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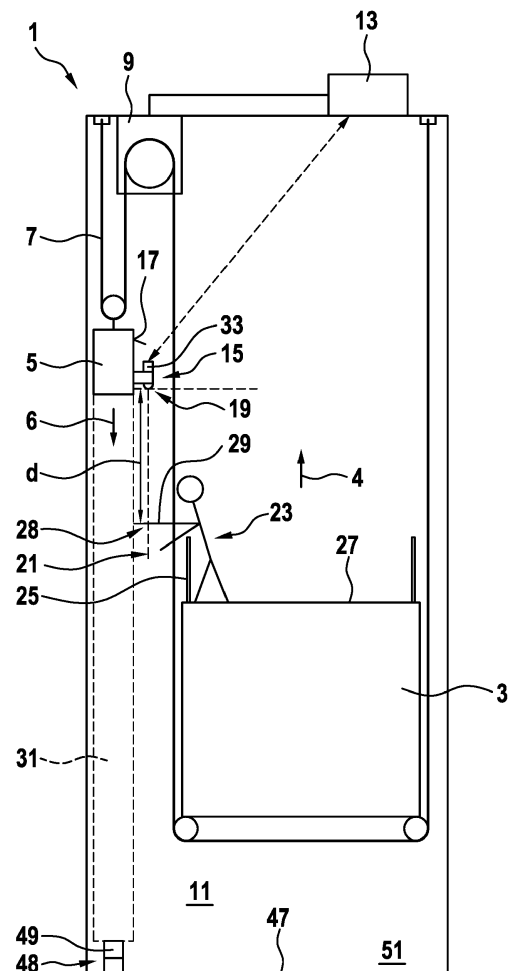
(71) Applicant: **Inventio AG**
6052 Hergiswil (CH)

(72) Inventors:
• **PRAKASH, Om**
411014 Pune (IN)
• **KAMATH, Danesh**
421301 Pune (IN)

(54) **ELEVATOR ARRANGEMENT WITH A SAFETY MONITORING DEVICE COMPRISING A 2D-SENSOR FOR CONTACTLESS SUPERVISING A SUPERVISION PLANE**

(57) An elevator arrangement (1) comprising a cabin (3) and a counterweight (5) being displaceable in traveling directions (4, 6) within an elevator shaft (11), an elevator controller (13) for controlling motions of the cabin (3) and the counterweight (5), and a safety monitoring device (15) is proposed. The safety monitoring device (15) comprises a 2D-sensor (19) for contactless supervising a supervision plane (21) extending away from the 2D-sensor (19) in an extension direction parallel to the traveling directions and for determining a distance (d) between the 2D-sensor (19) and an object (28) located within the supervision plane (21). Therein, the safety monitoring device (15) is adapted for initiating safety measures upon detecting that the determined distance (d) is smaller than a predetermined allowable minimum distance (d_m). The safety monitoring device (15) may be a relatively simple device such as a scanning laser distance measurement sensor (20). By suitably arranging its supervision plane (21) for example underneath the counterweight (5), serious collisions between the counterweight (5) and for example an extremity of a technician (23) may be avoided.

Fig. 1



Description

[0001] The present invention relates to an elevator arrangement comprising a safety monitoring device for increasing safety during operation of the elevator arrangement.

[0002] Elevators are generally used for transporting passengers or goods between various levels within a building. Typically, an elevator arrangement comprises a cabin (sometimes also referred to as a car) and a counterweight. The cabin and the counterweight are mechanically coupled to each other via a suspension traction means (STM), such as a rope arrangement or a belt arrangement, which may be driven by a drive engine such as to displace the cabin and the counterweight in opposite travelling directions within an elevator shaft. Motions of the cabin and the counterweight may be controlled using an elevator controller controlling an operation of the drive engine. The elevator controller may furthermore control other functions within the elevator arrangement such as for example safety functions. For example, the elevator controller may control a brake mechanism at the drive engine and/or an emergency brake mechanism at the cabin and/or the counterweight.

[0003] In order to guarantee correct and safe operation of the elevator arrangement, maintenance requirements generally have to be fulfilled on a regular basis. Therein, one or more technicians have to check correct functioning of various components within the elevator arrangement. Particularly, the technicians generally have to enter the elevator shaft in order to for example check an integrity of the suspension traction means and/or parts of the cabin and counterweight only being accessible from inside the elevator shaft.

[0004] Unfortunately, it has been observed that accidents of maintenance technicians in the elevator shaft are occurring due to for example accidentally being hit by the counterweight during installation or maintenance work.

[0005] For example, a technician may be required to go on a top of the elevator cabin and make some movement of the cabin. At a time when the car and the counterweight come close to each other during such motion, i.e. when their ways are crossing, a body part such as an arm or head of the technician may get hit in case the body part is exposed such that it is in line with the travel path of the counterweight.

[0006] In another scenario, a technician may be required to work in a pit of the elevator shaft. For several types of maintenance work, he may be required to give control of the cabin to another technician standing on a top of the cabin. A safety area may usually be away from the lower "pit stop" switch. If a mistake is committed by any of the technicians, then there may be a possibility of the technician working in the pit getting hit by the counterweight.

[0007] As safety instructions, which are to be followed to ensure safe working procedures, are sometimes ig-

nored or mistaken, it may be intended to improve safety of the maintenance technicians using technical solutions. Various approaches have been described. For example, JP 11-335018 describes a contact plate at the counterweight for detecting a collision. CN 101941622 A describes a sensor on the cabin for detecting a part protruding from the cabin and then stopping a motion. CN 101628676 A describes a light curtain being installed at predetermined crossing points.

