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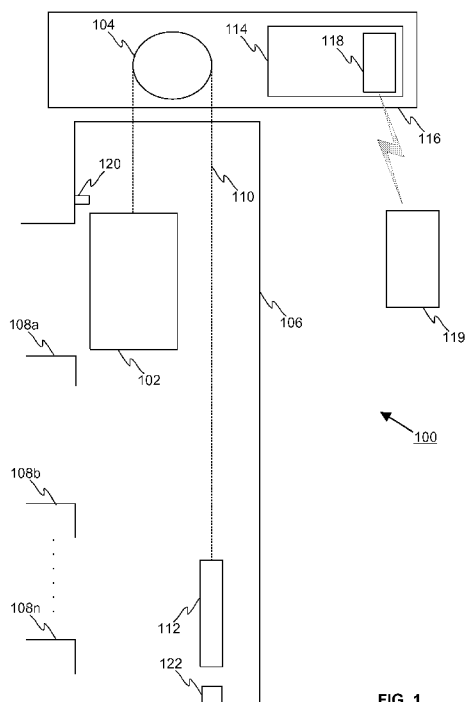


FIG. 1

(57) Abstract: The invention relates to a method for defining elongation of an elevator car (102) suspension means (110). The method comprises: obtaining periodically a value representing an overtravel distance of the elevator car (102), and defining the elongation of the elevator car (102) suspension means (110) on a basis of the periodically obtained values representing the overtravel distance of the elevator car (102). The invention relates also to an elevator system (100) performing at least partly the method.



A method and an elevator system for defining an elongation of an elevator car suspension means

TECHNICAL FIELD

The invention concerns in general the technical field of elevators. Especially
5 the invention concerns safety of elevators.

BACKGROUND

Typically an elevator system comprises an elevator car and a hoisting machine configured to drive the elevator car in an elevator shaft between floors. Furthermore, the elevator system comprises suspension means, such as a rope or
10 a belt, for carrying, i.e. suspending the elevator car and a counterweight. For example, the elevator car may be arranged to one end of the elevator car suspension means and a counterweight may be arranged to the other end of the elevator car suspension means. Alternatively, the elevator car and the counterweight may be suspended with the elevator car suspension means by
15 means of one or more diverter pulleys. Furthermore, the elevator system may comprise a final limit switch arranged to the elevator shaft within a door zone above the top floor. The final limit switch is configured to stop the movement of the elevator car in either direction, if the elevator car reaches an operating point of the final limit switch.

20 When the elevator system is installed or the elevator car suspension means are replaced with new elevator car suspension means, the length of the elevator car suspension means may be adjusted so that when the elevator car is at the top floor, the counterweight is configured to be a predefined overtravel distance from a buffer of the counterweight arranged at the bottom of the elevator
25 shaft.

During the use of the elevator, the elevator suspension means elongates. Typically, the elevator suspension means elongate strongly, when they are new. After that the elongation stabilizes and remains substantially small until the lifetime of the rope or belt approaches to the end and the elongation of the rope
30 or belt starts to increase again.

According to elevator safety regulations the final limit switch shall actuate, i.e. stop the movement of the elevator car, before the counterweight comes into

contact with the buffer. When elevator suspension means have elongated so that the final limit switch does not stop the movement of the elevator car before the counterweight comes into contact with the buffer, the elevator does not fulfill the elevator safety requirements and it should be taken out of operation. In
5 that case the counterweight comes into contact with the buffer before the final limit switch actuates. The elevator suspension means may be shortened so that the safety regulations are fulfilled again.

According to one prior art solution the operation of the final limit switch and a mechanical safety device is monitored and if it is detected that the operation of
10 the final limit switch or the operation of the mechanical safety device do not fulfill the regulations anymore, the elevator is taken out of the operation. At least one disadvantage of the prior art solution is that the failure in the operation of the final limit switch is not detected until the elevator is required to be taken out of the operation.

15 SUMMARY

An objective of the invention is to present a method and elevator system for defining an elongation of an elevator car suspension means. Another objective of the invention is that the method and elevator system for defining an elonga-
20 tion of an elevator car suspension means improve at least partly the safety of the elevators.

The objectives of the invention are reached by a method and an elevator system as defined by the respective independent claims.

According to a first aspect, a method for defining elongation of an elevator car suspension means is provided, wherein the method comprises: obtaining peri-
25 odically a value representing an overtravel distance of the elevator car, and defining the elongation of the elevator car suspension means on a basis of the periodically obtained values representing the overtravel distance of the elevator car.

