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(71) Applicant: **KONE Corporation**
00330 Helsinki (FI)

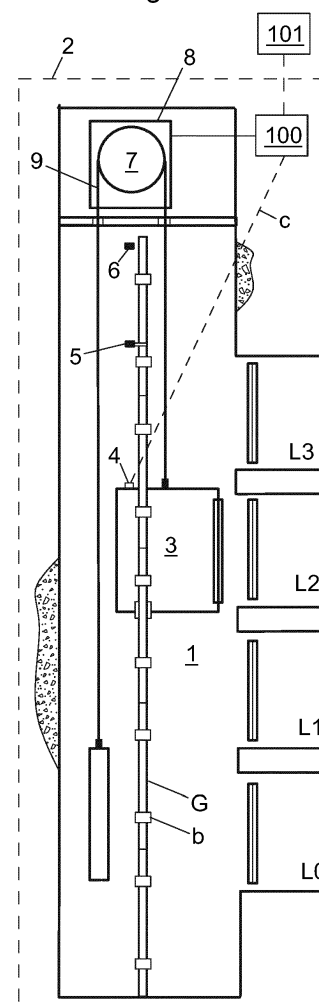
(72) Inventor: **Valjus, Petteri**
00330 Helsinki (FI)

(74) Representative: **Kolster Oy Ab**
(Salmisaarenaukio 1)
P.O. Box 204
00181 Helsinki (FI)

(54) **ELEVATOR ARRANGEMENT AND METHOD**

(57) The invention relates to an elevator arrangement comprising a sensing arrangement (4,5,6) connected with an elevator control system (100,101), the sensing arrangement (4,5,6) comprising a building-mounted sensing unit (6) mounted on a stationary part (W) of the building (2); at least one sensing unit (4) mounted on the elevator car (3) to travel therewith. The building-mounted sensing unit (6) is a counterpart for a sensing unit (4) mounted on the elevator car (3); and the elevator car (3) is movable by the elevator control system (100,101) to a first position, which is a reference position, and to a second position to place a sensing unit (4) mounted on the elevator car (3) to be level with the building-mounted sensing unit (6) for triggering interaction between them, the first and second position being vertically displaced. The elevator control system (100,101) is configured to monitor vertical distance (d) between the first position and the second position by aid of the sensing arrangement (4,5,6). The invention also relates to a method for monitoring shrinkage of a building (2) by an elevator control system (100,101), the method utilizing the aforementioned sensing arrangement (4,5,6).

Fig. 1



Description

FIELD OF THE INVENTION

[0001] The invention relates to an elevator arrangement and a method for monitoring an elevator arrangement. The elevator is preferably an elevator for transporting passengers and/or goods.

BACKGROUND OF THE INVENTION

[0002] Shrinkage of bearing structures is typical for new buildings. A bearing concrete structure of a building dries and is slowly compressed smaller in vertical direction when the time passes. Also a bearing steel structure of a building shrinks smaller in vertical direction. The bearing steel structure of a building shrinks elastically, for instance due to weight building on the uppermost parts of the building, such as due to mass being brought inside the building or additional floors being built on top of the building. Building shrinkage is a phenomenon that needs to be dealt with in design and maintenance of an elevator. The higher the building and the hoistway of the elevator, the more important it is to prevent shrinkage from causing component breakages, component deformations, excessive wear of components, safety issues or problems in ride comfort.

[0003] Guide rails are typically supported laterally on the hoistway walls by brackets, which grip the guide rail and do not freely slide along the guide rails. Building shrinkage is prone to cause the brackets, or corresponding means, to exert a downwards directed push on the guide rails. If not eliminated, together with gravity, the building shrinkage can cause forces even to such extent that the guide rails bend.

[0004] One way to eliminate problems caused by building shrinkage has been to fine-tune the elevator parts, such as guide rail support, occasionally so that compressions do not build up excessive. A drawback has been that it has been difficult to determine when the actions for eliminating the effect of shrinkage are to be done. It has been particularly difficult to find a cost effective, simple, reliable and effective system to timely enable initiation of such actions without doing this too seldom nor too frequently. As a result, various components, such as guide rails and brackets, for example, need to be dimensioned to withhold also the forces caused by the building shrinkage.

BRIEF DESCRIPTION OF THE INVENTION

[0005] The object of the invention is to provide a solution which is improved in terms of monitoring of building shrinkage and reacting thereto. An object is particularly to alleviate one or more of the above defined drawbacks of prior art and/or problems discussed or implied elsewhere in the description. Solutions are presented, *inter alia*, by which an elevator arrangement can monitor and

react to building shrinkage automatically. Solutions are presented, *inter alia*, where this can be achieved reliably, simply and cost effectively.

[0006] It is brought forward a new elevator arrangement comprising a hoistway formed in a building; an elevator car vertically movable in the hoistway along one or more guide rails mounted to take lateral support from a hoistway wall; an elevator control system for controlling movement of the car; a sensing arrangement connected (e.g. over a wireless or wired electrical connection) with the elevator control system, the sensing arrangement comprising a building-mounted sensing unit mounted on a stationary part of the building, said stationary part preferably being a hoistway wall or the hoistway ceiling; and at least one sensing unit mounted on the elevator car to travel therewith. The building-mounted sensing unit is a counterpart for a sensing unit mounted on the elevator car; and the elevator car is movable by the elevator control system to a first position, which is a reference position, and to a second position to place a sensing unit mounted on the elevator car to be level with the building-mounted sensing unit for triggering interaction between them. The first and second position are vertically displaced from each other. The elevator control system is configured to monitor vertical distance between the first position and the second position by aid of the sensing arrangement.

[0007] With this solution, one or more of the above mentioned advantages and/or objectives are achieved. Preferable further features are introduced in the following, which further features can be combined with the arrangement individually or in any combination.

[0008] In a preferred embodiment, the elevator control system comprises a local elevator control system located within the building and a remote monitoring system located outside the building.

[0009] In a preferred embodiment, the elevator control system, is configured to perform repeatedly distance determinations of prevailing distance, and in each distance determination the elevator car is configured to be driven, preferably by the elevator control system, most preferably by a local elevator control system thereof, from a first position to a second position.

[0010] In a preferred embodiment, when the elevator car is in said first position, a sensing unit mounted on the elevator car is level with a reference sensing unit mounted on a stationary part of the elevator arrangement, and wherein when the elevator car is in said second position, a sensing unit mounted on the elevator car is level with the building-mounted sensing unit.

[0011] In a preferred embodiment, the building-mounted sensing unit is carried by the stationary part of the building on which it is mounted, in particular such that when the mounting point of the part on which the building-mounted sensing unit is mounted descends due to building shrinkage, the building-mounted sensing unit descends together with it. For this end, the building-mounted sensing unit is preferably vertically immovable relative

to the stationary part of the building on which it is mounted.