[0008] There may be a need for an elevator arrangement comprising an alternative safety monitoring device for improving safety of the elevator arrangement, particularly during maintenance procedures. More specifically, there may be a need for an elevator arrangement with a safety monitoring device reliably preventing accidents due to technicians being hit for example by the counterweight. Furthermore, there may be a need for an elevator arrangement comprising a safety monitoring device being technically relatively simple and therefore reliable and/or cost-effective.

[0009] At least one of such needs may be met by the elevator arrangement according to the independent claim. Advantageous embodiments are described in the dependent claims and in the following specification.

[0010] According to an aspect of the present invention, an elevator arrangement comprising a cabin, a counterweight, an elevator controller and a safety monitoring device is proposed. The cabin and the counterweight are displaceable in traveling directions within an elevator shaft. The elevator controller controls motions of the cabin and the counterweight. The safety monitoring device specifically comprises a 2D-sensor for contactless supervising a supervision plane extending away from the sensor in an extension direction parallel to the traveling direction and for determining a distance between the 2D-sensor and an object located within the supervision plane. Therein, the safety monitoring device is adapted for initiating safety measures upon detecting that the determined distance is smaller than a predetermined allowable minimum distance.

[0011] Ideas underlying embodiments of the present invention may be interpreted as being based, inter alia and without restricting the scope of the invention, on the following observations and recognitions.

[0012] As indicated above, accidents in an elevator arrangement in which for example technicians are hit by the counterweight shall be avoided. However, prior approaches either appear to be technically complex or not sufficiently reliable in specific situations.

[0013] In the elevator arrangement proposed herein, a safety monitoring device is applied which, while being technically relatively simple, may reliably avoid severe accidents.

[0014] Specifically, the safety monitoring device comprises a special type of 2D-sensor. This 2D-sensor supervises a supervision plane. The supervision plane may have its origin at the 2D-sensor and extends away from the 2D-sensor. Particularly, the supervision plane ex-

tends in a direction parallel to the traveling direction of for example the counterweight. For the purposes of this application, the term "in parallel" shall include minor deviations from strict geometric parallelism of e.g. $\pm 1^\circ$ or corresponding tolerances. In other words, the supervision plane extends substantially in or in parallel to the plane in which the counterweight is displaced within the elevator shaft. Accordingly, the supervision plane is a two-dimensional area which is supervised by the 2D-sensor such as to detect any objects or obstacles entering into this supervision plane.

[0015] Particularly, such object could be a person or an extremity of a person located in or protruding into the supervision plane. For example, an arm of a technician standing on the top of the cabin could protrude into the supervision plane.

[0016] If the supervision plane coincides for example with an area within the elevator shaft being endangered for collision with any of the cabin or the counterweight, reliably and timely detecting the object within the supervision plane may allow initiating safety measures for avoiding the collision.

[0017] Specifically, the 2D-sensor supervises the supervision plane in a contactless manner. Accordingly, no mechanical contact is needed between the sensor and any object entering the supervision plane. Thereby, any wear or mechanical damages to the 2D-sensor may be avoided. For example, contactless detection technologies using optical techniques or other techniques based e.g. on electromagnetic or mechanic waves may be applied.

[0018] Particularly, the 2D-sensor may be adapted for not only determining whether or not any object enters the supervision plane but also to determine a distance between the 2D-sensor and the object located within the supervision plane. In other words, the 2D-sensor may be configured as a distance measurement device. More particularly, the 2D-sensor may measure a variety of distances in various directions extending within a common plane, i.e. with the supervision plane.

[0019] In fact, such distance measuring capability is the reason why the specific sensor used in the safety monitoring device proposed herein is referred to herein as "2D-sensor". Without such distance measuring capability, a sensor would only detect whether or not any object is within its supervision plane and would, at most, provide an information about a direction in which the object is located within the supervision plane, such information only being a one-dimensional information. However, including a further information about the distance between the object and the sensor, a two-dimensional information may be provided, i.e., the information clearly indicates at which location the object is situated within the two-dimensional supervision plane.

[0020] The information about the distance between the object and the 2D-sensor may then be used for suitably initiating safety measures in order to avoid critical situations or even accidents. Particularly, upon determining

that an object or obstacle has entered the supervision plane, it may be determined whether the distance to this object becomes smaller than a predetermined allowable minimum distance.

5 **[0021]** Such allowable minimum distance may be predetermined based on further knowledge and/or experiments and may be selected such that the safety measures may be initiated timely before the occurrence of a possible accident.

10 **[0022]** For example, as described in more detail below, the allowable minimum distance may be predetermined taking into account typical velocities of the counterweight and the cabin such that, if an object or obstacle is approaching, sufficient time remains for securely initiating suitable safety measures.

15 **[0023]** Various actions may be initiated as safety measures. For example, a motion of the counterweight and the cabin may be rapidly stopped thereby avoiding that the obstacle detected in the supervision plane hits one of such moving components. Alternatively, for example a warning signal may be issued and/or a travel velocity of the moving components may be temporarily reduced.

20 **[0024]** According to an embodiment, the 2D-sensor is fixed to the counterweight.

25 **[0025]** In fact, it has been found that mounting the 2D-sensor to the counterweight may provide for some benefits. For example, if the 2D-sensor is moved together with the counterweight, it may continuously supervise a supervision plane extending away from the counterweight. For example, the supervision plane may extend into a direction into which the counterweight is currently traveling such that, by supervising such supervision plane, it may be detected when any obstacle comes into the travel path of the counterweight. By initiating suitable safety measures, a collision with such object may then be timely avoided.

30 **[0026]** Particularly, according to an embodiment, the 2D-sensor may be adapted and arranged such that the supervision plane extends in a downward direction from the 2D-sensor.

