

Safety equipment for a lift installation as well as a lift installation with such safety equipment

The invention relates to safety equipment for a lift installation with at least one lift cage according to the introductory part of the independent claims. Moreover, the invention relates to a corresponding lift installation.

Lift cages in a multi-mobile lift installation are typically each equipped with an own drive and an own braking system. The electronic control of the overall lift installation is frequently so designed that no collisions of the individual lift cages should occur. In particular, in the case of an emergency stop or even in the case of a normal storey stop of a lift cage it cannot be guaranteed in all circumstances that a further lift cage disposed above or below in the same lift shaft can still stop at the correct time in order to avoid a collision. This could be avoided in that sufficient spacings between the individual lift cages and also appropriately adapted vertical speeds were predetermined by the control. However, due to such presetting the transport capacity of a multi-mobile lift installation cannot be fully utilised, which has an influence on the cost/utilisation efficiency.

A multi-mobile lift installation is now known from European Patent Specification EP 769 469 B1, which comprises means for opening the safety circuit of a lift installation if there is an undesired approach to another lift cage. According to the said patent specification safety modules which evaluate the cage positions and speeds so as, in a given case, to be able to trigger braking processes even at other lift cages, are present at each lift cage. The individual safety modules must always recognise and evaluate the cage positions and speeds of the other participating lift cages in order to be able to correctly react in an emergency case. A specific decision module is needed for that purpose, which in the emergency case is responsible for determining the stop commands.

A similarly complicated solution is known from International Patent Application WO 2004/043841 A1. According to this patent application infrared, laser or ultrasound sensors are arranged at each lift cage and measure the spacings from the adjacent lift cages disposed above and below the lift cage. Furthermore, it is additionally proposed to use a shaft information system so that, for example, measuring strips arranged in the shaft can be scanned by sensors at the lift cages in the form of light barriers. This electro-optical approach also makes it possible to control the spacing of the lift cages and in a given case

also the spacing from the shaft bottom and if needed to intervene in the control in order to prevent a collision.

The solution described in International Patent Application WO 2004/043841 A1 is, above all, complicated, because it obliges a communication between different opto-electronic components of the lift cages so as to enable statements about the instantaneous state and the instantaneous speeds of the lift cages.

Moreover, the described solutions are complicated to initialise when placing in operation, since all systems have to be matched to one another. The complexity of the systems makes these solutions possibly also susceptible to fault.

With consideration of the known arrangements a first object of the present invention is to provide a multi-mobile lift installation which on approach between two lift cages automatically stops the cages before collision without requiring a more complicated exchange of data between the lift cages.

A further object of the present invention consists in preventing, in a lift installation with at least one lift cage, an undesired approach of the cage to or collision of the cage with the shaft ends when the lift cage approaches the shaft ends.

Stated in other words, the objective is to improve the safety of lift installations by simple and reliable means.

Fulfilment of the objects takes place by the features of the independent claims. Advantageous developments of the invention are realised by the dependent patent claims.

The present invention is just as suitable for preventing a collision between two lift cages which relatively approach one another as for preventing collision between a lift cage and a shaft end. Equivalent variants of the safety equipment according to the invention or a lift installation are described in the following.

In a first variant the safety equipment for a lift installation with an upper lift cage and a lower lift cage, which are both movable substantially independently along a vertical direction in a common lift shaft of the lift installation, comprises a first electro-optical

detection system with a first light source in a lower region of the upper lift cage and with a first detector. The first detector has a light-sensitive first sensor region in an upper region of the lower lift cage. The first light source issues a focussed first light beam at a first angle with respect to the vertical direction. The first angle is so predetermined that on approach of the upper and the lower lift cages the first light beam is incident on the first sensor region and thus is detectable by the first detector and the first detector triggers a reaction in order to prevent a collision of the lift cages.

In addition, the safety equipment has a second electro-optical detection system with a second light source in an upper region of the lower lift cage and a second detector in a lower region of the upper lift cage.

With knowledge of the present invention the first variant can also be realised with more than two lift cages movable substantially independently vertically in a common lift shaft, wherein then at least one light source and a detector provided for this are present between each of these lift cages.

In a second variant the safety equipment for a lift installation with a lower shaft end and with at least one lift cage, which is movable substantially independently along a vertical direction in a lift shaft of the lift installation, comprises a first electro-optical detection system with a first light source in a lower region of the lift cage and with a first detector. The first detector has a light-sensitive first sensor region in the region of the lower shaft end. The first light source issues a focussed first light beam at a first angle with respect to the vertical direction. The first angle is so predetermined that on approach of the lift cage to the lower shaft end the first light beam is incident on the first sensor region and thus is detectable by the first detector and the first detector triggers a reaction so as to prevent a collision of the lift cage.

