brake spring in the method according to the invention can be achieved in that in addition to the second spring force of the compensating spring use is made for that purpose of an electromagnetic force of the at least one electromagnetic coil. The at least one electromagnetic coil could also be used for the purpose of completely releasing the lift brake, i.e. the magnetic force F_M is either with or without the second spring force F_{AF} greater than the first spring force F_{BF} of the at least one brake spring BF, and the force resulting therefrom is $F_N = 0$. The first spring force F_{BF} is thus cancelled by the magnetic force F_M either with or without the second spring force F_{AF} . A release of the lift brake thus means that the brake unit has no braking action and, for

example, no longer has contact with the brake disc by the brake lining.

Not only the stroke of the stroke unit by way of the actuator, but also the magnetic force of the at least one electromagnetic coil can in that case be controlled, regulated or varied by the control unit.

An advantage of the invention consists in that through the stroke unit, which acts on the brake unit, and the compensating spring the first spring force of the at least one brake spring can be regulated and thus, for example, a reliable possibility for controlled movement or controlled lowering of a lift cage to an evacuation storey in the case of an emergency can be offered.

A further advantage of the invention consists in that in the case of an emergency a smoother braking without transgressing safety standards can be performed for the lift cage by way of the method according to the invention.

The invention is explained in more detail on the basis of an exemplifying embodiment illustrated in the figures, in which:

- Fig. 1 shows a lift brake in a braking position,
- Fig. 2 shows the lift brake in a regulated braking position,
- Fig. 3 shows the lift brake in a starting position,
- Fig. 4a shows a plan view of an exemplifying ball cap unit,
- Fig. 4b shows a cross-section through the exemplifying ball cap unit in a starting position,
- Fig. 4c shows a cross-section through the exemplifying ball cap unit in a stroke position,
- Fig. 5 shows a braking diagram of the lift pull brake according to the invention,

Fig. 6a shows a further example of a lift brake,

Fig. 6b shows a section through the z-y plane of the further example of a lift brake and

Fig. 7 shows a control system for a regulated lift brake.

Figure 1 shows an example of a lift brake in a braking position. In this example the lift brake comprises a housing 4 in which at least two brake springs BF for generating a further spring force F_{BF} are arranged, and a brake unit 3, which is movable in axial direction, with a brake lining 2. The brake lining 2 in the braking position presses, by virtue of the first spring force F_{BF} of the at least two brake springs BF, against a brake disc 1. On the opposite side of the brake unit 3 with a braking lining 2 a further brake unit 9 with a brake lining 2 presses against the brake disc 1. It is thereby possible, for example, to brake a lift cage (not illustrated) of a lift installation, for example in the case of an emergency.

The brake unit 3 is disposed in operative connection with a pull unit 6 and in this example is fixedly connected with the pull unit 6. The brake unit 3 and the pull unit 6 can be formed from one piece, for example by a casting, milling, punching, etc., or can be joined together by way of suitable means, for example by screw-connecting, gluing, welding, etc. In this example the pull unit 6 is of rod-like construction and can be made of plastics material, metal, ceramic, etc. The pull unit 6 can protrude through the housing 4 centrally or in centred manner. Arranged in connection with the housing 4 is a stroke unit 5.

The stroke unit 5 is disposed in operative connection with the pull unit 6. Thus, it (5) can, as in this example, be arranged at or on the pull unit 6 so that a movement in axial direction of the pull unit 6 and thus of the brake unit 3 can be generated. The movement of the brake unit 3 or of the pull unit 6 is produced in that the stroke unit 5 generates a stroke or a movement in axial direction. How this stroke is generated depends on the stroke unit 5 used. Thus, for example, a ball cap unit, a hydraulic cylinder, a spindle unit, a trapezium thread unit, etc., can be used as the stroke unit 5. For generating the stroke the stroke unit for this purpose comprises at least one stroke generating unit 5.1. The stroke generating unit 5.1 can be a spindle unit, at least one ball cap as is described in Figure 4, a screw unit, etc. In addition, the stroke unit 5 can enclose the pull unit 6 and be fixedly