[0012] In a preferred embodiment, the sensing arrangement comprises a reference sensing unit mounted on a stationary part of the elevator arrangement. The reference sensing unit is preferably mounted on a stationary part of the elevator arrangement on a first level, said stationary part preferably being a guide rail; and the building mounted sensing unit is mounted on a stationary part of the building on a second level, wherein the reference sensing unit and the building-mounted sensing unit are each a counterpart for a sensing unit mounted on the elevator car; and wherein the elevator car is movable by the elevator control system to the first position, which is a reference position, to place a sensing unit mounted on the elevator car to be level with the reference sensing unit for triggering interaction between them.

[0013] In a preferred embodiment, the first level and the second level are vertically displaced from each other, preferably more than 0.5 meters, more preferably more than 1 meter. This reduces effect of error margins and facilitates detectability of changes in the distance between the first and second position thereby facilitating determination of the prevailing distance.

[0014] In a preferred embodiment, the reference sensing unit mounted on a stationary part of the elevator arrangement is carried by the stationary part of the elevator arrangement on which it is mounted. The reference sensing unit is preferably vertically immovable relative to the stationary part on which it is mounted.

[0015] In a preferred embodiment, the elevator control system is configured to detect interaction between the building-mounted sensing unit and a sensing unit mounted on the elevator car. Said interaction can be a contact between the interacting units when they come to be level with each other, e.g. one of them being a contact switch and the other being a member for actuating the contact switch or alternatively said interaction is contactless effect caused by one of the interacting units on the other, e.g. one being a proximity sensor and the other being a member for actuating the proximity sensor.

[0016] In a preferred embodiment, the elevator control system is configured to detect interaction between the reference sensing unit and a sensing unit mounted on the elevator car. Said interaction can be a contact between the interacting units when they come to be level with each other, e.g. one of them being a contact switch and the other being a member for actuating the contact switch or alternatively said interaction is contactless effect caused by one of the interacting units on the other, e.g. one being a proximity sensor and the other being a member for actuating the proximity sensor.

[0017] In a preferred embodiment, the stationary part of the building on which the building-mounted sensing unit is mounted is a wall of the hoistway. Preferably, the stationary part of the building on which the building-mounted sensing unit is mounted comprises concrete or is made of concrete. In this kind of context, it is highly

advantageous to monitor and react to shrinkage. Alternatively, the stationary part of the building on which the building-mounted sensing unit is mounted can comprise or be made of some other structure prone to shrinkage. Also steel structures can be prone to shrinkage within the meaning of this application.

[0018] In a preferred embodiment, the building comprises concrete as bearing wall material. In this kind of context, it is highly advantageous to monitor and react to shrinkage.

[0019] In the preferred embodiment, the building-mounted sensing unit is fixed on the stationary part of the building via a fixing bracket. Said fixing bracket is preferably a fixing arm.

[0020] In the preferred embodiment, the reference sensing unit is fixed on the stationary part of the elevator arrangement via a fixing bracket. Said fixing bracket is preferably a fixing arm.

[0021] In a preferred embodiment, said stationary part on which the reference sensing unit is mounted is a guide rail or a guide rail bracket.

[0022] In a preferred embodiment, the reference sensing unit and the building-mounted sensing unit are vertically aligned, i.e. on the same vertically oriented straight line, whereby a sensing unit mounted on the car can be moved by vertically linear movement from a position beside the reference sensing unit to a position beside the building-mounted sensing unit.

[0023] In a preferred embodiment, the aforementioned second position is higher or lower than the first position.

[0024] In a preferred embodiment, a sensing unit mounted on the elevator car is level with a reference sensing unit mounted on a stationary part of the elevator arrangement when the elevator car is in the first position, and a sensing unit mounted on the elevator car is level with the building-mounted sensing unit when the elevator car is in the second position. Said sensing unit mounted on the elevator car is preferably the same sensing unit, but alternatively there could be more than one sensing units mounted on the car.

[0025] In a preferred embodiment, the sensing unit mounted on the elevator car is level with the reference sensing unit when the elevator car is in the first position wherein it is level with a landing, i.e. when the sill of the car is level with the sill of the landing, the landing preferably being the uppermost landing of the elevator arrangement, and the building-mounted sensing unit is at a higher position than the reference sensing unit whereby for placing the sensing unit mounted on the elevator car level with the building-mounted sensing unit, the car is configured to be moved to the second position which is higher than the first position. This provides that the reference sensing unit can be the landing sensor of the elevator arrangement.

[0026] In a preferred embodiment, the sensing arrangement is configured to signal, preferably to the elevator control system, e.g. by sending a signal to elevator control system, when the reference sensing unit is level

with a sensing unit mounted on the elevator car, and when the building-mounted sensing unit is level with a sensing unit mounted on the elevator car.

[0027] In a preferred embodiment, in each said distance determination the elevator control system is configured to determine the prevailing distance based on length of travel of the car between the first position and the second position.

[0028] In a preferred embodiment, in each said distance determination the elevator control system is configured to determine the prevailing distance based on length of travel of the car between the first position where the sensing unit mounted on the elevator car is level with the reference sensing unit and the second position where a sensing unit mounted on the elevator car is level with the building-mounted sensing unit.

[0029] In a preferred embodiment, in each said distance determination the elevator control system is configured to determine length of travel of the car between the first position and the second position.

[0030] In a preferred embodiment, the elevator control system is configured to perform said determining the length of travel by measuring one or more parameters, most preferably by measuring at least the amount a wheel rotates during movement of the car from the first position to the second position, wherein a rope or a belt connected to the elevator car passes around the wheel. Preferably, the wheel is a drive wheel rotatable by a motor. Then preferably, the elevator control system is arranged to measure rotation angle of the motor. Said determining the prevailing distance can be then performed for example by calculating from the measured angle.

[0031] In a preferred embodiment, the elevator control system is configured to perform after each distance determination an analysis wherein at least the prevailing distance is analyzed, in particular for checking if the prevailing distance meets one or more criteria

[0032] In a preferred embodiment, the elevator control system is configured to perform one or more actions if the prevailing distance meets one or more criteria.

[0033] In a preferred embodiment, a criterion for one or more actions mentioned anywhere above can be that the prevailing distance has reached a threshold. Alternatively or additionally, a criterion for one or more actions mentioned anywhere above can be that that change of distance calculated based on the prevailing distance and a reference distance has reached a threshold.

[0034] In a preferred embodiment, said one or more actions mentioned anywhere above include sending or displaying a signal, such as an alarm signal. The signal can be a signal indicating a need for guide rail inspection or a need for repair or a need for compression release of the guide rail line support equipment supporting the guide rails on a hoistway wall.

[0035] In a preferred embodiment, the elevator control system is configured to compare the prevailing distance after each distance determination with a threshold.