35 **[0027]** For example, if the 2D-sensor is fixed to the counterweight and "looks" downwards upon the counterweight traveling in a downward direction, particularly dangerous collisions may be avoided. Specifically, when the counterweight is moving downwards and comes across the cabin moving in the opposite direction, there may be a risk of a fatal collision when for example an extremity of a technician protrudes into the travel path of the counterweight and might get clamped or even sheared-off by the downward moving counterweight. By supervising a supervision plane extending downwards from the 2D-sensor attached to the counterweight, such critical collisions may be avoided by timely initiating safety countermeasures.

40 **[0028]** According to an embodiment, the 2D-sensor comprises a laser distance-measurement sensor, a radar distance-measurement sensor or an ultrasonic dis-

tance-measurement sensor or a multiplicity or a combination of such sensors.

[0029] A laser distance-measurement sensor emits a laser beam towards an object and, upon a part of the laser beam being reflected at the object, measures the distance to the object based on the detected reflected laser beam light. Similarly, a radar distance-measurement sensor emits electromagnetic radar waves and determines a distance to an object upon a portion of the radar waves being reflected at a surface of the object and then being detected. Again similarly, an ultrasonic distance-measurement sensor emits ultrasonic waves, i.e. high frequency air pressure modulations, and detects reflected portions of such ultrasonic waves traveling back from a surface of an object. All such distance-measurement sensors may reliably measure the distance between the 2D-sensor and the object located within the supervision plane in a contactless manner.

[0030] According to a particular embodiment, the 2D-sensor comprises a laser source emitting a laser beam being scanned along the supervision plane.

[0031] In such specific implementation of a laser distance-measurement sensor, a single laser beam may be generated but is then not directed along a stationary beam path. Instead, the laser beam may be sequentially deviated such as to be scanned along a direction perpendicular to the laser beam direction. For example, the laser beam may be deviated using a galvo-scanner. Such galvo-scanner comprises a mirror which may be pivoted in a controllable manner such as to controllably deflect the laser beam along a scanning direction. The laser beam direction and the scanning direction then define the supervision plane within which objects may be detected.

[0032] Specifically, according to an embodiment, the distance between the 2D-sensor and the object may be measured using a time-of-flight technique.

[0033] In such time-of-flight (TOF) technique, the laser beam is generally not emitted continuously, i.e. quasi-stationary, but in a pulsed or time-modulated manner. Accordingly, the portion of the laser beam being reflected at the object will have a corresponding time-dependent intensity pattern. A distance between the 2D-sensor and the object may then be evaluated based upon a knowledge about the points in time of emitting and detecting the laser beam. Such time-of-flight techniques may allow accurate distance measurements, particularly for distances as they typically occur within an elevator arrangement, i.e. distances of between several meters and several tens of meters.

[0034] According to an embodiment, the safety monitoring device is adapted for signal communication with the elevator controller. The safety monitoring device then may transmit a signal to the elevator controller for initiating stopping of the motion of the counterweight upon detecting that the determined distance to an object within the supervision plane is smaller than the predetermined allowable minimum distance. Instead of the elevator con-

troller a safety controller may be used. Preferably the safety controller is used to monitor and control safety relevant issues of the elevator. The safety controller might be a part of the elevator controller or in might be a separate part.

[0035] In other words, for initiating the safety measures, the safety monitoring device itself may determine whether an object is occurring in its supervision plane and, if this is the case, may measure the distance to this object. Then, if this distance is critically short, the safety monitoring device may forward this information or a corresponding trigger signal to the elevator controller or the safety controller in order to cause the elevator controller or the safety controller to stop the current motion of the counterweight, for example by actuating a drive engine brake or an emergency brake. By cooperating with the elevator controller, the safety monitoring device may reliably stop any possibly dangerous motion of the cabin and the counterweight before an accidental collision may occur. To safely prevent collision with a technician standing on top of the cabin the predetermined allowable minimum distance takes into consideration that cabin and counterweight moves toward each other and therefore needs twice a distance to prevent collision.

[0036] For example, according to an embodiment, the safety monitoring device may be wired with the elevator controller.

[0037] A hard-wired connection between the safety monitoring device and the elevator controller may be used for one or both, energy supply to the safety monitoring device and signal transmission between the safety monitoring device and the elevator controller. Such power and/or data transmission may be established for example via a cord or a hanging cable connecting the elevator controller with the safety monitoring device, the elevator controller typically being installed within the elevator shaft at a stationary location, whereas the safety monitoring device generally being attached for example to the displaceable counterweight. Again, the safety controller might be used instead of the elevator controller.

[0038] According to a specific implementation, the safety monitoring device may comprise a relay which is switched upon detecting an object being closer than the allowable minimum distance. Such relay may be included into a safety chain of the elevator arrangement. The safety chain typically includes various other relays and/or safety switches, such as door switches for monitoring a correct closing state of elevator doors. Generally, such safety chain is continuously or repeatedly monitored by the elevator controller. Upon one of the relays and/or safety chains being opened, the safety chain is interrupted and the elevator controller, upon detecting such interruption, typically stops or at least modifies the operation of the elevator, i.e. for example stops or slows down the drive engine.

[0039] Alternatively or additionally, according to an embodiment, the safety monitoring device may be powered via inductive power transmission.

[0040] Such inductive power transmission typically provides power to the safety monitoring device in a contactless manner, i.e. "over the air". Generally, electromagnetic waves may be used for inductively transmitting sufficient power for operating the safety monitoring device. Accordingly, no hard-wiring may be required, thereby avoiding substantial wiring efforts. For the inductive power transmission, powerful coils may be provided as an emitter coil, e.g. at a stationary location within the elevator shaft, and as a receiver coil, e.g. at the displaceable counterweight.