connected with the pull unit 6. In this example a ball cap unit with balls 7 of steel, plastics material, ceramic, etc., is used as stroke unit 5 for generating a movement in axial direction of the brake unit 3 or of the pull unit 6. By movement in axial direction there is to be understood a movement along the x axis in a Cartesian co-ordinate system. Obviously, it is possible in accordance with the invention for the stroke unit 5 to also generate a movement of the brake unit 3 or of the pull unit 6 in any spatial direction (x, y, z co-ordinates in a Cartesian co-ordinate system).

A compensating spring AF is stressed by the generated movement or the generated stroke of the stroke unit 5. For that purpose the compensating spring AF is disposed in operative connection with the stroke unit 5. The compensating spring AF can, as illustrated in this exemplifying embodiment, be arranged behind the stroke unit 5 on the pull unit 6. For that purpose the pull unit 6 has a terminal 13 so that the compensating spring AF can be stressed. It is equally possible for the compensating spring AF to be integrated in the stroke unit 5 or in another unit of the lift brake, for example in the brake unit 3, in an actuator 8, etc. In addition, it (AF) could also be arranged as a separate unit in the housing of the lift brake.

Generation of the stroke or the movement in the case of the stroke unit 5 is usually effected by an actuator 8. Thus, the braking force generated by the first spring force F_{BF} of the at least one brake spring BF of the at least one brake spring BF can be controlled or regulated by means of the movement of the stroke unit 5. The actuator 8 can be a manual lever, but it is also possible to use a motor-spindle unit, a motor, a stroke magnet, a hydraulic unit, etc., as actuator 8. The control or regulation of the movement of the actuator 8 can be effected with the help of a control unit which is connected with the actuator 8, but not illustrated in this example. For that purpose the actuator 8 is connected by way of a suitable communications network, for example a wire-bound or wire-free communications network, a radio communications network, etc., with the control unit. A lift control unit of a lift installation or a separate unit can, for example, be used as control unit.

In this example the lift brake is disposed in the braking position. This means that by virtue of the first spring force F_{BF} of the at least one brake spring BF the movable brake unit 3 presses by the brake lining 2 against the brake disc 1. At the opposite side of the brake unit 3 a further brake unit 9 presses by a brake lining 2 against the brake disc 1. The braking force of the first spring force F_{BF} of the at least one brake spring BF in that case

corresponds with the oppositely acting normal force or resultant force F_N and thus the maximum braking force, i.e. $F_N = F_{BF}$.

In the braking position of the lift brake no stroke or no movement is generated by the stroke unit 5. Thus, neither a movement of the brake unit 3 in axial direction is produced nor is the compensating spring AF stressed. The actuator 8 can in this situation be disposed in a position A, i.e. a starting position.

Figure 2 shows the lift brake, which is described in accordance with Figure 1, in a regulated braking position. For that purpose the actuator 8 is brought into a position B which leads to generation of a stroke H_1 or a movement by the stroke unit 5, which stroke H_1 has the consequence of stressing of a compensating spring AF. In this example the stroke H_1 of the stroke unit 5 is generated by a ball cap unit. The larger the generated stroke H_1 of the stroke unit 5 the greater in that case the second spring force F_{AF} of the stressed compensating spring AF. The position B is not a discrete position. Rather, it is intended by that that in the position B a reduced, but nevertheless still present, braking action of the lift brake is present.

By virtue of generation of the stroke H_1 of the stroke unit 5 the first spring force F_{BF} of the at least one brake spring BF or the amount of the first spring force F_{BF} is reduced by the second spring force F_{AF} of the compensating spring AF or by the amount of the second spring force F_{AF} . The resultant force F_N or the residual braking action can thus be described by the formula $F_N = F_{BF} - F_{AF}$.