The method may further comprise: defining a longtime trend of the overtravel distance on a basis of the periodically obtained values representing the over-
30 travel distance, and defining a suitable moment for adjusting the length of the elevator car suspension means on a basis of the defined longtime trend.

Moreover, the method may further comprise defining the longtime trend on a basis of at least one elevator type specific parameter of said elevator together with the periodically obtained values representing the overtravel distance, wherein the at least one elevator type specific parameter may be at least one
5 of the following: operating distance of a final limit switch, travel height, suspension ratio, load, number of ropes, type of ropes.

Alternatively or in addition, the method may comprise generating a first signal indicating a need for adjusting the length of the elevator car suspension means for an elevator service unit, in response to a detection that the periodically ob-
10 tained value representing the overtravel distance meets a predefined first limit for the overtravel distance.

Moreover, the method may further comprise generating a second signal comprising an instruction to take the elevator car out of service for an elevator control unit, in response to a detection of that the periodically obtained value rep-
15 resenting the overtravel distance meets a predefined second limit for the overtravel distance.

The value representing the overtravel distance may obtained by overcoupling a final limit switch arranged to the elevator shaft above the top floor; driving the elevator car upwards from a top floor until a counterweight comes into a contact with a buffer; and obtaining a distance travelled by the elevator car from
20 the top floor up to a detection of a change in a torque of a hoisting motor indicating that the counterweight comes into a contact with the buffer, wherein said distance corresponds to the value representing the overtravel distance of the elevator car.

Alternatively or in addition, the method may further comprise obtaining an operating distance of a final limit switch in order to verify actual operating position of the final limit switch.
25

According to a second aspect, an elevator system for defining elongation of an elevator car suspension means is provided, the elevator system comprises: an
30 elevator car, an elevator suspension means for carrying the elevator car, an elevator service unit, and an elevator safety control unit, wherein the elevator safety control unit is configured to obtain periodically a value representing an overtravel distance of the elevator car, and wherein the elevator safety control unit or the elevator service unit is configured to define the elongation of the el-

elevator car suspension means on a basis of the periodically obtained values representing the overtravel distance of the elevator car.

- 5 The elevator safety control unit or the elevator service unit may further be configured to: define a longtime trend of the overtravel distance on a basis of the periodically obtained value representing the overtravel distance, and define a suitable moment for adjusting the length of the elevator car suspension means on a basis of the defined longtime trend.

- 10 Moreover, the elevator safety control unit or the elevator service unit may further be configured to define the longtime trend on a basis of at least one elevator type specific parameter of said elevator together with the periodically obtained values representing the overtravel distance, wherein the at least one elevator type specific parameter may be at least one of the following: operating distance of a final limit switch, travel height, suspension ratio, load, number of ropes, type of ropes.

- 15 Alternatively or in addition, the elevator safety control unit may be configured to generate a first signal comprising an instruction to take the elevator car out of service for an elevator control unit, in response to a detection that the obtained value representing the overtravel distance meets a predefined second limit for the overtravel distance.

- 20 Moreover, the elevator safety control unit may further be configured to generate a second signal comprising an instruction to take the elevator car out of service for an elevator control unit, in response to a detection that the obtained value representing the overtravel distance meets a predefined second limit for the overtravel distance.

- 25 The value representing the overtravel distance may be obtained by: overcoupling a final limit switch arranged to the elevator shaft above the top floor; driving the elevator car upwards from a top floor until a counterweight comes into a contact with a buffer; and obtaining a distance travelled by the elevator car from the top floor up to a detection of a change in a torque of a hoisting motor
30 indicating that the counterweight comes into a contact with the buffer, wherein said distance corresponds to the value representing the overtravel distance of the elevator car.

Alternatively or in addition, the elevator safety control unit may further be configured to obtain an operating distance of a final limit switch in order to verify actual operating position of the final limit switch.

5 The exemplary embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" is used in this patent application as an open limitation that does not exclude the existence of also un-recited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated.

10 The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objectives and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF FIGURES

The embodiments of the invention are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings.

20 Figure 1 illustrates schematically an example of an elevator system according to the invention.

Figure 2 illustrates schematically an example of a method according to the invention.

Figure 3a illustrates schematically an example of an operating distance of a final limit switch of an elevator system according to the invention.