[0041] Further alternatively or additionally, according to an embodiment, the safety monitoring device may exchange signals with the elevator controller or the safety controller via wireless signal transmission.

[0042] In other words, also a signal transmission between the elevator controller or the safety controller and the safety monitoring device may be established without requiring any hard-wiring, thereby again avoiding substantial wiring efforts. Wireless signal transmission may be established using a variety of standards and/or technologies based e.g. on radio-wave transmission.

[0043] According to an embodiment, the predetermined allowable minimum distance may be selected to be longer than a distance required for stopping a current motion of the counterweight.

[0044] In other words, the value for the allowable minimum distance, at which, when an object is detected within the supervision plane, safety measures are to be initiated, may be set such that sufficient time remains for stopping the counterweight before a collision occurs. Such distance may also be interpreted as braking distance.

[0045] Preferably, the predetermined allowable minimum distance should be set to be even longer than twice a distance required for stopping the current motion of the counterweight. Thereby, it may be taken into account that the counterweight and the cabin are moving in opposite directions towards each other. Accordingly, e.g. the counterweight should be stopped before it reaches the approaching cabin.

[0046] The allowable minimum distance then generally depends on the actual velocity of the counterweight. I.e., the faster the counterweight is displaced throughout the elevator shaft, the longer the allowable minimum distance should be set.

[0047] Therein, the allowable minimum distance may be set as a fixed value taking into account for example a maximum velocity with which the counterweight is displaced. For example, the allowable minimum distance may be fixedly set to 5m, 2m or the like.

[0048] Alternatively, the allowable minimum distance may be adapted to the actual current velocity of the counterweight, i.e. is set to a shorter value in cases where the counterweight is moved with a slowed-down velocity. In such cases, information about the current velocity of the counterweight may be provided for example from the elevator controller to the safety monitoring device. For ex-

ample, the allowable minimum distance may be fixedly set to e.g. 5m, 2m or the like as long as the counterweight moves at its nominal speed, but is reduced e.g. to 1m or 0.5m, when the counterweight approaches e.g. an end of its travel path and is therefore significantly decelerated.

[0049] According to an embodiment, the safety monitoring device is arranged at a lateral surface of the counterweight.

[0050] In other words, while it may in principle be possible to arrange the safety monitoring device at any location at for example the counterweight, it may be beneficial to arrange it at a lateral surface of the counterweight. For example, it might be intuitive at first view to arrange the safety monitoring device at a lower surface of the counterweight in order to monitor a supervision plane extending downwards from the counterweight. However, for such downward looking configuration, it may be beneficial to locate the safety monitoring device at a lateral surface of the counterweight at a position slightly upwards to a lower end of the counterweight. Preferably, the safety monitoring device is arranged at the lateral surface closest to the travel path of the elevator cabin. In such arrangement, the supervision plane having its origin at the 2D-sensor may be arranged in parallel to the lateral surface of the counterweight such that any object or obstacle may be detected already before it enters for example the travel path of the counterweight.

[0051] According to an embodiment, the safety monitoring device is adapted for modifying its operation upon the counterweight approaching a pit at a lower end of the elevator shaft.

[0052] Thereby, it may be taken into account that in a preferred embodiment, the safety monitoring device is arranged at the counterweight and supervises a supervision plane arranged underneath the counterweight. In such embodiment, when the counterweight approaches the lower end of the elevator shaft, the monitoring device will detect for example a bottom of the elevator shaft or a buffer provided at the pit of the elevator shaft entering the supervision plane sooner or later at a distance shorter than the predetermined allowable minimum distance. Accordingly, if the operation of the safety monitoring device would not be modified in such situation, safety measures would automatically be initiated. In order to suppress such erroneous initiation of safety measures, the operation of the safety monitoring device should be temporarily modified for example such that the initiation of safety measures is temporarily suppressed or the predetermined allowable minimum distance is temporarily set to a smaller value. For example, if the counterweight approaches the bottom of the elevator shaft and a distance to this bottom becomes smaller than for example 2 m, the safety monitoring device may be modified such that the predetermined allowable minimum distance is reduced to for example significantly less than 2 m or the safety monitoring device is even temporarily completely switched-off or set to a waiting mode.

[0053] According to an embodiment, the safety moni-

toring device is adapted for learning information about positions of regular objects within the elevator shaft during a teach-in process and the safety monitoring device is adapted for taking into account the learned information upon initiating the safety measures.

[0054] In other words, for example before taking the safety monitoring device into actual operation within the elevator arrangement, the teach-in process may be performed. During such teach-in process, the safety monitoring device may "learn" at which positions within the elevator shaft objects are arranged regularly or by default. For example, the safety monitoring device may learn at which position for example a buffer arranged at the pit of the elevator shaft is located.

[0055] For such teach-in process, the safety monitoring device may for example be moved along an entire travel path through the elevator shaft, i.e. from an upper end to a lower end of the elevator shaft. For example, upon being fixed to the counterweight, the safety monitoring device may be transported together with the counterweight along the entire height of the elevator shaft. During the teach-in process, no extraordinary obstacles or persons should be present within the elevator shaft, such that the safety monitoring device may at most detect some regular objects in its supervision plane which are always present in the elevator shaft and which are arranged such that during normal operation of the elevator arrangement no collision occurs. Accordingly, the safety monitoring device may for example "learn" that detecting a buffer arranged at the pit of the elevator shaft is no reason for initiating any safety measures and may take this learned information into account upon later operation of the safety monitoring device.

[0056] According to an embodiment, the safety monitoring device may further comprise a second 2D-sensor for contactless supervising a second supervision plane extending away from the sensor in an extension direction opposite to the extension direction of the first supervision plane and for determining a second distance between the 2D-sensor and an object located within the second supervision plane. Therein, the safety monitoring device may be adapted for initiating safety measures upon detecting that the determined second distance is smaller than a second predetermined allowable minimum distance.

