

Lift installation, a guide rail of a lift installation, brake equipment of a lift installation and a method for guiding, holding and braking a lift installation

Description:

The invention relates to a lift installation, to a guide rail of a lift installation, to brake equipment of a lift installation and to a method for guiding, holding and braking a lift installation, according to the introductory part of the independent patent claims.

A lift installation substantially serves for vertical transport of goods or persons. The lift installation includes for this purpose a lift cage for reception of the goods or persons, which lift cage is movable along a guide path. As a rule, the lift installation is installed in a building and the lift cage transports goods or persons from and to various storeys of this building. In a customary construction the lift cage is installed in a shaft of the building and it contains, apart from the cage, support means which connect the cage with the counterweight. The lift cage is moved by means of a drive, which acts selectably on the support means or directly on the lift cage or the counterweight. The guide path for guidance of the lift cage is usually a guide rail which is fixedly arranged in the building or in the shaft. From time to time a lift installation of that kind is also arranged outside a building, wherein then the guide path can be part of a structure. Lift installations of that kind are equipped with brake systems which on the one hand can hold the lift cage in a stopping position and/or can brake and hold the lift cage in the event of a fault.

A lift installation with brake equipment is known from EP 1 213 249, in which holding and braking is achieved in that a brake part is brought into mechanically positive contact with a stationary part. The brake part is for that purpose pressed against the stationary part by a small force. In this connection a defined sliding movement, which enables braking, is brought about at the brake part. The brake equipment requires, in particular, low brake actuating forces and thus also low brake release forces.

The problem with this solution is now to be seen in the fact that the brake equipment has to include sliding equipment so as to make possible, in the case of braking, a gentle stopping of the lift cage. This requires, above all in the case of higher speeds, long slide paths and associated elements defining braking force, such as, for example, springs. This necessitates much constructional space and is expensive.

The invention is based on the object of providing brake equipment of a lift installation which can hold a lift cage in a lift installation at standstill with low actuating forces, but in the case of emergency is also in a position of braking the lift cage. In addition, it shall demand little constructional space.

The invention defined in the characterising features of the independent patent claims fulfils this object.

The lift installation comprises a lift cage and brake equipment for braking and holding the lift cage. The brake equipment comprises a brake lining which co-operates with a brake surface for the purpose of the holding and braking.

Moreover, the invention relates to a guide rail of a lift installation. The brake rail brakes and holds the lift cage by means of brake equipment. In that case the brake rail has a brake region as brake surface for interaction with the brake equipment.

Equally, the invention relates to a method for guiding, holding and braking the corresponding lift installation.

According to the invention the brake surface has at least one longitudinal wedge groove or wedge elevation which is oriented in braking direction and on which the brake lining acts in case of need. This longitudinal wedge groove or longitudinal wedge elevation can be a groove or elevation of appropriate width or several wedge grooves can lie adjacent to one another. The advantage of this construction is to be seen in that the wedge groove shape effects an amplification of a normal force and that with this normal force a high braking force can thus be achieved, wherein a possibility of sliding is additionally given.

The normal force F_N is that force which presses the brake lining towards the planar brake surface in the case of need. The planar brake surface is oriented perpendicularly (90°) relative to the normal force F_N . This normal force F_N produces a braking force F_B which is defined by the coefficient of friction μ between brake lining and brake surface.

$$F_B = F_N \times \mu$$

If the brake equipment in relation to the brake surface is disposed at standstill, a coefficient of static friction μ_H is to be used as coefficient of friction μ and in the case of a relative movement between brake equipment and brake surface a coefficient of sliding friction μ_G is used. A braking force amplification in correspondence with a wedge plane form results with use of a wedge groove. In the case of a wedge plane inclination in correspondence with an angle α , wherein the angle α denotes the plane deviation of the wedge plane from the planar brake surface, a braking force amplification of $1/\cos\alpha$ results. The resulting braking force F_{BK} is:

$$F_{BK} = (1/\cos\alpha) \times F_N \times \mu$$

A significant amplification of braking force can thus be achieved by means of the longitudinal wedge groove or wedge elevation. It is clear that as a rule there is selection of a symmetrical wedge shape so that lateral forces mutually cancel.