[0036] In a preferred embodiment, the elevator control

system is arranged to calculate, preferably after each distance determination, a change of distance based on the prevailing distance and a reference distance, such as a reference distance between the first and second position determined earlier using the sensing arrangement.

[0037] In a preferred embodiment, in each said distance determination, the elevator control system is arranged to drive the car from the first to second position such that no passengers are within the car.

[0038] In a preferred embodiment, the elevator control system is configured to perform said distance determinations periodically, preferably a preset number of times in a period, said period preferably being a month, and said number of times preferably being one, two, three or more.

[0039] It is also brought forward a new method for monitoring an elevator arrangement by an elevator control system, in particular for monitoring shrinkage of a building of an elevator arrangement by an elevator control system, wherein the elevator arrangement comprises a hoistway formed in a building; an elevator car vertically movable in the hoistway along one or more guide rails mounted to take lateral support from a hoistway wall; an elevator control system for controlling movement of the car; a sensing arrangement connected with the elevator control system, the sensing arrangement comprising a building-mounted sensing unit mounted on a stationary part of the building, said stationary part preferably being a hoistway wall or the hoistway ceiling; at least one sensing unit mounted on the elevator car to travel therewith, wherein the building-mounted sensing unit is a counterpart for a sensing unit mounted on the elevator car; and the elevator car is movable by the elevator control system to a first position, which is a reference position, and to a second position to place a sensing unit mounted on the elevator car to be level with the building-mounted sensing unit for triggering interaction between them, the first and second position being vertically displaced from each other; the method comprising monitoring vertical distance between the first position and the second position by aid of the sensing arrangement.

[0040] With this solution, one or more of the above mentioned advantages and/or objectives are achieved.

[0041] Preferable further features/steps of the method are introduced in the following, as well as above in context of description of the arrangement, which further features/steps can be combined with the method individually or in any combination.

[0042] In a preferred embodiment, monitoring the vertical distance comprises performing one or more distance determinations of prevailing distance by the elevator control system, each distance determination comprising driving the elevator car, in particular by the elevator control system, most preferably by the local elevator control system, from the first position to the second position.

[0043] In a preferred embodiment, monitoring the vertical distance comprises performing repeatedly distance

determinations of prevailing distance by the elevator control system, each distance determination comprising driving the elevator car, in particular by the elevator control system, most preferably by the local elevator control system, from the first position to the second position.

[0044] In a preferred embodiment, the elevator control system comprises a local elevator control system located within the building and a remote monitoring system located outside the building.

[0045] In a preferred embodiment, each distance determination comprises by the elevator control system determining the prevailing distance based on length of travel of the car between the first position and the second position.

[0046] In a preferred embodiment, each distance determination comprises by the elevator control system determining length of travel of the car between the first position and the second position.

[0047] In a preferred embodiment, said determining the length of travel comprises measuring one or more parameters, most preferably measuring at least the amount a wheel rotates during movement of the car from the first position to the second position, wherein a rope or a belt connected to the elevator car passes around the wheel. Preferably, the wheel is a drive wheel rotatable by a motor. Then preferably, the measuring comprises measuring rotation angle of the motor. Said determining the prevailing distance can be then performed for example by calculating from the measured angle.

[0048] In a preferred embodiment, the method comprises after each distance determination analyzing the prevailing distance, said analyzing preferably comprising checking if the prevailing distance meets one or more criteria.

[0049] In a preferred embodiment, the method comprises performing one or more actions, by the elevator control system, if the prevailing distance meets one or more criteria. The preferred details and alternatives of the criteria are described earlier above.

[0050] In a preferred embodiment, said one or more actions include sending or displaying a signal, such as an alarm signal. The preferred details and alternatives of the signal are described earlier above.

[0051] In a preferred embodiment, the method comprises comparing, preferably after each distance determination, the prevailing distance with a threshold.

[0052] In a preferred embodiment, the method comprises calculating, preferably after each distance determination, change of distance based on the prevailing distance and a reference distance, such as a reference distance between the first and second position determined earlier using the sensing arrangement.

[0053] In a preferred embodiment, said distance determination are performed periodically, preferably a preset number of times in a period, said period preferably being a month, and said number of times preferably being one, two, three or more.

[0054] In a preferred embodiment, the sensing ar-

rangement comprises a reference sensing unit mounted on a stationary part of the elevator arrangement on a first level, said stationary part preferably being a guide rail; and the building mounted sensing unit is mounted on a stationary part of the building on a second level, wherein the reference sensing unit and the building-mounted sensing unit are each a counterpart for a sensing unit mounted on the elevator car; and wherein the elevator car is movable by the elevator control system to the first position, which is a reference position, to place a sensing unit mounted on the elevator car to be level with the reference sensing unit for triggering interaction between them.

[0055] In a preferred embodiment, the method comprises signaling by the sensing arrangement, preferably to the elevator control system, e.g. by sending a signal to elevator control system, when the reference sensing unit is level with a sensing unit mounted on the elevator car, and when the building-mounted sensing unit is level with a sensing unit mounted on the elevator car.

[0056] In a preferred embodiment, said performing a distance determination comprises driving the car from the first to second position such that no passengers are within the car.

[0057] In a preferred embodiment, the sensing unit mounted on the elevator car is level with the reference sensing unit when the elevator car is in the first position wherein it is level with a landing of the elevator, i.e. when the sill of the car is level with the sill of the landing, the landing preferably being the uppermost landing, and the building-mounted sensing unit is at a higher or lower position, preferably at a higher position, than the reference sensing unit.

[0058] The elevator is in general preferably such that it comprises an elevator car vertically movable to and from plurality of landings, i.e. two or more vertically displaced landings. Preferably, the elevator car has an interior space suitable for receiving a passenger or passengers, and the car can be provided with a door for forming a closed interior space.

BRIEF DESCRIPTION OF THE DRAWINGS

[0059] In the following, the present invention will be described in more detail by way of example and with reference to the attached drawings, in which

Figure 1 illustrates an elevator arrangement according to an embodiment of the invention implementing the method according to the invention.

Figure 2 illustrates the elevator car of the elevator arrangement of Fig 1 in a first position in a hoistway. Figure 3 illustrates the elevator car of the elevator arrangement of Fig 1 in a second position in a hoistway.

Figure 4 illustrates a partial side view of Fig 2.

Figure 5 illustrates a partial side view of Fig 3.

[0060] The foregoing aspects, features and advantages of the invention will be apparent from the drawings and the detailed description related thereto.

DETAILED DESCRIPTION

[0061] Figure 1 illustrates an elevator arrangement according to an embodiment. The elevator arrangement comprises a hoistway 1 formed in a building 2; an elevator car 3 vertically movable in the hoistway 1 along at least one guide rail G mounted to take lateral support from a hoistway wall W, in particular by brackets b. The elevator arrangement comprises an elevator control system 100,101 for controlling movement of the car 3, and a sensing arrangement 4,5,6 connected over a connection c, which is preferably a wireless or wired electrical connection, with the elevator control system 100,101.