[0057] In other words, the safety monitoring device may comprise more than one 2D-sensor and the sensors may "look" into substantially opposite directions.

[0058] For example, a safety monitoring device may be provided with its two or more 2D-sensors fixed at the counterweight and one 2D-sensor supervising a supervision plane underneath the counterweight and the second 2D-sensor supervising a second supervision plane upwards of the counterweight. Accordingly, the safety monitoring device may be used for detecting objects or obstacles approaching the safety monitoring device upon the counterweight being moved in each one of possible opposite travel directions. For example, when the coun-

terweight is moved downwards, the supervising capability and distance measurements provided by the 2D-sensor "looking" downwards may be used for initiating safety measures whereas, when the counterweight is moved in the upwards directions, the second 2D-sensor "looking" upwards is taken into account for deciding upon initiating any safety measures.

[0059] It shall be noted that possible features and advantages of embodiments of the invention are described herein partly with respect to an elevator arrangement, partly with respect to a safety device to be applied in such elevator arrangement and partly with respect to a method of operating such safety device. One skilled in the art will recognize that the features may be suitably transferred from one embodiment to another and features may be modified, adapted, combined and/or replaced, etc. in order to come to further embodiments of the invention.

[0060] In the following, advantageous embodiments of the invention will be described with reference to the enclosed drawings. However, neither the drawings nor the description shall be interpreted as limiting the invention.

[0061] Fig. 1 shows a side view of an elevator arrangement according to an embodiment of the present invention.

[0062] Fig. 2 shows a front view onto a safety monitoring device for an elevator arrangement according to an embodiment of the present invention.

[0063] The figures are only schematic and not to scale. Same reference signs refer to same or similar features.

[0064] Fig. 1 shows an elevator arrangement 1 according to an embodiment of the present invention. The elevator arrangement 1 comprises a cabin 3 and a counterweight 5, which are suspended by a suspension traction means 7 such as a plurality of belts. The suspension traction means 7 may be driven by a drive engine 9 such as to displace the cabin 3 and the counterweight 5 within an elevator shaft 11 along opposing travelling directions 4, 6. An operation of the drive engine 9 is controlled via an elevator controller 13.

[0065] Specifically, the elevator arrangement 1 comprises a safety monitoring device 15. In the example shown, this safety monitoring device 15 is arranged at a lateral surface 17 of the counterweight 5. The safety monitoring device 15 comprises a 2D-sensor 19. The 2D-sensor 19 is adapted for supervising a supervision plane 21 in a contactless manner. The supervision plane 21 extends away from the 2D-sensor in a downward vertical direction and substantially parallel to the travelling directions 4, 6 of the cabin 3 and the counterweight 5 throughout the elevator shaft 11.

[0066] Particularly, the 2D-sensor 19 is adapted for determining a distance towards an object 28 located within the supervision plane 21. Furthermore, in case such object 28 is detected, the safety monitoring device 15 may determine whether this object 28 is excessively close, i.e. the determined distance d between the 2D-sensor 19 and the object 28 is smaller than a predetermined allowable minimum distance d_m , such that suitable safety

measures should be initiated.

[0067] In such case, for example, the safety monitoring device 15 may communicate for example with the elevator controller 13 in order to cause instant stopping of a current motion of the cabin 3 and the counterweight 5. Alternative safety measures such as an alarm may be initiated by the safety monitoring device 15. Instead of the elevator controller 13 a safety controller, if available, might be used to cause instant stopping of a current motion of the cabin 3 and the counterweight 5. The safety controller might be used in addition to the elevator controller 13. Thereby the elevator controller is designed to control the elevator in general and the safety controller is designed to monitor that all safety relevant parameters are fulfilled. The safety controller should fulfil higher safety levels (e.g. SIL 3) than the normal elevator controller. Of course, the full safety functions can be integrated as a safety part in the elevator controller 13.

[0068] For example, if a maintenance technician 23 is standing on top of a roof 27 of the cabin 3 and leans over a balustrade 25, a hand 29 of the technician 23 may protrude into the downward travel path 31 of the counterweight 5. Therein, the travel path 31 defines the volume or footprint through which the counterweight 5 may be displaced. When the cabin 3 and the counterweight 5 come close to each other and their ways are crossing, the hand 29 of the technician 23 could collide with the approaching counterweight 5 such that the technician 23 could be seriously injured.

[0069] In order to avoid such accident, the safety monitoring device 15 may span its supervision plane 21 underneath the counterweight 5, i.e. it could "look" down in parallel to the travel direction 6 of the counterweight 5 and along the travel path 31. Specifically, the safety monitoring device 15 may monitor the entire two-dimensional supervision plane 21 for any objects 28 or obstacles coming close to or even protruding into the travel path 31 of the counterweight 5.

[0070] Particularly, as the supervision plane 21 preferably extends between the travel path 31 of the counterweight 5 and the upwards-directed travel path of the cabin 3, the safety monitoring device 15 may detect any obstacles already before they actually protrude into the travel path 31.

[0071] Optionally, such objects 28 as the technician's 23 hand 29 may already be detected well before they come critically close to the counterweight 5. In such case, the safety monitoring device 15 may ignore the information about the object 28 or, as a precaution, for example may initiate some preliminary safety measures such as issuing a warning signal.

[0072] However, if the counterweight 5 and the cabin 3 continue coming closer to each other and the object 28, such as the hand 29, comes closer to the 2D-sensor 19, sooner or later, the distance d between the 2D-sensor 19 and the object 28 will go below the predetermined allowable minimum distance d_m . In such case, it is realised that there is an acute risk for a collision.