In addition, the safety equipment comprises a second electro-optical detection system with a second light source in the region of the lower shaft end and a second detector in a lower region of the lift cage.

In a third variant the safety equipment for a lift installation with an upper shaft end and with at least one lift cage, which is movable substantially independently along a vertical direction in a lift shaft of the lift installation, comprises a first electro-optical detection

system with a first light source in the region of the upper shaft end and with a first detector. The first detector has a light-sensitive first sensor region in the upper region of the lift cage. The first light source issues a focussed first light beam at a first angle with respect to the vertical direction. The first angle is so predetermined that on approach of the lift cage to the upper shaft end the first light beam is incident on the first sensor region and thus is detectable by the first detector and the first detector triggers a reaction in order to prevent a collision of the lift cage.

Moreover, the safety equipment comprises a second electro-optical detection system with a second light source in an upper region of the lift cage and a second detector in the region of the upper shaft end.

These variants can obviously also be advantageously combined, i.e. the lift cage of the second variant can be the lower of several lift cages in a common lift shaft of the lift installation of the first variant, which both are movable substantially independently along a vertical direction in the lift shaft.

Analogously, the lift cage of the third variant can be the upper of several lift cages in a common lift shaft of the lift installation of the first variant, which both are movable substantially independently along a vertical direction in the lift shaft.

Obviously, a combination of all three variants in one lift installation is possible. Such a combination realises a prevention of collisions of the two lift cages with one another and with shaft ends.

An advantage of the invention results from the simple arrangement of commercially available electro-optical components in order to prevent a collision of a lift cage in a lift shaft. A further advantage lies in the automatic detection of the spacing by the detector and the triggering of an autonomous reaction on undesired approach of the lift cages. Moreover, the detector in co-operation with a local computer unit is capable of triggering, with low computing cost, a collision-preventing reaction on the basis of speed data. Moreover, the redundant design of the safety equipment offers additional safety and enables an autonomous and rapid collision-preventing reaction of all lift cages.

In the following the invention is described in more detail on the basis of examples of

embodiment and with reference to the drawings, which are not to scale and in which:

- Fig. 1A shows a schematic side view of a first multi-mobile lift installation according to the invention at a first point in time;
- Fig. 1B shows a schematic side view of the multi-mobile lift installation according to Fig. 1A at a later point in time;
- Fig. 2 shows a schematic side view of a part of a second multi-mobile lift installation according to the invention; and
- Fig. 3 shows a schematic side view of a part of a third multi-mobile lift installation according to the invention.

A first form of embodiment of the invention is described in conjunction with the two snapshots in Figures 1A and 1B. A simple multi-mobile lift installation 10 with an upper lift cage A1 and a lower lift cage A2, which two are movable substantially independently vertically in a common lift shaft 11 of the lift installation 10 along a vertical direction z, is shown. For this purpose the lift cages A1, A2 can be provided with a drive and a holding brake per lift cage A1, A2 or, for example, can be individually coupled to a central drive system in order to enable individual movement in the lift shaft 11. Beyond that, there are also other approaches in order to be able to individually move the lift cages of a multi-mobile lift installation.

Safety equipment is provided which comprises a first electro-optical detection system 20 with a first light source 21 arranged in a lower region of the upper lift cage A1, as schematically indicated in Figures 1A and 1B. Light-emitting diodes, which deliver focussed light, are particularly suitable as light sources. Laser diodes or solid-body lasers are even more suitable.

In addition, the detection system 30 comprises a first detector 22 which comprises a light-sensitive first sensor region 22 in an upper region of the upper lift cage A2. Photodiodes, phototransistors or other light-sensitive elements can be used as sensor region 22.

The first light source 21 is so designed and arranged that it delivers a focussed first light

beam L1 at a first angle W1 with respect to the vertical direction z. In the illustrated example the light beam L1 is directed downwardly.

A snapshot (spacing between the cages amounts to S1) is shown in Fig. 1A, where the upper lift cage A1 moves downwardly at a speed v_1 and the lower lift cage A2 is stationary ($v_2 = 0$). At the illustrated instant the light beam L1 is incident anywhere above the lower lift cage A2 against a wall of the lift shaft 11.

If the relative spacing of the two lift cages A1 and A2 now reduces to a minimum spacing S2, as shown in Fig. 1B, then the light beam L1 is incident for the first time on the sensor region 22.