Advantageously, the brake lining has a counter-shape adapted to the longitudinal wedge groove or wedge elevation of the brake surface. Wear of the brake lining can thereby be kept small, since the wedge surfaces rest or rub on one another. Obviously it is to be ensured that in the case of wear the brake lining can be appropriately urged forward. In this connection it is to be noted that current items of brake equipment are increasingly employed for sole holding of the lift cage at a floor. This holding force F_H results from, for example, a maximum load difference between cage and counterweight. In inversion of the above-mentioned formula for calculation of the braking force, there accordingly results a required normal force F_{NH} for holding a cage at a floor of:

$$F_{NH} = F_H \times \cos\alpha / \mu_H$$

Analogously, a required normal force F_{NB} for braking a cage results:

$$F_{NB} = F_B \times \cos\alpha / \mu_G$$

In this connection, the required braking force F_B is used instead of the holding force F_H and the coefficient of sliding friction μ_G is used instead of the coefficient of static friction μ_H .

A pressing device for holding and braking the cage can be designed, in correspondence

with the wedge angle α , with lower pressing forces F_N . This enables use of smaller drive units or brake release units, which is correspondingly more favourable.

Advantageously, in the design of the brake equipment the number of brake linings and/or items of brake equipment which co-operate is to be taken into consideration.

In a preferred embodiment the brake equipment is arranged in the region of the lift cage and the brake surface is integrated in a guide rail, which guide rail at the same time guides the lift cage. Advantageously at least one brake equipment is used per guide rail. This is advantageous, since the cage can thereby be directly held at a stop. Stretchings of support means thereby do not influence a loading or unloading process.

A further advantage of this solution according to the invention is to be seen in that the brake lining and thus the brake equipment is at the same time laterally guided by the longitudinal grooves. Derailing of the braking lining and thus failure of the braking action are effectively prevented.

An embodiment in which the guide rail has a guide region for interaction with the guide means and a brake region as brake surface for interaction with the brake equipment is particularly advantageous, wherein the guide region and brake region have different surfaces and the guide region is geometrically separated from the brake region. This embodiment allows an optimum and functionally appropriate design of the respective regions.

Advantageously the guide rail is a T-shaped guide rail, which has a rail web, and this rail web has both the guide region for interaction with the guide means and the brake region for interaction with the brake equipment. Other forms of brake rails are obviously also possible, such as, for example, guide rails in the form of an angle profile member or any other shapes. T-shaped guide rails are widely known in lift construction and manufacture thereof is possible in simple manner.

In an embodiment of particularly elevated quality the guide region is provided with a slide means for reducing friction or it is furnished with a slide coating, wherein the slide coating is a profile member, preferably a synthetic material profile member which contains 'Teflon' and which, for example, is plugged onto the relevant web of the guide rail.

Nano-composites, for example homogeneously formed nickel-fluoropolymer coatings, are, for example, also particularly suitable as the slide means coating, since they enable unchanging slide characteristics in conjunction with good chemical and mechanical properties. This construction enables provision of a guide rail which does justice to high demands on comfort.

The brake region can be formed directly in the basic structure of the brake track. The brake track or the corresponding guide rail is, for example, drawn, rolled or mechanically processed. Alternatively, the brake region can also be produced by means of a brake profile member mounted on the basic structure of the guide rail. The brake region can obviously be provided with a friction-influencing means, for example nano-composite, or with a surface structure for increasing friction. An advantage of this embodiment is that a coefficient of friction can be selected to be as high as possible, whereby the required normal force is in turn reduced. This makes possible creation of an economic brake equipment.

In an advantageous embodiment the separation between guide region and brake region is constructed in such a manner that a transmission of lubricants such as, for example, oil or other slide means from the guide region to the brake region is prevented or reduced. A functional reliability of the brake equipment is thereby significantly increased, since no substances which reduce the coefficient of friction can easily pass into the brake region.

In an alternative embodiment the brake equipment is arranged in the region of a drive engine and the brake surface is disposed in direct connection with a drive pulley or a drive shaft of the drive engine. In this connection the braking and holding action of the brake equipment is transmitted to the lift cage by way of supporting and drive means. A holding brake in the drive can thereby be provided economically, since as a consequence of the wedge action a reduced braking force is possible.