[0062] The sensing arrangement 4,5,6 comprises a reference sensing unit 5 mounted on a stationary part of the elevator arrangement on a first level, said stationary part being in the illustrated embodiment a guide rail G. The sensing arrangement 4,5,6 moreover comprises a building-mounted sensing unit 6 mounted on a stationary part W of the building on a second level, said stationary part W being in the illustrated embodiment a hoistway wall W. Said stationary part could alternatively be the hoistway ceiling.

[0063] The building-mounted sensing unit 6 is preferably carried by the stationary part W of the building such that when the mounting point of the part W on which the building-mounted sensing unit 6 is mounted descends due to building shrinkage, the building-mounted sensing unit 6 descends together with it. For this end, the building-mounted sensing unit 6 is vertically immovable relative to the stationary part W of the building.

[0064] Likewise, the reference sensing unit 5 mounted on a stationary part of the elevator arrangement is carried by the stationary part G of the elevator arrangement. The reference sensing unit 5 is preferably vertically immovable relative to the stationary part G on which it is mounted.

[0065] The elevator arrangement moreover comprises a sensing unit 4 mounted on the elevator car 3 to travel therewith, and the elevator car 3 is movable by the elevator control system 100,101 to a first position, which is a reference position, to place the sensing unit 4 mounted on the elevator car 3 level with the reference sensing unit 5 for triggering interaction between them. Moreover, the elevator car 3 is movable by the elevator control system 100,101 to a second position to place the sensing unit 4 mounted on the elevator car 3 to be level with the building-mounted sensing unit 6 for triggering interaction between them. The first and second position are vertically displaced from each other. The reference sensing unit 5 and the building-mounted sensing unit 5,6 are counterparts for the sensing unit 4 mounted on the elevator car 3.

[0066] The sensing arrangement 4,5,6 is configured indicate, preferably to the elevator control system 100,101, e.g. by sending a signal to elevator control sys-

tem 100,101, when the reference sensing unit 5 is level with sensing unit 4 mounted on the elevator car 3, and when the building-mounted sensing unit 6 is level with sensing unit 4 mounted on the elevator car 3.

[0067] The elevator control system 100,101 is configured to monitor distance d between the first position and the second position by aid of the sensing arrangement 4,5,6. Hereby, the elevator arrangement can also monitor shrinkage of the building 2 effectively.

[0068] Because the stationary part W on which the building-mounted sensing unit 6 is mounted is a stationary part of the building, the building-mounted sensing unit 6 mounted thereon descends slightly when the building shrinks. Thus, the second position descends slightly when the building shrinks. By monitoring distance d between the second position, which is dependent on shrinkage of the building, and a reference position, i.e. the aforementioned first position, shrinkage of the building can be effectively monitored,

[0069] In the preferred embodiment, the reference position is determinable by aid of the aforementioned reference sensing unit 5. The position of the reference sensing unit 5 is dependent on the position of the stationary part on which it is mounted, i.e. the guide rail G in the preferred embodiment.

[0070] Monitoring the distance d between the first and second position determined by aid of sensing units 5, 6 of the sensing arrangement 4,5,6, reveals dimension changes which can effectively be used for determining building shrinkage or at least as a basis for an alarm signal. When the stationary part on which the reference sensing unit 5 is mounted is the guide rail G, as in the preferred embodiment, a change in distance d indicates at the same time an effect of building shrinkage on the elevator which effect is highly valuable for elevator maintenance. When the monitoring is focused such that it reliably and accurately can sense those dimension changes which are most relevant regarding build of compression in guide rails, those dimension changes need not be taken into account in guide rail design in the same way as otherwise. For example, owing to optimally focused, accurate and thereby reliable shrinkage monitoring facilitates that building up of the compression problems can reliably be eliminated by preemptive maintenance, and therefore the guide rails G can be dimensioned lighter. This increases cost efficiency of the elevator in general. Alternatively, the stationary part on which the reference sensing unit 5 is mounted can alternatively be a stationary part W of the building, i.e. it can be also a building-mounted sensing unit in the same way as the aforementioned sensing unit 6, since also distance between two points of a building can be used to determine shrinkage of the building.

[0071] The elevator control system 100,101 preferably comprises at least a local elevator control system 100 located within the building 2. Preferably, although not necessarily, the elevator control system 100,101 additionally comprises a remote monitoring system 101 lo-

cated outside the building 2 and connected with the local elevator control system 100, as in the preferred embodiment presented in Figures. Use of the remote monitoring system 101 is advantageous since it can facilitate analysis of the need for maintenance and schedule optimally the maintenance as well as communicate the related information forward. Said maintenance may involve releasing of compression built in the elevator system due to shrinkage. Optimal timing of such release is advantageous since thus too frequent and too rare release can be avoided. Although, the presented solution facilitates reliability of shrinkage monitoring to a high level, the remote monitoring system 101 increases reliability of the solution even further. When the shrinkage monitoring and the reactions initiated by it are reliable, building of such compressions need not be taken into account in elevator design, for example in dimensioning of elevator components, whereby components such as guide rails can be dimensioned lighter. This increases cost efficiency of the elevator in general.

[0072] In the preferred embodiment, the building 2 comprises concrete as bearing wall material. Then, the aforementioned stationary part W of the building is preferably made of concrete.

[0073] In the preferred embodiment, the building-mounted sensing unit 6 is fixed on the stationary part W of the building 2 via a fixing bracket a2, which is in the presented embodiment a fixing arm a2.

[0074] In the preferred embodiment, the reference sensing unit 5 is fixed on the stationary part G of the elevator arrangement via a fixing bracket a1, which is in the presented embodiment a fixing arm. In the preferred embodiment, the elevator control system 100,101 is configured to detect interaction between the reference sensing unit 5 and a sensing unit 4 mounted on the elevator car 3 and interaction between the building-mounted sensing unit 6 and the sensing unit 4 mounted on the elevator car 3. This detection can be based on a signal received from the sensing arrangement.

[0075] Said interaction can be a contact between the interacting sensing units 4 and 5 ; 4 and 6 when they come to be level with each other, e.g. one being contact switch and the other being a member for actuating the contact switch. Alternatively, said interaction can be a contactless effect caused by one of the interacting sensing units 4 and 5 ; 4 and 6 on the other. For example, one of the interacting units can be a proximity sensor and the other can be a member for actuating the proximity sensor. For example, said other can be arranged to interfere with a metal object thereof a magnet field generated by said one, or alternatively said other can induce by a magnet field of a magnet comprised in it an electric current on said one. Thus, one of the sensing units interacting can at simplest be any object suitable for triggering an action in the sensing unit to which it is a counterpart. The sensing units could include for example a light curtain device for transmitting a light curtain and an object suitable for changing the light curtain in a manner that can

be sensed by the light curtain device. In general, there are numerous alternative sensing units commercially available that can interact between each other when brought to each other's proximity such that interaction is enabled, which interaction can be detected by an entity such as the aforementioned control system 100,101.