According to the invention the first angle W1 is so predetermined or set that on approach of the upper and lower lift cages A1, A2 the first light beam L1 is incident on the first sensor region 22 as soon as the minimum spacing S2 is reached. At this instant of incidence the light beam L1 is thus detectable by the first detector 22, 24 and this detector 22, 24 triggers a reaction R1 which, for example, is passed on by way of a line or connection 23 to a control or the like.

The present invention now allows different forms of realisation or constructional stages of the safety equipment.

In the simplest form of realisation a reaction can be triggered directly on the first occasion of incidence of the light beam L1 on the sensor region 22. In this case it is sufficient if the sensor region 22 has a size - in the sense of area extent - which allows it to ensure that notwithstanding fluctuations in the lift installation 10 a secure detection of the light beam L1 by the detector 22, 24 is possible.

A further form of realisation of the invention is indicated in Fig. 2. In this figure there is shown a snapshot shortly after the light beam L1 was detected the first time by a light-sensitive section 22.1 of the sensor region 22.

These sections are preferably able to be separately evaluated, i.e. they have respective individual electrical connections. For preference, with the different forms of embodiment there is provided an appropriate evaluating system 24 (or 24 and 28 in the case of Fig. 3)

in order to be able to trigger a matched reaction (R1, R2, R3, R4) in dependence on the sections (22.1 - 22.n) on which the first light beam L1 is incident.

If now the same spacings as in Figures 1A and 1B are adopted then at the illustrated instant the spacing is less than S2.

Since the upper lift cage A1 continues to move forward at the speed v_1 towards the lower cage A2 the 'light spot' generated by the light beam L1 displaces to the left. The safety equipment can now be so designed, programmed or set that with the first incidence at the section 22.1 of the sensor region 22 a pre-warning is given as a reaction or the lift installation 10 or lift cage A1 and/or A2 is transferred to a pre-warning mode. If the light spot now goes beyond a previously fixed further section 22.4 of the sensor region 22 a final reaction can be triggered (for example, an emergency stop by triggering the braking equipment or the safety brake of the upper and/or the lower lift cage A1, A2). This two-stage approach offers additional safety and thereby assists with avoidance of erroneous triggerings.

A further form of realisation of the invention is now explained by reference to Fig. 2. As indicated by an arrow below the sensor region 22, the light spot migrates to the left at a speed v_1^* when the relative spacing between the lift cages A1, A2 reduces at a speed v_1 . This speed v_1^* allows computerised determination of the speed v_1 with use of simple trigonometric formulations. If, for example, the angle W1 amounts to 45 degrees then $v_1 = v_1^*$, since $\tan 45 = 1$. If the angle W1 is greater than 45 degrees, then v_1^* is also greater than v_1 . With smaller angles W1, v_1^* is less than v_1 , i.e. a form of speed step-down or slowing is achieved. The size of the sensor region 22 can be reduced by such a slowing, which can possibly be of advantage since the appropriate sensors are expensive.

A further variant is shown in Fig. 3. This variant is currently preferred since it offers the greatest safety. Use is made, as shown, of two electro-optical detection systems. The first detection system is designed analogously to the system shown in the preceding figures. The second detection system can be constructionally identical, but is seated quasi in mirror image in the upper region of the lower lift cage A2. The corresponding second sensor region 26 is seated in the lower region of the upper lift cage A1.

In the illustrated example the two angles are the same, i.e. $W_1 = W_2$. The angles can,

however, also be predetermined or set to be different. In the case of identical execution of the electro-optical detection systems and if $W1 = W2$, the two electro-optical detection systems transmit signals at the same time or trigger reactions R3, R4 at the same time.

It is schematically indicated in the figures that the detectors trigger respective reactions. The form of reactions differs depending on the respective form of embodiment, programming or setting of the devices. In the figures it is indicated that the detectors are in a position of issuing signals or data by way of lines or other connections 23 or 27. These signals or data are then either processed before reactions are triggered or they directly trigger the reactions, for example in that they open a switch which is part of a safety circuit.

There are numerous possibilities of managing the triggering of the reactions. The respective realisation depends on various details of the respective lift installation 10. If, for example, the lift installation has an own safety circuit per lift cage A1, A2, the safety circuit of the upper and/or lower lift cage A1, A2 can be interrupted by the detector or detectors.