Figure 3 shows the lift brake, which is described in accordance with Figures 1 and 2, in a starting position. In this starting position there is no braking effect, i.e. the lift brake is opened or released. This can be achieved in that the actuator 8 is brought into a position C so that the second spring force F_{AF} of the compensating spring is the same as or greater than the first spring force F_{BF} of the at least one brake spring BF. The resultant force F_N is in that case $F_N = 0$. Through the displacement or rotation of the actuator 8 into the position C the stroke unit 5 generates a stroke H_2 or movement of such a size that the brake unit 3 no longer has contact by the brake lining 2, which is moved in axial direction, with the brake disc 1 and the second spring force F_{AF} of the compensating spring AF in terms of amount is equal to or greater than the amount of the first spring force F_{BF} of the at least one brake spring BF. In addition, the brake unit 9 is in that case no longer pressed against

the brake disc 1 by the brake lining 2, so that overall there is no braking action of the lift brake.

Figure 4a shows a plan view of an exemplifying ball cap unit with three stroke generating units 5.1 or caps K1, K2 and K3, such as can be used, for example, as the stroke unit 5 according to the invention. The ball cap unit has, for example, a circular shape in plan view. As plan view there is meant in this example a section through the area (y-z plane) spanned by the y axis and the z axis of a Cartesian co-ordinate system. A ball cap unit basically consists, as illustrated in Figures 4b and 4c, of at least one first unit 16 provided with caps and ideally a second unit 17, which is used as cover unit for the first unit 16, and balls or rollers which are embedded usually in identical caps K1, K2 and K3 and thus are arranged between the first unit 16 and the second unit 17. A so-called double cap unit is illustrated in Figures 4b and 4c. A double-cap unit of that kind consists of two single cap units disposed one over the other. A double cap unit has on the one hand the advantage that a larger stroke can be generated and on the other hand that only the second unit 17 has to be moved or has to be rotatable relative to the first unit 16 and in that case the first units 16 can be designed to be secure against rotation. In this exemplifying embodiment the angle between a cap K1, K2, K3 is 120 degrees. Thus, it is to be understood that the caps K1, K2, K3 are arranged symmetrically on the circular area of the first unit 16. The number and angle between the caps K1, K2, K3 are obviously freely selectable. A respective ball of steel, plastics material, ceramic, etc., is embedded in the caps K1, K2, K3.

If the second unit 17 is rotated relative the first units 16 of the ball cap unit about the x axis, the balls or rollers are moved in the stroke generating units 5.1 or caps K1, K2, K3 from a first position P1 to a second position P2 and a stroke H thereby arises in the x axis in the case of the cap unit or stroke unit 5, which is used for the method according to Figures 1 to 3.

Figures 4b and 4c show a cross-section of the cap unit according to Figure 4a along the line A-A through the cap K2 or the stroke generating unit 5.1. The cap K2 has in that case an inclination α . A ball 7 is disposed with its geometric centre on a position P1 or in its starting position in the cap K2. In the starting position the stroke H of the cap unit is equal to zero ($H = 0$). If, as described in Figure 4a, the second unit 17 is rotated relative to the first units 16, the ball 7 moves from the position P1 or out of its starting position to a

position P2, as is illustrated in Figure 4c. A stroke $H = H_1$ or H_2 thereby arises, which in the case of a single cap unit is basically at most as large as the diameter of the ball 7 and in the case of the double cap unit appropriately larger.

Figure 5 shows a braking diagram of the lift pull brake according to the invention. A stroke H generated by the stroke unit 5 in accordance with Figures 1 to 4b is applied against a force F . In that case a plot $F_N(H)$ of the normal force or resultant force and a plot $F_{AF}(H)$ of the (second) spring force of the compensating spring AF arise.

If the spring force F_{AF} is greater due to generation of the stroke H , H_1 , H_2 of the stroke unit 5, the braking action of the lift brake progressively reduces, as can be seen on the basis of the region RBM. From a point DB there is no longer a braking effect. The theoretical course of the spring force F_{AF} is illustrated in the diagram by a dashed line. The resultant force F_N from the second spring force F_{AF} plus the first spring force F_{BF} is smaller than the theoretical spring force of the second spring force F_{AF} .