25 Figure 3b illustrates schematically an example of an overtravel distance of an elevator car of an elevator system according to the invention.

Figure 4 illustrates schematically another example of the method according to the invention.

Figure 5 illustrates schematically an example of defining a suitable moment for adjusting length of an elevator car suspension means according to the invention.

5 Figure 6 illustrates schematically another example of the method according to the invention.

Figure 7 illustrates schematically an example of an elevator safety control unit according to the invention.

Figure 8 illustrates schematically an example of an elevator service unit according to the invention.

10 DESCRIPTION OF SOME EMBODIMENTS

Figure 1 illustrates schematically an example of an elevator system 100 according to the invention, wherein the embodiments of the invention may be implemented as will be described. The elevator system 100 may comprise an elevator car 102 and a hoisting machine 104 configured to drive the elevator car 102 in an elevator shaft 106 between floors 108a-108n, i.e. landings. Furthermore, the elevator system 100 may comprise suspension means 110 for carrying, i.e. suspending the elevator car 102 and a counterweight 112. The suspension means 110 may be at least one of the following: rope, belt. A belt may comprise a plurality of ropes travelling inside the belt. Furthermore, the ropes may be coated for example with a polyurethane coating. In order to carry the elevator car 102 the elevator suspension means may be arranged to pass from the elevator car 102 over a pulley of the hoisting machine 104 to the counterweight 112. For example, the elevator car 102 may be arranged to one end of the elevator car suspension means 110 and the counterweight 112 may be arranged to the other end of the elevator car suspension means 110. Alternatively, the elevator car 102 and the counterweight 112 may be suspended with the elevator car suspension means 110 by means of one or more diverter pulleys. The counterweight 112 may be a metal tank with a ballast of weight approximately 40-50 percent of the weight of a fully loaded elevator car 102.

30 The elevator system 100 according to the invention may further comprise an elevator control unit 114 that may be configured to control the operation of the elevator system 100. The elevator control unit 114 may reside in a machine room 116. According to one embodiment a safety control unit 118 according to

the invention may be implemented as a part of the elevator control unit 114 as illustrated in Figure 1. According to another embodiment the safety control unit 118 may be implemented as a separate unit.

5 The elevator system 100 according to the invention may further comprise an external elevator service unit 119 that may be communicatively coupled to the elevator safety control unit 118. The communication between the elevator safety control unit 118 and the elevator service unit 119 may be based on one or more known communication technologies, either wired or wireless. The elevator service unit 119 may be for example a service center, service company
10 or similar.

Furthermore, the elevator system 100 according to the invention may comprise a final limit switch 120 arranged to the elevator shaft 106 within a door zone above the top floor 108a. The final limit switch 120 may be configured to stop the movement of the elevator car 102 in either direction, if the elevator car 102
15 reaches an operating point of the final limit switch 120.

The method according to the invention enables defining elongation of an elevator car suspension means 110 by monitoring an overtravel distance of the elevator car 102. Next an example of a method according to the invention is described by referring to Figure 2. Figure 2 schematically illustrates the invention as a flow chart. The elevator safety control unit 118 obtains 202 periodical-
20 ly a value representing the overtravel distance of the elevator car 102. Furthermore, the elevator safety control unit 118 may define 204 the elongation of the elevator car suspension means 110 on a basis of the periodically obtained values representing the overtravel distance of the elevator car 102. The
25 change of the overtravel distance may be considered to be substantially directly proportional to the elongation of the elevator car suspension means 110. The defined elongation of the elevator car suspension means 110 may be an absolute value of the elongation of the elevator car suspension means 110 and/or rate of change of the elongation of the elevator car suspension means
30 110.

Alternatively or in addition, the elevator safety control unit 118 may communicate the obtained values to the elevator service unit 119 after the step 202 and the elevator service unit 119 may perform the step 204, i.e. define the elongation of the elevator car suspension means 110 on a basis of the periodically