[0073] The safety monitoring device 15 may then use for example a wireless transmitter device 33 for transmitting a trigger signal towards the elevator controller 13 or the corresponding safety controller in order to cause the elevator controller 13 to stop any motion of the counterweight 5 and the cabin 3. Alternatively, the safety monitoring device 15 could send a signal for initiating safety measures via hardwiring, including for example a hanging cable between the displaceable counterweight 5 and some stationary structures within the elevator shaft 11, towards the elevator controller 13 or the safety controller. As a further alternative, the safety monitoring device 15 could comprise a relay which is opened upon detecting that an object 28 coming closer than the predetermined allowable minimum distance d_m , the relay being included into a safety chain continuously monitored by the elevator controller 13 respectively the safety controller.

[0074] Similarly, hardwiring could also be used for supplying electricity to the safety monitoring device 15 as an energy supply. Alternatively, such powering of the safety monitoring device 15 could be established via an inductive power transmission.

[0075] Fig. 2 shows a more detailed front view onto a safety monitoring device 15 attached to a lateral surface 17 of a counterweight 5. In the example shown, the 2D-sensor 19 of the safety monitoring device 15 comprises a laser source 35. The laser source 35 emits a laser beam 37 towards a mirror 39. The mirror 39 may pivot and may therefore deviate the laser beam 37 reflected at this mirror 39 into a variety of angles. Accordingly, a downstream portion 41 of the laser beam 37 may be scanned linearly along scanning directions 43 throughout the supervision plane 21.

[0076] Therein, the downstream portion 41 of the laser beam 37 may cover a triangular two-dimensional area forming the supervision plane 21. The fact, that the safety monitoring device 15 is not arranged at a lower bottom surface 45 of the counterweight 5 but substantially upwards from such bottom surface 45 at the lateral surface 17 of the counterweight 5 results in the beneficial feature that, at the level of the bottom surface 45 where a collision with the counterweight 5 typically occurs, the triangular supervision plane 21 already covers an entire width of the counterweight 5 or at least a major portion thereof. Accordingly, a risk that an obstacle is arranged within the travel path of the counterweight 5 but is not detected within the supervision plane 21 may be minimised.

[0077] Upon an obstacle such as the hand 29 of the technician 23 coming into the supervision plane 21, a part of the scanned downstream portion 41 of the laser beam 37 is reflected back towards the safety monitoring device 15. There, it may be detected using for example a light sensor such as a light-sensitive diode.

[0078] As the emitted laser beam 37 is typically pulsed or otherwise modulated in time, upon detecting such reflected part of the laser beam 37, a time-of-flight (TOF) analysis may be performed. Therein, based upon the time needed from emittance until detection of the laser

beam 37, the distance d between the hand 29 and the safety monitoring device 15 may be determined. In such case, the 2D-sensor 19 forms a laser distance-measurement sensor 20.

[0079] As long as such distance d is sufficiently large such that no acute risk for any collision between the hand 29 and the counterweight 5 is to be assumed, no further measures are necessarily to be taken. However, in case such distance d becomes smaller than a predetermined allowable minimum distance d_m , it may be assumed that the technician did not recognise the approaching counterweight 5 and therefore there is a high risk of a collision between his hand 29 and the counterweight 5, when the technician does not withdraw his hand 29. In such case, the safety monitoring device 15 may automatically initiate suitable safety measures such as rapidly stopping any motion of the counterweight 5 and the cabin 3 carrying the technician 23.

[0080] Additionally to the scenario shown in fig. 1, in which the technician 23 stands on top of the cabin 3, thereby risking a collision with the counterweight 5 when both moving components come across each other, there may also be scenarios where for example a technician 23 works in a pit 51 close to a bottom 47 of the elevator shaft 11. Also in such scenario, a displaceable component such as the counterweight 5 or the cabin 3 coming close to the pit 51 may collide with the technician 23. Accordingly, also in such situation, the safety monitoring device 15 may be applied and may significantly reduce a risk for such collisions.

[0081] However, upon coming close to the pit 51, the safety monitoring device 15 may not only detect obstacle objects 28 such as the technician 23, but may also detect some regular objects 48 such as buffers 49 arranged in the pit 51 by default. Typically, such default objects 48 are arranged close to, but outside, the travel path 31 of any displaceable components of the elevator arrangement 1. However, as the supervision plane 21 is typically not completely limited to such travel path 31 but may extend laterally beyond such travel path 31, default objects 48 such as the buffers 49 may be detected upon approaching the pit 51.

[0082] Accordingly, the safety monitoring device 15 may be adapted such that its operation is modified upon the safety monitoring device 15 or the counterweight 5, to which the safety monitoring device 15 is attached, approaching the pit 51 at the lower end of the elevator shaft 11. Particularly, the safety monitoring device 15 may temporarily be switched off, may temporarily ignore any object 28, 48 being detected within its supervision plane 21 or may reduce the predetermined allowable minimum distance d_m to a distance being smaller than the current distance to the bottom 47 of the pit 51 and/or to regular objects 48 such as the buffer 49 arranged there.

[0083] Before taking the elevator arrangement 1 and its safety monitoring device 15 into actual operation, a teach-in process may be performed during which the safety monitoring device 15 may learn about positions of

any regular or default objects 48 within the elevator shaft 11. For example, the safety monitoring device 15 attached to the counterweight 5 may be displaced throughout an entire travel range of the counterweight 5. During such travel, any detection of regular objects 48 may be analysed and/or stored such that corresponding information may later, during normal operation of the elevator arrangement 1, be taken into account. Particularly, such information may help in deciding whether an object 28, 48 detected within the supervision plane 21 at a distance shorter than the allowable minimum distance represents a real risk for a collision or whether this object is a default object 48 within the elevator shaft 11 being regularly arranged outside any travel paths 31 and therefore not forming a reason for taking safety measures in order to avoid collisions.