[0076] In the preferred embodiment, the first and building-mounted sensing unit 5,6 are vertically aligned, i.e. on the same vertically oriented straight line, whereby the same sensing unit 4 mounted on the car 3 can be moved by vertically linear movement from a position beside the reference sensing unit 5 to a position beside the reference sensing unit 6. Interaction can thus be simply triggered between the same sensing unit 4 mounted on the car 3 and both the first and building-mounted sensing unit 5,6.

[0077] In the preferred embodiment, the sensing unit 4 mounted on the car 3 is level with the reference sensing unit 5 when the elevator car 3 is in a first position wherein it is level with the uppermost landing L3 of the elevator, i.e. when the sill of the car 3 is level with the sill of the landing L3, and the building-mounted sensing unit 6 is at a higher position the reference sensing unit 5 whereby for placing the sensing unit 4 mounted on the car 3 level with the building-mounted sensing unit 6, the car 3 is configured to be moved to a second position which is higher than the first position. As illustrated, in the preferred embodiment, when the elevator car 3 in said second position the elevator car 3 is above its highest position of normal elevator use for transporting passengers, in this case partially in the headroom of the hoistway 1. High position of the building-mounted sensing unit 6 is advantageous since hereby it can simple be positioned out of path of the elevator car 3 during normal elevator use for transporting passengers.

[0078] In the preferred embodiment, the elevator control system 100,101 is configured to perform repeatedly distance determinations of prevailing distance d between the first position and the second position, and in each distance determination the elevator car 3 is configured to be driven, preferably by the local elevator control system 100 of the elevator control system, from a first position to a second position, wherein when the elevator car 3 is in said first position the sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 and wherein when the elevator car 3 is in said second position the sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6. The car 3 being in the first position is presented in Figures 2 and 4, and car 3 being in the second position in Figures 3 and 5. In each said detection the elevator control system 100,101 is arranged to determine the prevailing distance d.

[0079] The elevator control system 100,101 is preferably configured to determine in each said distance determination the prevailing distance d based on length of travel of the car 3 between the first position where the sensing unit 4 mounted on the elevator car 3 is level with

the reference sensing unit 5 and the second position where the sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6. For this purpose, the elevator control system 100,101 is preferably configured to determine length of travel of the car 3 between the first position where the sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 and the second position where the sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6. This is preferably implemented such that the elevator control system 100, 101 is configured to perform said determining the length of travel by measuring at least the amount a wheel 7 rotates during movement of the car 3 from the first position to the second position, wherein a rope or a belt 9 connected to the elevator car 3 passes around the wheel 7. In the preferred embodiment, the wheel 7 is a drive wheel rotatable by a motor 8. Preferably, the measuring comprises measuring rotation angle of the motor. Said determining the prevailing distance d can be then performed for example by calculating from the measured angle.

[0080] The sensing arrangement 4,5,6 provides a signal when the car is placed such that the counterpart units 4 and 5 are level with each other as well as when the car is placed such that the counterpart units 4 and 6 are level with each other. In the embodiment presented, the rope wheel 7 and the rope or belt 9 are used to determine how long a distance the car 3 travels between a first position where the sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 to a second position where the sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6. There are alternative ways to determine said length of travel. The rope or belt need not be a suspension rope or a suspension belt, since in known elevators encoder systems are known to be used implementing a belt or rope moving together with the car which belt or rope is separate from the hoisting function of the elevator.

[0081] For the sake of safety and/or accuracy of the determination, preferably in each said distance determination, the elevator control system 100,101 is arranged to drive the car 3 from the first to second position such that no passengers are within the car 3. This can be achieved simply during low traffic time, such as during night time, for example.

[0082] The elevator control system 100,101 is configured to perform after each distance determination an analysis at least analyzing the prevailing distance d , in particular checking if the prevailing distance meets one or more criteria.

[0083] The elevator control system 100,101 is configured to perform one or more actions if the results of said monitoring the distance d between the first and second position by aid of the sensing arrangement 4,5,6 meets one or more criteria, and particularly if the prevailing distance d meets one or more criteria.

[0084] One effective criterion is that the prevailing distance d has reached a threshold. Another, alternative or

additional, criterion is that a change of distance d calculated based on the prevailing distance d and a reference distance has reached a threshold. Said reference distance can be a distance between the first and second position determined earlier using the sensing arrangement, or a preset distance such as one input by a person in context of installing of the elevator.

[0085] For enabling assessment of the first mentioned criterion above, preferably the elevator control system 100,101 is configured to compare the prevailing distance d preferably after each distance determination with a threshold.

[0086] For enabling assessment of the second mentioned criterion above, preferably the elevator control system 100,101 is arranged to calculate, preferably after each distance determination, change of distance based on the prevailing distance d and a reference distance, such as a reference distance between the first and second position determined earlier using the sensing arrangement.

[0087] The aforementioned one or more actions preferably include sending or displaying a signal, such as an alarm signal. The signal preferably indicates a need for guide rail inspection or a need for repair or a need for compression release of the guide rail line support equipment supporting the guide rails on a hoistway wall.

[0088] The elevator control system 100,101 is preferably configured to perform said distance determinations periodically, preferably a preset number of times in a period, said period preferably being a month, and said number of times preferably being one.

[0089] In a preferred embodiment of a method for monitoring shrinkage of a building 2, the method is performed by an elevator control system 100,101, the method comprising monitoring distance d between a first and building-mounted sensing unit 5, 6 of a sensing arrangement 4,5,6. The sensing arrangement 4,5,6 comprises a reference sensing unit 5 mounted on a stationary part of the elevator arrangement on a first level, said stationary part preferably being a guide rail G ; a building-mounted sensing unit 6 mounted on a stationary part W of the building 2 on a second level, said stationary part W preferably being a hoistway wall W or the hoistway ceiling; and at least one sensing unit 4 mounted on the elevator car 3 to travel therewith. The elevator car 3 is movable by the elevator control system 100,101 to a first position to place a sensing unit 4 mounted on the elevator car 3 to be level with the reference sensing unit 5 for triggering interaction between them, and to place a sensing unit 4 mounted on the elevator car 3 to be level with the building-mounted sensing unit 6 for triggering interaction between them. Figure 1 illustrates an elevator arrangement implementing the method. The elevator arrangement is as described referring to any of Figs 1-6. The sensing unit 4 mounted on the elevator car 3 being level with the reference sensing unit 5 is presented in Figures 2 and 4, and the sensing unit 4 mounted on the elevator car 3 being level with the building-mounted sensing unit 6 is

presented in Figures 3 and 5. The car 3 when it is in its second position is illustrated in Figure 4 by broken line.