- obtained values representing the overtravel distance of the elevator car 102. The communication between the elevator safety control unit 118 and the elevator service unit 119 may be continuous, i.e. real-time communication. Alternatively or in addition, the data, i.e. obtained overtravel distances and/or defined elongation of the elevator car suspension means 110, may be communicated from the elevator safety control unit 118 to the elevator service unit 119 according to a predefined time scheme. The communication of the data according to the predefined time scheme means that the data is not communicated continuously or in real-time. Instead the data may be communicated at a time instant, which the elevator safety control unit 118 or the elevator service unit 119 defines to be suitable for the communication. The suitable time instant may be for example one of the following: regular time interval, irregular time interval, when no data memory of the elevator safety control unit 118 is full or almost full.
- 15 In case of One to One (1:1) roping the change of the overtravel distance is directly proportional to the elongation of the elevator car suspension means 110. In 1:1 roping one end of elevator suspension means 110 passes from the elevator car 102 over the pulley, i.e. the traction sheave, of the hoisting machine 104, over the secondary or divertor sheave, and then to the counterweight 112. With 1:1 roping the elevator car 102, counterweight 112, and the elevator suspension means 110 all travel at the same speed. In case of any other ropings, such as 1:2 roping, the elongation of the elevator car suspension means 110 may be defined by taking into account also a suspension ratio of the elevator suspension means 110 in addition to the overtravel distance.
- 25 When the elevator system is installed or the elevator car suspension means 110 are replaced with new elevator car suspension means 110, the length of the elevator car suspension means 110 is adjusted so that when the elevator car 102 is at the top floor 108a the counterweight 112 is configured to be a predefined overtravel distance, i.e. an initial value for the overtravel distance, from a buffer 122 of the counterweight 112 arranged at the bottom of the elevator shaft 106. The predefined overtravel distance may be defined so that the predefined overtravel distance is more than the operating distance of the final limit switch 120, i.e. the distance between the operating point of the final limit switch 120 and the roof level of the top floor 108a. If the predefined overtravel distance is equal or less than the operating distance of the final limit switch 120, the final limit switch 120 is not able to actuate, i.e. stop the movement of

the elevator car 102, before the counterweight 112 comes into contact with the buffer 122. In that case the overtravel distance is less than the operating distance of the final limit switch 120 and the elevator safety regulations are not fulfilled. Furthermore, the operating distance of the final limit switch 120 may
5 be preferably defined to be as short as possible, but the final limit switch 120 may not be arranged too close to the roof level of the top floor 108a so that the movement of the elevator car 102 is not stopped too easily, because it may reduce the availability of the elevators. Figure 3a illustrates schematically an example of the operating distance of the final limit switch 120. Figure 3b in turn illustrates schematically an example of the overtravel distance of the elevator
10 car 102.

During the use of the elevator the elevator suspension means 110 elongates, which in turn causes that the overtravel distance decreases. Next one example for obtaining a value representing the overtravel distance is described. First
15 the elevator car 102 that is empty is driven to the top floor 108a and the elevator is taken out of the normal operation. Furthermore, the final limit switch 120 is overcoupled in order to allow the elevator car pass the final limit switch 120 so that the final limit switch 120 does not stop the movement of the elevator car 102. Next the elevator car 202 is driven upwards with a reduced speed until the counterweight 112 reaches the buffer 122. The reduced speed may be
20 for example less than 0.25 m/s. A detection of a change in a torque of a hoisting motor indicates that the counterweight 112 reaches the buffer 122. The overtravel distance corresponds to the distance travelled by the elevator car 102 upwards from the top floor 208 up to the detection of the change in the torque of the hoisting motor indicating that the counterweight 212 comes into a
25 contact with the buffer 220. The overtravel distance may be obtained for example with the elevator safety control unit 118. After obtaining the overtravel distance, the elevator car 102 is driven back to the top floor 108 and the elevator is returned back to the normal operation. The above described example is
30 non-limiting example and the present invention is not limited to that. Thus, the overtravel distance may be obtained also by any other way.

Alternatively or in addition, the operating distance of the final limit switch 120 may be obtained concurrently with the overtravel distance. A distance travelled by the elevator car 102 from the top floor 108a up to the operating point of the
35 final limit switch 120 corresponds to the operating distance of the final limit switch 120. The operation distance of the final limit switch 120 does not

change during the use of the elevator. Thus, the periodical monitoring of the operation distance of the final limit switch 120 is not needed similarly as the periodical monitoring of the overtravel distance. However, the operating distance of the final limit switch 120 may be obtained at least once after the installation of the elevator system in order to ensure that the final limit switch 120 is arranged, i.e. installed, at the intended operating position of the final limit switch. This enables that the actual operating distance of the final limit switch 120 may be obtained and verified after the installation of the elevator.