A multi-mobile lift installation 10 preferably comprises an own safety circuit per lift cage A1, A2 in which several safety elements, such as, for example, safety contacts and safety switches, are arranged in a series circuit. The corresponding lift cage A1 or A2 can be moved only when the safety circuit and thus also all safety contacts integrated therein are closed. The safety circuit is connected with the drive or the brake unit of the lift installation 10 in order to interrupt travel operation of the corresponding lift cage A1 or A2 if such a reaction is desired.

The invention can, however, also be used in lift installations which are equipped with a safety bus system instead of the mentioned safety circuit.

Alternatively or additionally to opening the safety circuits also the brakes of the respective lift cages A1, A2 can be triggered.

Alternatively or additionally also possible safety brakes of the respective lift cages A1, A2 can be triggered.

Thus, one or several of the following reactions can be triggered by the detectors 22, 24 or

26, 28 depending on the respective form of embodiment:

- opening a safety circuit of at least one lift cage A1, A2,
- signal to a lift control,
- triggering a braking device of at least one lift cage A1, A2,
- triggering a safety brake of at least one lift cage A1, A2,
- transferring at least one lift cage A1, A2 to a pre-warning state,
- adaptation of the vertical speed v_1 , v_2 of at least one lift cage A1, A2.

Thus, a spacing control or a combined spacing and safety control can be realised by the invention.

The angles W_1 , W_2 can be set in a range of 0 to 90° with respect to the vertical direction z . The angles W_1 , W_2 preferably lie in the range between 0 and 60 degrees and, particularly preferably, between 10 and 50 degrees.

Advantageously the angle W_1 , W_2 is set to be variable in time in dependence on single or several parameters, such as the position, speed or acceleration of a lift cage A1, A2, the spacing, relative speed or relative acceleration of the lift cage A1, A2 relative to a reference point or the operational state of the lift installation 10.

Thanks to the setting of the angle W_1 , W_2 the angle W_1 , W_2 can, for example, be set to be smaller in the case of a greater speed of the cage A1, A2 so that the light beam L_1 , L_2 is incident at an earlier point in time on the detector 22, 24 and this can thus trigger a reaction R_1 , R_2 , R_3 , R_4 at an earlier point in time. With a lower speed, the necessity of an early reaction R_1 , R_2 , R_3 , R_4 correspondingly reduces and thus a greater angle W_1 , W_2 can be set. The connection between acceleration and angle behaves in analogous manner.

The operational state of the lift installation 10, such as, for example, in the inspection or maintenance state, often presets a reduced maximum speed. Thus, in the case of an inspection travel of the lift cage A1, A2 the angle W_1 , W_2 of the light beam L_1 , L_2 can be increased after transfer of the lift cage A1, A2 to an inspection state, since the lift cage A1, A2 can be moved only at reduced speed.

The position of the lift cages A1, A2 serves, for example, for the purpose of determining

the time instant of a variable setting of the angle $W1$, $W2$. Accordingly, a critical spacing between the lift cages $A1$, $A2$ or between a lift cage $A1$, $A2$ and the shaft end is defined. If this value is fallen below, the variable setting of the angle $W1$, $W2$ begins.

If several lift cages travel in the same shaft 11, then corresponding safety equipment can also be provided between these lift cages.

Moreover, corresponding sensor regions can also be provided at the lower and/or upper shaft end of the lift shaft 11 so as to prevent a risk-laden approach of a lift cage to the respective shaft end. The operating principle is the same in this case as described in connection with the other forms of embodiment.

Patent Claims

1. Safety equipment for a lift installation (10) with an upper lift cage (A1) and a lower lift cage (A2), which are both movable substantially independently along a vertical direction (z) in a common lift shaft (11) of the lift installation (10), wherein the safety equipment comprises a first electro-optical detection system (20) with a first light source (21) in a lower region of the upper lift cage (A1) and with a first detector (22, 24), characterised in that

- the first detector (22, 24) comprises a light-sensitive first sensor region (22) in an upper region of the lower lift cage (A2) and
- the first light source (21) issues a focussed first light beam (L1) at a first angle (W1) with respect to the vertical direction (z) and the first angle (W1) is so predetermined that on approach of the upper and the lower lift cages (A1, A2) the first light beam (L1) is incident on the first sensor region (22) and thus is detectable by the first detector (22, 24) and the first detector (22, 24) triggers a reaction (R1, R2, R3, R4).

2. Safety equipment (20) according to claim 1, characterised in that the safety equipment (20) comprises a second electro-optical detection system with a second light source (25) in an upper region of the lower lift cage (A2) and with a second detector (26, 28) in a lower region of the upper lift cage (A1).