[0090] The elevator control system 100,101 preferably comprises a local elevator control system 100 located within the building 2 and a remote monitoring system 101 located outside the building 2.

[0091] The aforementioned monitoring the distance d comprises performing repeatedly distance determinations of prevailing distance d by the elevator control system 100,101, each distance determination comprising driving the elevator car 3, in particular by the local elevator control system 100, from a first position to a second position, wherein when the elevator car 3 is in said first position the sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 and wherein when the elevator car 3 is in said second position the sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6. The car 3 being in the first position is presented in Figures 2 and 4, and the car 3 being in the second position in Figures 3 and 5.

[0092] Each said distance determination comprises by the elevator control system 100,101 determining the prevailing distance d based on length of travel of the car 3 between the first position where the sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 and the second position where a sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6.

[0093] In a preferred embodiment, each distance determination comprises by the elevator control system 100,101 determining length of travel of the car 3 between the first position where a sensing unit 4 mounted on the elevator car 3 is level with the reference sensing unit 5 and the second position where a sensing unit 4 mounted on the elevator car 3 is level with the building-mounted sensing unit 6.

[0094] In a preferred embodiment, said determining the length of travel comprises measuring one or more parameters, most preferably measuring at least the amount a wheel 7 rotates during movement of the car 3 from the first position to the second position, wherein a rope or a belt 9 connected to the elevator car 3 passes around the wheel 7. Preferably, the wheel 7 is a drive wheel rotatable by a motor 8. Then preferably, the measuring comprises measuring rotation angle of the motor 8. Said determining the prevailing distance d can be then performed for example by calculating from the measured angle.

[0095] The method preferably comprises performing after each distance determination analyzing the prevailing distance d , said analyzing in particular comprising checking if the prevailing distance d meets one or more criteria.

[0096] The method comprises performing one or more actions by the elevator control system 100,101, if the prevailing distance d meets one or more criteria.

[0097] One effective criterion is that the prevailing distance d has reached a threshold. Another, alternative or

additional, criterion is that a change of distance d calculated based on the prevailing distance d and a reference distance has reached a threshold. Said reference distance can be a distance between the first and second position determined earlier using the sensing arrangement, or a preset distance such as one input by a person in context of installing of the elevator.

[0098] For enabling assessment of the first mentioned criterion above, preferably the method comprises comparing the prevailing distance d preferably after each distance determination with a threshold.

[0099] For enabling assessment of the second mentioned criterion above, preferably the method comprises calculating, preferably after each distance determination, change of distance based on the prevailing distance and a reference distance, such as a reference distance between the first and second position determined earlier using the sensing arrangement.

[0100] The aforementioned one or more actions preferably include sending or displaying a signal, such as an alarm signal. The signal preferably indicates a need for guide rail inspection or a need for repair or a need for compression release of the guide rail line support equipment supporting the guide rails on a hoistway wall.

[0101] Each said performing a distance determination comprises driving the car 3 from the first to second position such that no passengers are within the car 3. This can be achieved simply during low traffic time, such as during night time, for example. Preferably, said distance determinations are performed periodically, preferably a preset number of times in a period, said period preferably being a month, and said number of times preferably being one.

[0102] The method preferably comprises signaling by the sensing arrangement, e.g. by the sensing unit 4 mounted on the car 3, to the elevator control system 100,101, e.g. by sending a signal to elevator control system 100,101, when the reference sensing unit 5 is level with sensing unit 4 mounted on the elevator car 3, and when the building-mounted sensing unit 6 is level with sensing unit 4 mounted on the elevator car 3.

[0103] In the preferred embodiment, the method comprises detecting by the elevator control system 100,101 interaction between the reference sensing unit 5 and a sensing unit 4 mounted on the elevator car 3 and detecting interaction between the building-mounted sensing unit 6 and the sensing unit 4 mounted on the elevator car 3. This detection can be based on a signal received from the sensing arrangement. Said interaction can be a contact between the interacting sensing units 4 and 5 ; 4 and 6 when they come to be level with each other.

[0104] With the term prevailing distance d it is meant the vertical distance d between the first position and the second position at the moment of the determination. If repeated distance determinations are performed, a prevailing distance becomes an earlier determined distance after a subsequent distance determination, and the distance determined in said subsequent distance determi-

nation becomes the prevailing distance.

[0105] In the preferred embodiment, the reference position is determinable by aid of the aforementioned reference sensing unit 5. However, this is not necessary since there are alternative ways to determine a reference position. For example, the reference position could be determined using a GPS system.

[0106] It is to be understood that the above description and the accompanying Figures are only intended to teach the best way known to the inventors to make and use the invention. It will be apparent to a person skilled in the art that the inventive concept can be implemented in various ways. The above-described embodiments of the invention may thus be modified or varied, without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that the invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. An elevator arrangement comprising

a hoistway (1) formed in a building (2);
 an elevator car (3) vertically movable in the hoistway (1) along one or more guide rails (G) mounted to take lateral support from a hoistway wall (W);
 an elevator control system (100,101) for controlling movement of the elevator car (3);
 a sensing arrangement (4,5,6) connected with the elevator control system (100,101), the sensing arrangement (4,5,6) comprising
 a building-mounted sensing unit (6) mounted on a stationary part (W) of the building (2), said stationary part (W) preferably being a hoistway wall (W) or the hoistway ceiling;
 at least one sensing unit (4) mounted on the elevator car (3) to travel therewith,
 wherein the building-mounted sensing unit (6) is a counterpart for a sensing unit (4) mounted on the elevator car (3); and
 the elevator car (3) is movable by the elevator control system (100,101) to a first position, which is a reference position, and to a second position to place a sensing unit (4) mounted on the elevator car (3) to be level with the building-mounted sensing unit (6) for triggering interaction between them, the first and second position being vertically displaced;

wherein the elevator control system (100,101) is configured to monitor vertical distance (d) between the first position and the second position by aid of the sensing arrangement (4,5,6).