The method according to the invention may further enable defining a suitable moment for adjusting, i.e. shortening, the length of the elevator car suspension means. Figure 4 schematically illustrates an example of the method according to the invention as a flow chart for defining a suitable moment for adjusting the length of the elevator car suspension means. After the step 202 or 204 the elevator safety control unit 118 may define 402 a longtime trend, i.e. gradual change, on a basis of the periodically obtained values representing the overtravel distance. An expectable behavior of the value representing the overtravel distance in future may be defined on the basis of the longtime trend. As described above the change of the overtravel distance may be considered to be substantially directly proportional to the elongation of the elevator car suspension means 110. Thus, by obtaining periodically the overtravel distance as function of time, the change of the overtravel distance and thus the elongation of the elevator car suspension means may be considered to be substantially constant and predictable until the condition of the elevator suspension means 110 deteriorate, i.e. the lifetime of the elevator car suspension means 110 approaches to the end. This enables that the longtime trend may be defined on a basis of the periodically obtained values representing the overtravel distance, which in turn enables that the overtravel distance and/or the elongation of the elevator car suspension means 110 in the future may be predicted substantially accurately. The elevator safety control unit 118 may define 404 a suitable moment for adjusting, i.e. shortening, the length of the elevator car suspension means 110 on a basis of the defined longtime trend.

Furthermore, the elevator service unit 118 may generate a control signal for the elevator service unit 119, wherein the control signal comprises at least the suitable moment for adjusting the length of the elevator car suspension means 110. In response to receiving the control signal the elevator service unit 119 may be configured to instruct maintenance personnel to adjust the length of

the elevator car suspension means 110. After adjusting the length of the elevator car suspension means 110 the elevator car may be returned back to the normal operation.

Alternatively or in addition, if the safety control unit 118 communicates the obtained values to the elevator service unit 119 after the step 202 the elevator safety service unit 119 may perform the steps 402 and 404, i.e. define the longtime trend and the suitable moment for adjusting the length of the elevator car suspension means 110. In response to defining the suitable moment for adjusting the length of the elevator car suspension means 110 the elevator service unit 119 may be configured to instruct maintenance personnel to adjust the length of the elevator car suspension means 110. After adjusting the length of the elevator car suspension means 110 the elevator car may be returned back to the normal operation.

In addition the longtime trend may be defined on a basis of at least one elevator type specific parameter of said elevator together with the periodically obtained values representing the overtravel distance. The at least one elevator type specific parameter may be at least one of the following: operating distance of the final limit switch 120, travel height, suspension ratio of the elevator car suspension means 110, load, number of ropes, type of rope(s) or belt.

The suitable moment for adjusting the elevator car suspension means 110 may be defined on a basis of the defined longtime trend so that the suitable moment is sufficiently before the overtravel distance is predicted to meet, i.e. be equal to or less than, the operating distance of the final limit switch 120. Figure 5 illustrates schematically an example of defining the suitable moment for adjusting the length of the elevator car suspension means 110 from the longtime trend. The longtime trend of the overtravel distance is illustrated with the curves 502. The longtime trend of the overtravel distance may be represented as the absolute values of the overtravel distance and/or as the rate of change of the overtravel distance. The suitable moment for adjusting the elevator car suspension means 110 may be for example one time instant or a time frame. In Figure 5 the rectangles 504 represents the suitable time frames for adjusting the elevator car suspension means 110. The time frame 504 may be for example a couple of weeks or months. The time frames 504 may be such that maintenance personnel have enough time to adjust the length of the elevator car suspension means 110 before the elevator suspension means

110 elongates so that the overtravel distance may be predicted to meet, i.e. be equal to or less than, the operating distance of the final limit switch 120, which is illustrated in Figure 5 with the line 506.

Preferably the suitable moment for adjusting the elevator car suspension means 110 is defined so that the unavailability of the elevators may be minimized. The time frame allows that the maintenance, i.e. adjusting the length of the elevator car suspension means 110, may be provided when it suits best for the users of the elevator and/or the maintenance personnel. In the example illustrated in Figure 5 the length of the elevator car suspension means 110 is adjusted, i.e. shortened, at the time instant T_1 . If the length of the elevator car suspension means 110 is not adjusted, the overtravel distance would meet the operating distance of the final limit switch 120 as illustrated with the dashed lines 508, which means that the overtravel distance is less than the operating distance of the final limit switch 120 and the elevator safety regulations are not fulfilled. After the adjustment of the length of the elevator car suspension means 110 the elevator safety control unit 118 continues the monitoring of the overtravel distance of the elevator car 102 and the longtime trend 502 may be defined again in order to define another suitable moment for adjusting the elevator car suspension means 110. In the example illustrated in Figure 5 the length of the elevator car suspension means 110 is adjusted, i.e. shortened, again at a time instant T_2 .