3. Safety equipment for a lift installation (10) with a lower shaft end and with at least one lift cage (A2), which is movable substantially independently along a vertical direction (z) in a lift shaft (11) of the lift installation (10), wherein the safety equipment comprises a first electro-optical detection system (20) with a first light source (21) in a lower region of the lift cage (A2) and with a first detector (22, 24), characterised in that

- the first detector (22, 24) comprises a light-sensitive first sensor region (22) in the region of the lower shaft end and
- the first light source (21) issues a focused first light beam (L1) at a first angle (W1) with respect to the vertical direction (z) and the first angle (W1) is so predetermined that on approach of the lift cage (A2) to the lower shaft end the first light beam (L1) is incident on the first sensor region (22) and thus is detectable by the first detector (22, 24) and the first detector (22, 24) triggers a reaction (R1, R2, R3, R4).

4. Safety equipment (20) according to claim 3, characterised in that the safety

equipment (20) comprises a second electro-optical detection system with a second light source (25) in the region of the lower shaft end and with a second detector (26, 28) in a lower region of the lift cage (A2).

5. Safety equipment for a lift installation (10) with an upper shaft end and with at least one lift cage (A1), which is movable substantially independently along a vertical direction (z) in a lift shaft (11) of the lift installation (10), wherein the safety equipment comprises a first electro-optical detection system (20) with a first light source (21) in the region of the upper shaft end and with a first detector (22, 24), characterised in that

- the first detector (22, 24) comprises a light-sensitive first sensor region (22) in the upper region of the lift cage (A1) and
- the first light source (21) issues a focused first light beam (L1) at a first angle (W1) with respect to the vertical direction (z) and the first angle (W1) is so predetermined that on approach of the lift cage (A1, A2) to the upper shaft end the first light beam (L1) is incident on the first sensor region (22) and thus is detectable by the first detector (22, 24) and the first detector (22, 24) triggers a reaction (R1, R2, R3, R4).

6. Safety equipment (20) according to claim 5, characterised in that the safety equipment (20) comprises a second electro-optical detection system with a second light source (25) in an upper region of the lift cage (A1) and with a second detector (26, 28) in the region of the upper shaft end.

7. Safety equipment (20) according to claim 3 or 4, characterised in that the lift cage (A2) is the lower of several lift cages (A1, A2) in a common lift shaft (11) of the lift installation (10), which are both movable substantially independently along a vertical direction (z) in the lift shaft (11).

8. Safety equipment (20) according to claim 5 or 6, characterised in that the lift cage (A1) is the upper of several lift cages (A1, A2) in a common lift shaft (11) of the lift installation (10), which are both movable substantially independently along a vertical direction (z) in the lift shaft (11).

9. Safety equipment according to any one of the preceding claims, characterised in that the sensor region (22) comprises several light-sensitive sections (22.1 - 22.n) able to separately evaluated.

10. Safety equipment according to any one of the preceding claims, characterised in that the first detector (22, 24) comprises an evaluating system (24) so as to be able to trigger a matched reaction (R1, R2, R3, R4) in dependence on the sections (22.1 - 22.n) on which the first light beam (L1) is incident.

11. Safety equipment according to any one of the preceding claims, characterised in that one or more of the following reactions can be triggered by the first detector (22, 24):

- opening a safety circuit of at least one lift cage (A1, A2),
- signal to a lift control,
- triggering a braking device of at least one lift cage (A1, A2),
- triggering a safety brake of at least one lift cage (A1, A2),
- transferring at least one lift cage (A1, A2) to a pre-warning state,
- adaptation of the vertical speed (v1, v2) of at least one lift cage (A1, A2).

12. Safety equipment according to any one of the preceding claims, characterised in that a spacing control or a combined spacing and speed control is realised by means of the electro-optical detection system or systems.

13. Safety equipment according to any one of the preceding claims, characterised in that the angle (W1, W2) between the light beam (L1, L2) and the vertical direction (z) is settable to be variable in time in dependence on individual or several parameters.

14. Safety equipment according to claim 13, characterised in that the parameters represent the position, speed or acceleration of a lift cage (A1, A2), the spacing, the relative speed or the relative acceleration of a lift cage (A1, A2) with respect to a reference point or the operational state of the lift installation (10).

15. Lift installation (10) with safety equipment (20) according to any one of the preceding claims, wherein the lift installation (10) comprises at least one lift cage (A1, A2), with a drive and a holding brake per lift cage (A1, A2) and wherein a collision of the lift cages (A1, A2) can be prevented by the reaction (R1, R2, R3, R4).