2. An elevator arrangement according to claim 1, wherein the elevator control system (100, 101) is configured to perform repeatedly distance determinations of prevailing distance (d), and in each said distance determination the elevator car (3) is configured to be driven, in particular by the elevator control system (100,101), from the first position to the second position.
3. An elevator arrangement according to any of the preceding claims, wherein when the elevator car (3) is in said first position a sensing unit (4) mounted on the elevator car (3) is level with a reference sensing unit (5) mounted on a stationary part of the elevator arrangement, and wherein when the elevator car (3) in said second position a sensing unit (4) mounted on the elevator car (3) is level with the building-mounted sensing unit (6).
4. An elevator arrangement according to any of the preceding claims, wherein the sensing arrangement (4,5,6) comprises a reference sensing unit (5) mounted on a stationary part of the elevator arrangement on a first level, said stationary part preferably being a guide rail (G); and the building mounted sensing unit (6) is mounted on a stationary part (W) of the building (2) on a second level, wherein the reference sensing unit and the building-mounted sensing unit (5,6) are each a counterpart for a sensing unit (4) mounted on the elevator car (3); and wherein the elevator car (3) is movable by the elevator control system (100,101) to the first position, which is a reference position, to place a sensing unit (4) mounted on the elevator car (3) to be level with the reference sensing unit (5) for triggering interaction between them.
5. An elevator arrangement according to any of the preceding claims, wherein the building-mounted sensing unit (6) is carried by the stationary part (W) of the building on which it is mounted, in particular such that when the mounting point of the part (W) on which the building-mounted sensing unit (6) is mounted descends due to building shrinkage, the building-mounted sensing unit (6) descends together with it.
6. An elevator arrangement according to any of the preceding claims, wherein the building-mounted sensing unit (6) is vertically immovable relative to the stationary part (W) of the building (2).
7. An elevator arrangement according to any of the preceding claims, wherein the reference sensing unit (5) mounted on a stationary part of the elevator arrangement is carried by the stationary part (G) of the elevator arrangement on which it is mounted.
8. An elevator arrangement according to any of the pre-

ceding claims, wherein the stationary part (W) of the building (2) on which stationary part (W) the building-mounted sensing unit (6) is mounted is a wall of the hoistway (W).

9. An elevator arrangement according to any of the preceding claims, wherein said stationary part (G) on which the reference sensing unit (5) is mounted is a guide rail (G) or a guide rail bracket (b).

10. An elevator arrangement according to any of the preceding claims, wherein the sensing unit (4) mounted on the elevator car (3) is level with the reference sensing unit (5) when the elevator car (3) is in the first position wherein it is level with a landing (L3) of the elevator, i.e. when the sill of the car is level with the sill of the landing (L3), the landing (L3) preferably being the uppermost landing (L3), and the building-mounted sensing unit (6) is at a higher or lower position, preferably at a higher position, than the reference sensing unit (5), whereby for placing the sensing unit (4) mounted on the elevator car (3) level with the building-mounted sensing unit (6), the car is configured to be moved to a second position which is higher or lower, preferably higher, than the first position.

11. An elevator arrangement according to any of the preceding claims, wherein in each said distance determination the elevator control system (100, 101) is configured to determine the prevailing distance (d) based on length of travel of the car (3) between the first position and the second position.

12. An elevator arrangement according to any of the preceding claims, wherein in each said distance determination the elevator control system (100, 101) is configured to determine length of travel of the car (3) between the first position and the second position.

13. An elevator arrangement according to any of the preceding claims, wherein the elevator control system (100,101) is configured to perform after each distance determination an analysis wherein at least the prevailing distance is analyzed, in particular for checking if the prevailing distance meets one or more criteria.

14. Method for monitoring an elevator arrangement by an elevator control system (100,101), wherein the elevator arrangement comprises

a hoistway (1) formed in a building (2);
an elevator car (3) vertically movable in the hoistway (1) along one or more guide rails (G) mounted to take lateral support from a hoistway wall (W);
an elevator control system (100,101) for control-

ling movement of the car (3);

a sensing arrangement (4,5,6) connected with the elevator control system (100,101), the sensing arrangement (4,5,6) comprising a building-mounted sensing unit (6) mounted on a stationary part (W) of the building (2), said stationary part (W) preferably being a hoistway wall (W) or the hoistway ceiling;
at least one sensing unit (4) mounted on the elevator car (3) to travel therewith, wherein the building-mounted sensing unit (6) is a counterpart for a sensing unit (4) mounted on the elevator car (3); and
the elevator car (3) is movable by the elevator control system (100,101) to a first position, which is a reference position, and to a second position to place a sensing unit (4) mounted on the elevator car (3) to be level with the building-mounted sensing unit (6) for triggering interaction between them, the first and second position being vertically displaced;

the method comprising monitoring vertical distance (d) between the first position and the second position by aid of the sensing arrangement (4,5,6).

15. A method according to claim 14, wherein said monitoring the vertical distance (d) comprises performing repeatedly distance determinations of prevailing distance (d) by the elevator control system (100,101), each distance determination comprising driving the elevator car (3), preferably by a local elevator control system (100), from the first position to the second position.

16. A method according to any of the preceding claims 14-15, wherein when the elevator car (3) is in said first position a sensing unit (4) mounted on the elevator car (3) is level with a reference sensing unit (5) mounted on a stationary part of the elevator arrangement, and wherein when the elevator car (3) is in said second position a sensing unit (4) mounted on the elevator car (3) is level with the building-mounted sensing unit (6).

17. A method according to any of the preceding claims 14-16, wherein the method comprises after each distance determination analyzing the prevailing distance (d), said analyzing preferably comprising checking if the prevailing distance (d) meets one or more criteria.

18. A method according to any of the preceding claims 14-17, wherein each said distance determination comprises by the elevator control system (100,101) determining the prevailing distance (d) based on length of travel of the car (3) between the first position and the second position.