Further advantageous embodiments are described in the dependent claims.

The invention is explained in more detail in the following by way of several examples of embodiment in conjunction with the figures, in which:

Fig. 1 shows a schematic view of a lift installation,

Fig. 2 shows a view of known brake equipment,

Fig. 3 shows a schematic view of a guide rail with integrated brake track,

Fig. 4 shows a schematic view of an alternative guide rail with integrated brake track and separate guide region and

Fig. 5 shows a diagrammatic view of a wedge groove.

One possible overall arrangement of a lift installation is illustrated in Fig. 1. The lift installation 1 consists of a lift cage 3 for reception of goods or persons. The cage is arranged to be movable along a guide path or by guide rails 7. The lift installation 1 is installed in a shaft 2 of a building. The lift cage is connected with a counterweight 4 by way of supporting and drive means 5. The cage 3 is moved in opposite sense to the counterweight 4 by means of a drive 6, which in the illustrated example acts on the support means 5. The guide rail 7 for guidance of the cage, as well as guide rails 8 for guidance of the counterweight 4, are fixedly arranged in the building or in the shaft 2. The cage 3 is guided by means of guide shoes or guide rollers 9 along the guide rails 7. The lift cage 3 is equipped with items of brake equipment 10, which on the one hand hold the lift cage 3 in a holding position and/or can brake and hold the lift cage 3 in a fault case.

In the illustrated example items of brake equipment 10 are arranged below the cage 3. An attachment 10a above the cage 3 is obviously also possible, as optionally illustrated in Fig. 1, or the brake equipment 10 can in accordance with the respective requirement be arranged at the drive 6, 10b, at the counterweight 4, 10c or at a deflecting roller.

Fig. 2 shows an example of embodiment of known brake equipment 10. The brake equipment comprises two brake levers 10.1 which are mounted substantially at one axis 13. Brake linings 12 are arranged at front ends of the brake levers 10.1. The brake levers 10.1 are urged apart by a spring force F_F . Due to the mounting of the brake levers 10.1 at the axis 13, front ends of the brake levers 10.1 with the brake linings 12 are pressed, in correspondence with the lever dimensions, by a pressing force F_N against brake surfaces 11 of the guide rail 7. A resultant friction force or holding force F_H or braking force F_B

thereby results at the brake surface 11. The resultant friction force is in that case equal to the pressing force F_N multiplied by the number of brake surfaces (in the illustrated example two brake surfaces) and a coefficient of friction μ . The coefficient of friction μ in that case corresponds, in the holding state, with a coefficient of static friction μ_H and in a braking state with a coefficient of sliding friction μ_G .

The holding force is thus calculated as: $F_H = F_N \times 2 \times \mu_H$ [1]

The braking force is correspondingly calculated as: $F_B = F_N \times 2 \times \mu_G$ [2]

For release of the brake equipment 10, i.e. when the cage 3 is to be moved, the brake levers 10.1 are drawn together at the rearward ends thereof by means of an actuator force F_A , whereby the brake linings 12 are relieved and a braking or holding force thereby removed.

Fig. 3 shows a guide rail 7 as it is constructed for co-operation with brake equipment 10. The guide rail is realised in the form of a T-profile member. The guide rail 7 has a rail web 7a in which the brake surface 11 is worked in the form of a longitudinal wedge groove. The longitudinal wedge groove is, in the illustrated example, worked in at a front side and rear side of the web 7a. The longitudinal wedge groove has two lateral flanks 7c which are inclined relative to the web main surface 7a in correspondence with an angle α . The lateral flanks 7c are provided for co-operation with the brake lining 12, which has the equally inclined lateral flanks or the adapted counter-shape. The lateral flanks of the brake lining 12 and/or the lateral flanks 7c of the longitudinal wedge groove are, if required, provided with coatings influencing the coefficient of friction. These can be ceramic layers, it can be a specially roughened surface, or nano-composites can be applied for increasing friction. The brake lining 12 is pressed by the pressing force F_N into the longitudinal wedge groove for the purpose of braking, for example with brake equipment as illustrated in Fig. 2. The wedge base 7b has in that case a sufficient play relative to the brake lining 12 in order to absorb any wear of the lateral flanks. The pressing force in that case acts in perpendicular direction (90°) relative to the web surface 7a.