Figure 6 shows a further schematic example for an embodiment of a lift brake according to the invention, as is described in Figures 1 to 3. For reasons of clarity no housing is shown in this exemplifying embodiment. The lift brake comprises a brake unit 3 with a brake lining 2, which presses against brake disc 1 and thus achieves a braking action of, for example, a lift cage. In an inactive position, i.e. the brake unit 3 does not press by the brake lining 2 against the brake disc 1, the brake unit 3 is held in the starting position by at least one electromagnetic coil 10. Instead of the at least one electromagnetic coil 10 use could obviously also be made of a mechanical holding device for the brake unit 3.

The brake unit 3 is pressed by means of a first spring force of at least one brake spring BF - in this example the brake spring BF is formed as a plate spring - against the brake disc 1.

In order to regulate or control the lift brake use is made of a stroke unit 5. This stroke unit comprises a first unit 11 which is connected with a second unit 12 by way of a pull unit 6, in this example being at least one cable, wire cable, synthetic material cable, etc. The first unit 11 and the second unit 12 can consist of metal, plastics material, ceramic, etc. The first unit 11 is connected with the brake unit 3 so that the pull unit 6 is disposed in operative connection with the brake unit 3. The form of the first unit 11 and the second unit 12 depends on the construction of the lift brake and/or the kind of stroke unit 5. The

second unit 12 additionally comprises an actuator 8, in this example being a manually operable lever. Obviously use can also be made of an actuator 8 such as is described in Figures 1 to 3. In addition, instead of at least one cable, wire cable, etc., use could also be made of a spindle unit, a screw unit, a hydraulic cylinder, etc., as the pull unit 6. A compensating spring AF - in this example a plate spring - is disposed between the first unit 11 and the second unit 12.

Due to a movement of the stroke unit 5, i.e. a turning of the second unit 12 relative to the first unit 11, by the actuator 8 the brake unit 3 is moved by way of the pull unit 6 in axial direction and the compensating spring AF is stressed. The turning or rotation of the second unit 12 relative to the first unit 11 takes place in this example about the x axis. Figure 6a shows a section through the x-y plane of a Cartesian co-ordinate system.

Figure 6b shows a section through the z-y plane of the Cartesian co-ordinate system. The first unit 11 in the case of turning either does not rotate or rotates against the rotational direction of the second unit 12. The first spring force of the brake spring BF is thereby reduced by a second spring force of the compensating spring AF, so that the resultant force, as already described in Figures 1 to 5, is calculated from the formula $F_N = F_{BF} - F_{AF}$.

The reduction of the first spring force F_{BF} of the brake spring BF can take place, apart from use of the second spring force F_{AF} of the compensating spring AF, additionally in that an electromagnetic force F_M of the at least one electromagnetic coil 10 is used. This possibility for additional reduction of the first spring force F_{BF} of the brake spring BF can also be used in the exemplifying embodiment according to Figures 1 to 3. The at least one electromagnetic coil 10 could also be used for the purpose of entirely releasing the lift brake, i.e. the magnetic force F_M is, either with or without the second spring force F_{AF} , greater than the first spring force F_{BF} of the at least one brake spring BF and the force resulting therefrom is $F_N = 0$. The first spring force F_{BF} is thus cancelled, either with or without the spring force F_{AF} , by the magnetic force F_M . A release of the lift brake means that the brake unit 3 does not produce any braking effect and, for example, no longer has contact by the brake lining 2 with the brake disc 1. For that purpose the lift brake according to Figures 1 to 3 comprises at least one electromagnetic coil 10, which, for example, can be arranged in the housing 4.

The electromagnetic force F_M can be regulated by means of a control unit such as is

described in Figures 1 to 3 and 7. The control unit could obviously control or regulate not only the electromagnetic force F_M , of the at least one electromagnetic coil 10, but also the actuator 8 or the stroke unit 5. From use of the electromagnetic coil 10 and the compensating spring AF for control or regulation of the lift brake there results as formula for the resultant force: $F_N = F_{BF} - F_{AF} - F_M$.