Fig. 1

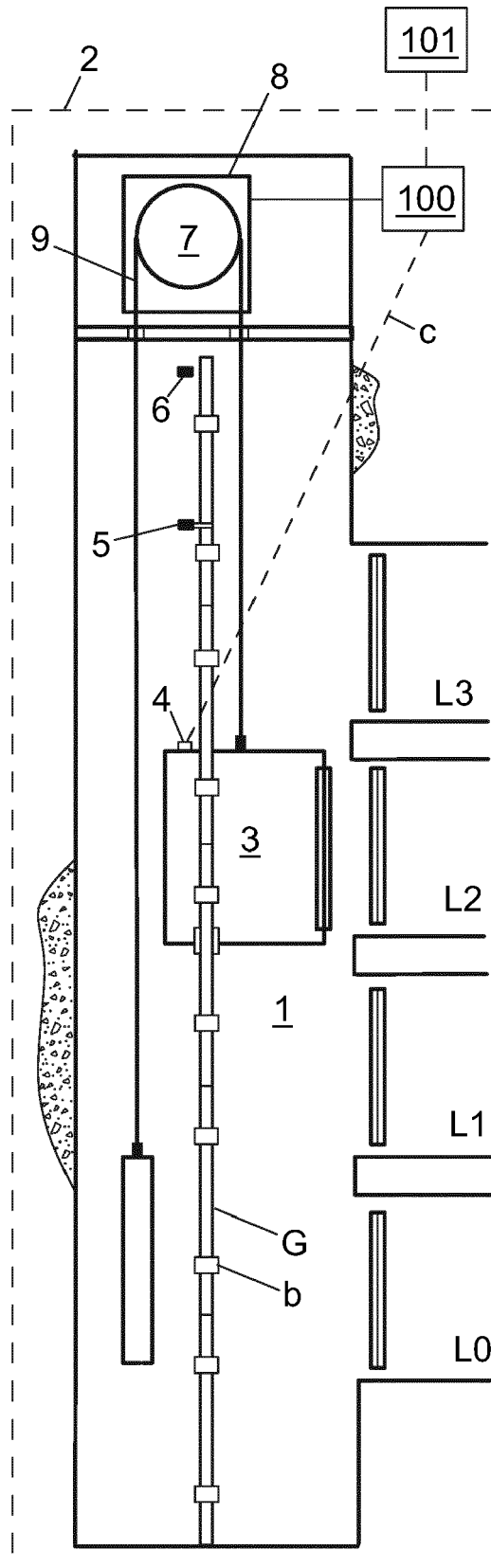


Fig. 2

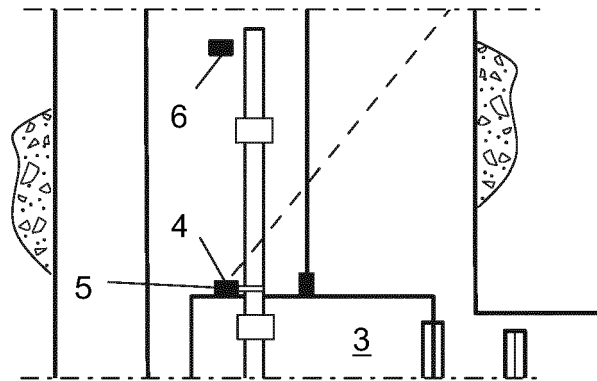


Fig. 3

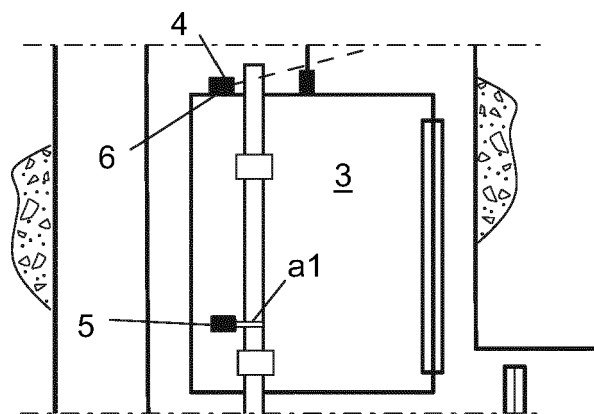


Fig. 4

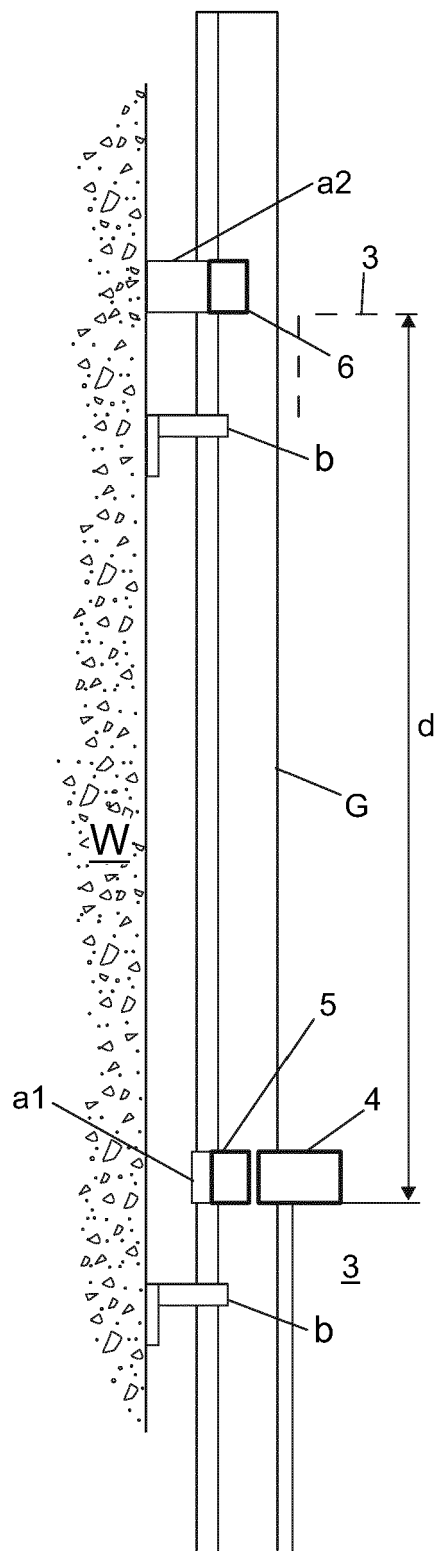
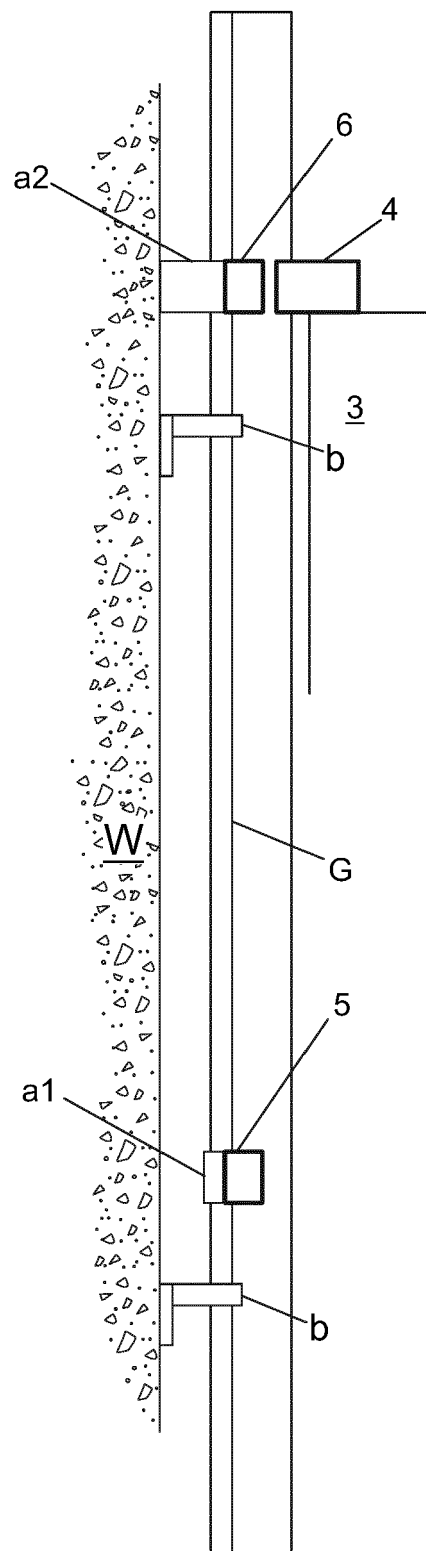


Fig. 5





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Place of search The Hague		Date of completion of the search 15 May 2019	Examiner Lohse, Georg
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