As schematically illustrated in Fig. 5, a resultant braking force F_B or holding force F_H results, with consideration of the wedge angle α , of:

$$\text{holding force:} \quad F_H = (1/\cos\alpha) \times F_N \times 2 \times \mu_H \quad [1.1]$$

$$\text{braking force:} \quad F_B = (1/\cos\alpha) \times F_N \times 2 \times \mu_G \quad [2.1]$$

This holding or braking force in turn relates to brake equipment 10 with two brake surfaces 11 as illustrated in principle in Fig. 1, wherein a brake surface 11 with the corresponding brake lining 12 is present on either side of the rail web 7a. The direction of action of the braking or holding force in this connection results from a movement direction or force traction direction acting on the brake equipment.

The following table gives an overview of achievable braking force amplification in dependence on the selected wedge angle α :

Wedge angle α	Resulting braking force amplification
30°	+ 15%
45°	+ 41%
60°	+ 100%
75°	+ 285%

In the case of use of a wedge angle α of 30° a braking force amplification of approximately 15% or an amplification factor of 1.15 thus results. With consideration of the resulting braking force amplification and the loading, which increases therewith, of the brake linings 12, a proposed optimum wedge angle α in the region of 30° to 60° results.

A correspondingly reduced pressing force F_N can also now be selected for achieving a desired holding force, which in turn enables use of brake equipment 10 with small actuator forces. A longitudinal wedge groove further has the advantage that the brake lining 12 is laterally guided. Derailing of the brake lining 12 is thereby prevented. It is obviously conceivable to provide a longitudinal wedge groove primarily for the purpose of lateral guidance. In this connection, longitudinal grooves of other shapes, such as, for example, a curved groove could be used or also flat wedge angles in an angular range below 30° could also be used. In addition, these grooves produce, in correspondence with the above embodiments, as before an amplification of the resulting braking force.

Fig. 4 shows a further guide rail 7 as can be constructed for co-operation with brake equipment 10. This guide rail is also realised in the form of a T-profile member. The guide rail 7 has a rail web 7a in which the brake surface 11 in the form of several parallelly extending longitudinal wedge grooves is worked. A rail of that kind can, for example, be

easily produced by a drawing process or the longitudinal wedge grooves can be worked, as illustrated by way of example in Fig. 4, into a basic carrier 7.1 which is inserted as a whole into the rail web 7a. In this example as well the wedge flanks 7c are arranged in correspondence with a wedge angle α and a brake lining 12 co-operates with these wedge grooves. The calculation of the holding or braking forces takes place as illustrated in the formulae [1.1, 2.1] and the resulting braking force amplification results as in the tables explained with respect to Fig. 5. This multiple groove shape has the advantage that the flank area is significantly increased by comparison with the previous example and that wear is thereby reduced. The guide rail 7 illustrated in this example has separate brake regions or brake surfaces 11 and guide regions 14. The brake region 11 serves, as already explained, for holding or braking the cage and the guide region 14 serves for guiding the cage 3 by means of guide shoes or guide rollers 9 (Fig. 1). In the example according to Fig. 4 the brake region 11 is separated from the guide region by means of a groove 7d. This makes it possible to prevent flowing into the brake region 11 of, for example, an oil film applied to the guide surface 14 for reducing guide resistance. Moreover, the guide region 14 can be provided with other measures reducing slide resistance or noise. Thus, a special slide film or slide lining 15, for example of a 'Teflon'-coated synthetic material profile member, can be mounted on the surface of the guide region or the surface of the guide region can be treated with, for example, nano-composites for reducing friction.

The solutions shown by way of Figs. 3 and 4 can be combined. The wedge grooves can obviously be arranged to be protruding or deepened or the web 7a can be arranged at a guide rail of any shape. In addition, the illustrated solutions for separation of guide region and brake region are usable as desired.