[0084] Finally, it should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. Elevator arrangement (1) comprising:

a cabin (3) and a counterweight (5) being displaceable in traveling directions (4, 6) within an elevator shaft (11),
an elevator controller (13) for controlling motions of the cabin (3) and the counterweight (5), and a safety monitoring device (15),
wherein the safety monitoring device (15) comprises a 2D-sensor (19) for contactless supervising a supervision plane (21) extending away from the 2D-sensor (19) in an extension direction parallel to the traveling directions and for determining a distance (d) between the 2D-sensor (19) and an object (28) located within the supervision plane (21),
wherein the safety monitoring device (15) is adapted for initiating safety measures upon detecting that the determined distance (d) is smaller than a predetermined allowable minimum distance (d_m).

2. Elevator arrangement of claim 1, wherein the 2D-sensor (19) is fixed to the counterweight (5).

3. Elevator arrangement of one of the preceding claims, wherein the supervision plane (21) extends in a downward direction from the 2D-sensor (19).

4. Elevator arrangement of one of the preceding claims, wherein the 2D-sensor (19) comprises at least one

of a laser distance-measurement sensor (20), a radar distance-measurement sensor and an ultrasonic distance-measurement sensor.

5. Elevator arrangement of one of the preceding claims, wherein the 2D-sensor comprises a laser source (35) emitting a laser beam (37, 41) being scanned along the supervision plane (21). 5
6. Elevator arrangement of claim 5, wherein the distance (d) between the 2D-sensor (19) and the object (28) is measured using a time-of-flight technique. 10
7. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is adapted for signal communication with the elevator controller (13) or with a safety controller, and wherein the safety monitoring device (15) transmits a signal to the elevator controller (13) or to the safety controller for initiating stopping of the motion of the counterweight (5) upon detecting that the determined distance (d) is smaller than the predetermined allowable minimum distance (d_m). 15 20
8. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is wired with the elevator controller (13) or with the safety controller. 25
9. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is powered via inductive power transmission. 30
10. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) exchanges signals with the elevator controller (13) or with the safety controller via wireless signal transmission. 35
11. Elevator arrangement of one of the preceding claims, wherein the predetermined allowable minimum distance (d_m) is longer than a distance required for stopping a current motion of the counterweight (5), preferably longer than twice a distance for stopping a current motion of the counterweight (5). 40 45
12. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is arranged at a lateral surface (17) of the counterweight (5). 50
13. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is adapted for modifying its operation upon the counterweight (5) approaching a pit (51) at a lower end of the elevator shaft (11). 55
14. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) is adapted

for learning information about positions of regular objects (48) within the elevator shaft (11) during a teach-in process and the safety monitoring device (15) is adapted for taking into account the learned information upon initiating the safety measures

15. Elevator arrangement of one of the preceding claims, wherein the safety monitoring device (15) further comprises a second 2D-sensor (19) for contactless supervising a second supervision plane (21) extending away from the 2D-sensor (19) in an extension direction opposite to the extension direction of the first supervision plane and for determining a second distance between the 2D-sensor (19) and an object (28) located within the second supervision plane, wherein the safety monitoring device (15) is adapted for initiating safety measures upon detecting that the determined second distance is smaller than a second predetermined allowable minimum distance.