Figure 7 shows a control system for a regulated lift brake according to Figures 1 to 6. As described in Figures 1 to 6, a stroke H , H_1 , H_2 is generated by the actuator 8 in the stroke unit 5 and thus the lift brake is regulated. The control or regulation of the actuator 8 takes place through a control unit 14, which, for example, can be the lift control or a separate control unit. In order to regulate or control the lift brake the control unit 14 obtains data or parameters from at least one sensor unit 15. These data or parameters can be, for example, positional data or parameters, speed data or parameters, acceleration data or parameters, etc. Any sensor unit 15 which can supply the requisite data can be used as sensor unit 15. Thus, for example, an acceleration sensor, a position sensor, an incrementing motor or incremental transmitter, a speed sensor, etc., can be used. The control unit 14 controls the actuator 8 and thus the stroke unit 5 in dependence on a comparison, an analysis or an evaluation of data or parameters obtained by the sensor unit 15. The braking action or the retardation of the lift brake is thus regulated. It is obviously possible for the control unit 14 to control or regulate the stroke unit 5 and/or the at least one electromagnetic coil of Figure 6. The actuator 8 can be integrated in the stroke unit 5.

Patent claims

1. Method of controlling a lift brake comprising a housing (4) and a brake unit (3), which is movable in axial direction on a path between a braking position and a starting position and is disposed in operative connection with at least one pull unit (6) and which is moved at least by means of a first spring force (F_{BF}) of at least one brake spring (BF), characterised in that a movement in axial direction against the spring force (F_{BF}) of the at least one brake spring (BF) is generated by means of a stroke unit (5), which generates a stroke (H, H_1, H_2), at the pull unit (6) of the brake unit (3) and that the first spring force (F_{BF}) of the at least one brake spring (BF) is reduced by means of a second spring force (F_{AF}) of a compensating spring (AF) stressed by the stroke (H, H_1, H_2) of the stroke unit (5).
2. Method according to claim 1, characterised in that the compensating spring (AF) is arranged in or near the stroke unit (5).
3. Method according to claim 2, characterised in that at least one ball cap unit, a non-self-locking thread, a spindle unit or a plate spring unit is used as stroke unit (5).
4. Method according to claim 1, characterised in that the pull unit (6) of the brake unit (3) is so arranged that it projects through the housing (4).
5. Method according to any one of the preceding claims, characterised in that the movement in axial direction is executed by the brake unit (5) by means of at least one actuator (8) connected with the stroke unit (5).
6. Method according to claim 5, characterised in that a manually operable lever, a motor-spindle unit, a stroke magnet, a motor or a hydraulic unit is used as at least one actuator (8).
7. Method according to claim 6, characterised in that the at least one actuator (8) is controlled by a control unit (14) connected with the at least one actuator (8).
8. Method according to claim 1, characterised in that the stroke unit (5) is controlled by the control unit (14).

9. Method according to claim 1, characterised in that the first spring force (F_{BF}) of the at least one brake spring (BF) is either reduced or cancelled by means of the second spring force (F_{AF}) of the compensating spring (AF) and an electromagnetic force (F_M) of at least one electromagnetic coil (10).

10. Device for controlling a lift brake comprising a housing (4) and a brake unit (3) movable in axial direction on a path between a braking position and a starting position, wherein the brake unit (3) is operatively connected with at least one pull unit (6) and wherein the brake unit (3) moves due to a first spring force (F_{BF}) of at least one brake spring (BF), characterised in that a stroke unit (5), which generates a stroke (H, H_1, H_2), at the pull unit (6) of the brake unit (3) generates a movement in axial direction against the first spring force (F_{BF}) of the at least one brake spring (BF) and that a second spring force (F_{AF}) of a compensating spring (AF), which is stressed by the stroke (H, H_1, H_2) of the stroke unit (5), reduces the first spring force (F_{BF}) of the at least one brake spring (BF).