The illustrated solutions are obviously also translatable to counterweight guide rails or to a brake disc of the drive and the production methods of the longitudinal wedge grooves are selected by the web manufacturer.

1	lift installation
2	shaft
3	cage
4	counterweight
5	support means
6	drive
7	cage guide rail
8	counterweight guide rail
9	guide shoe
10	brake equipment
11	brake surface / brake region
12	brake lining
13	axis
14	guide region
15	slide layer
F_N	brake normal force
F_F	spring force
F_A	release force

Patent Claims:

1. Lift installation with a lift cage (3) and brake equipment (10) for braking and holding the lift cage (3), the brake equipment (10) comprising a brake lining (12) which co-operates with a brake surface (11) for the purpose of the braking and holding, characterised in that the brake surface (11) has at least one longitudinal wedge groove or wedge elevation which is oriented in braking direction and on which the brake lining (12) acts in case of need.
2. Lift installation according to claim 1, characterised in that the brake lining (12) has a counter-shape adapted to the longitudinal wedge groove or wedge elevation of the brake lining (11).
3. Lift installation according to claim 1 or 2, characterised in that the brake equipment (10) is arranged in the region of the lift cage (3) and the brake surface (11) is integrated in a guide rail (7) which guides the lift cage (3).
4. Lift installation according to claim 3, characterised in that the guide rail (7) has a guide region (14) for interaction with the guide means and a brake region as brake surface (11) for interaction with the brake equipment (10), wherein the guide region (14) and brake region have different surfaces and the guide region (14) is geometrically separated from the brake region.
5. Lift installation according to one of claims 3 and 4, characterised in that the guide rail (7), which is preferably a T-shaped guide rail (7), has a rail web and this rail web has both the guide region (14) for interaction with the guide means and the brake region (11) for interaction with the brake equipment (10).
6. Lift installation according to any one of claims 3 to 5, characterised in that the guide region (14) is provided with a slide means, for example a nano-composite, for reducing friction or with a slide coating (15), wherein the slide coating (15) is a profile member, preferably a synthetic profile member containing 'Teflon'.
7. Lift installation according to any one of the preceding claims, characterised in that the brake region (11) is worked into the basic structure of the guide rail (7), alternatively

drawn, rolled or mechanically processed, and/or that the brake region (11) is produced by means of a brake profile member mounted on the basic structure of the guide rail (7) and/or that the brake region (11) is provided with means influencing friction, for example a nano-composite for increasing friction.

8. Lift installation according to any one of the preceding claims, characterised in that the separation between guide region (14) and brake region (11) prevents transmission of slide means in particular from the guide region (14) to the brake region (11).

9. Lift installation according to claim 1 or 2, characterised in that the brake equipment (10) is arranged in the region of a drive engine (6) and the brake surface (11) is disposed in direct connection with a drive pulley or a drive shaft of the drive engine (6), wherein the braking and holding action of the brake equipment (10) is transmitted to the lift cage (3) by way of supporting and drive means (5).

10. Guide rail of a lift installation, which guide rail (7) has a brake surface (11) for interaction with brake equipment (10), characterised in that the brake surface (11) has at least one longitudinal wedge groove or wedge elevation which is oriented in braking direction and on which the brake equipment (10) acts in case of need.

11. Brake equipment of a lift installation for braking and holding a lift cage (3), the brake equipment (10) comprising a brake lining (12) which co-operates with a brake surface (11) for the purpose of the braking and holding, characterised in that the brake lining (12) has at least one longitudinal wedge groove or wedge elevation which is oriented in braking direction and which acts on the brake surface (11) in the case of need.

12. Method for guiding, holding and braking a lift installation (3) with a lift cage, wherein the lift cage (3) is guided along guide rails (7) by way of guide means (9), and the lift cage (3) is braked and held by means of braking equipment (10), wherein the brake equipment (10) acts on the guide rail (7) for the purpose of the braking and holding and wherein the guide rail (7) is provided with a guide region (14) for interaction with the guide means and with a brake surface (11) for interaction with the brake equipment (10), characterised in that the brake surface (11) is constructed with at least one longitudinal wedge groove or wedge elevation which is oriented in braking direction and on which a brake lining (12) can act in case of need.