Fig. 1

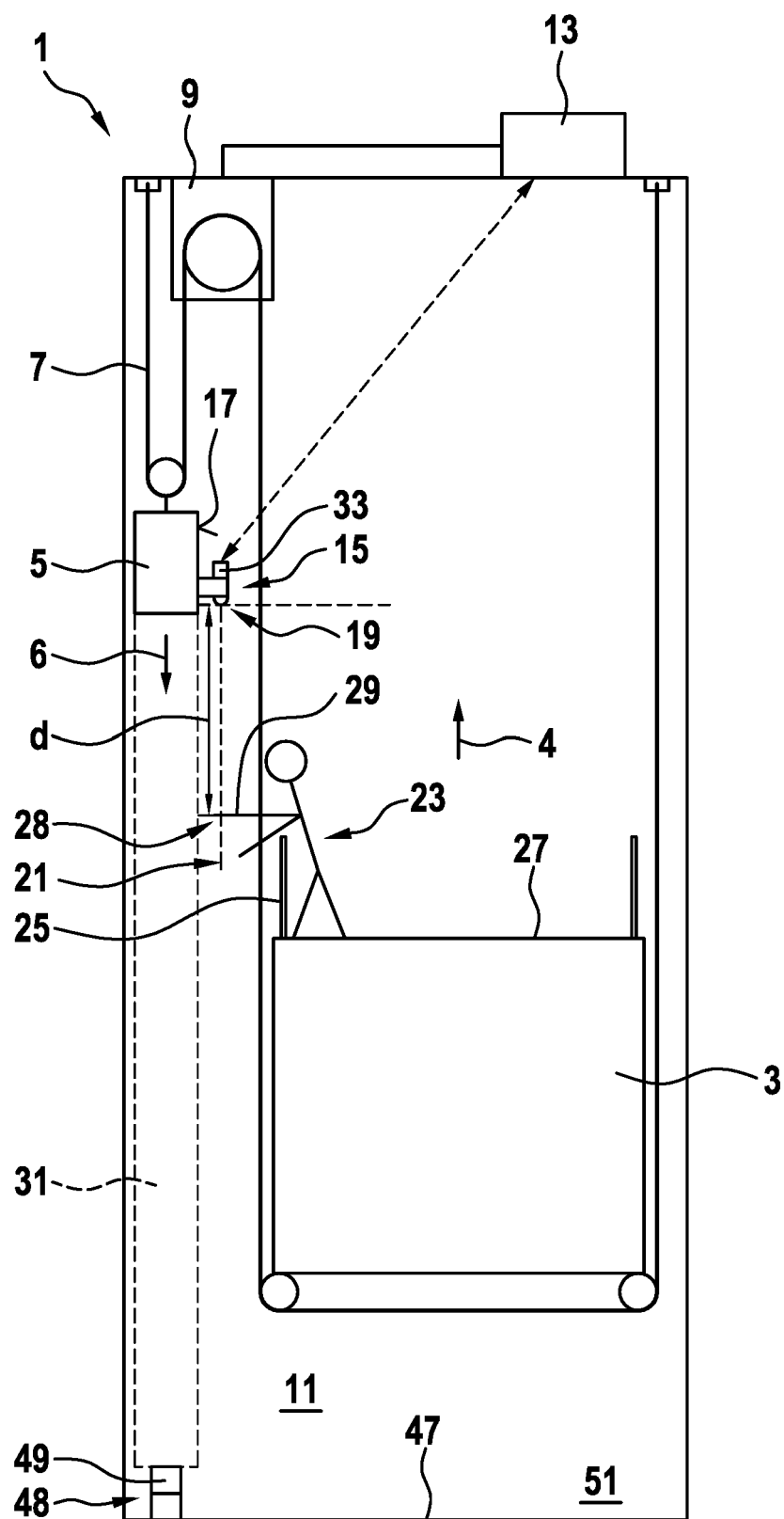
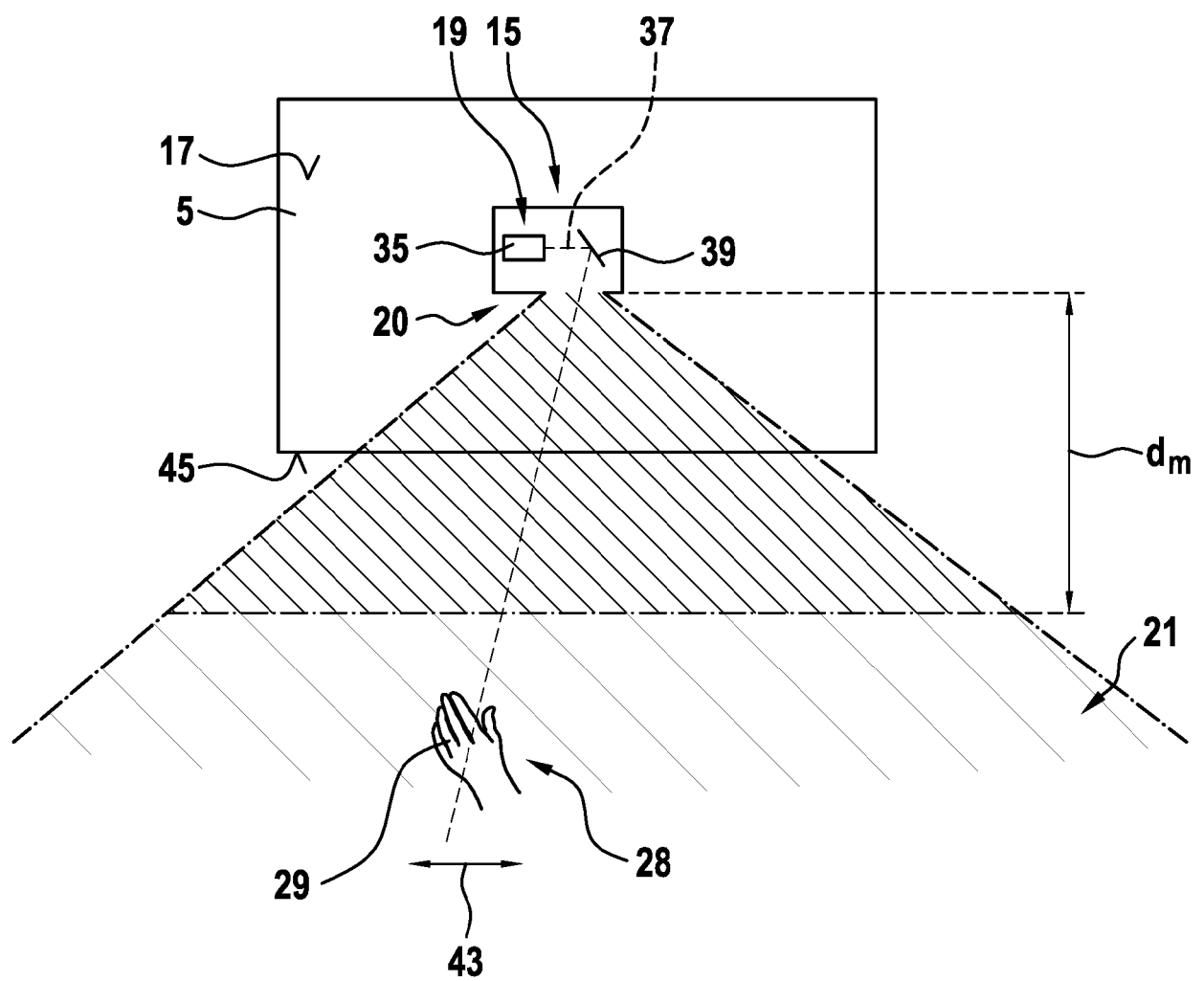


Fig. 2





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Application Number
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	* column 2, line 38 - column 3, line 61 *		
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Place of search The Hague		Date of completion of the search 21 December 2017	Examiner Bleys, Philip
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