Next another example of the method according to the invention for defining a suitable moment for adjusting the length of the elevator car suspension means is described by referring to Figure 6. Figure 6 schematically illustrates the invention as a flow chart. The elevator safety control unit 118 may detect 602 that the periodically obtained value representing the overtravel distance meets a predefined first limit for the overtravel distance. In response to the detection the elevator safety control unit 118 may generate 604 a first signal indicating a need for adjusting, i.e. shortening, the length of the elevator car suspension means 110 for the elevator service unit 119. In response to receiving the first control signal the elevator service unit 119 may be configured to instruct maintenance personnel to adjust the length of the elevator car suspension means 110. The elevator safety control unit 119 may continue 606 obtaining periodically the overtravel distance of the elevator car 102. If the elevator safety control unit 118 detects 608 that the periodically obtained value representing the overtravel distance meets a predefined second limit for the overtravel dis-

tance before the length of the elevator car suspension 110 means is adjusted, the elevator safety control unit 118 may generate 610 a second signal comprising an instruction to take the elevator car 102 out of service for the elevator control unit 114. Additionally, the elevator safety control unit 118 may generate
5 a third control signal indicating a need for adjusting the length of the elevator car suspension means 110 for the elevator service unit 119. In response to receiving the third control signal the elevator service unit 119 may be configured to instruct maintenance personnel to adjust the length of the elevator car suspension means 110. After adjusting the length of the elevator car suspension
10 means 110 the elevator car may be returned back to the normal operation.

The predefined first limit for the overtravel distance is lower than the predefined predefined second limit for the overtravel distance. The predefined first and second limits for the overtravel distance may be defined for example during the installation of the elevator system 100. The predefined second limit for
15 the overtravel distance may be defined so that the elevator safety regulations are fulfilled, i.e. the overtravel distance is more than the operating distance of the final limit switch 120. Thus, the second limit for the overtravel distance may be defined to be the operating distance of the final limit switch 120. The predefined first limit for the overtravel distance may preferably be defined for exam-
20 ple to be a certain percent, such as about 5-20 percent, of the predefined second limit. The suitable percent value for each suspension means 110 depends on the rate of change of the elongation of said elevator car suspension means 110. This enables that the maintenance personnel have enough time to adjust the length of the elevator car suspension means 110 before the elevator sus-
25 pension means 110 elongates so that the overtravel distance meets the predefined second limit. For example the predefined first limit may be defined so that it allows a time frame of couple of months for example, for the maintenance personnel to adjust the length of the elevator car suspension means 110. Thus, it allows for the maintenance personnel to define a suitable moment for
30 the adjusting the length of the elevator car suspension means 110 so that the unavailability of the elevators may be minimized. The time frame allows also that the maintenance, i.e. adjusting the length of the elevator car suspension means 110, may be provided when it suits best for the users of the elevator and/or the maintenance personnel.

35 Figure 7 illustrates schematically an example of an elevator safety control unit 118 according to the invention. The elevator safety control unit 118 may com-

prise at least one processor 702, at least one memory 704, a communication interface 706, and one or more user interfaces 708. The at least one processor 702 may be any suitable for processing information and control the operation of the elevator safety control unit 118, among other tasks. The at least one processor 702 of the elevator safety unit 118 is at least configured to implement at least some method steps as described above. The at least one processor 702 of the elevator safety control unit 118 is thus arranged to access the at least one memory 704 and retrieve and store any information therefrom and thereto. The operations may also be implemented with a microcontroller solution with embedded software. The at least one memory 704 may be volatile or non-volatile. Moreover, the at least one memory 704 may be configured to store portions of computer program code 705a-705n and any data values. The at least one memory 704 is not limited to a certain type of memory only, but any memory type suitable for storing the described pieces of information may be applied in the context of the present invention. The communication interface 706 provides interface for communication with any external unit, such as with the elevator control unit 114, the elevator service unit 119 and/or any external systems. The communication interface 706 may be based on one or more known communication technologies, either wired or wireless, in order to exchange pieces of information as described earlier. The mentioned elements of the elevator safety unit 118 may be communicatively coupled to each other with e.g. an internal bus.

Figure 8 illustrates schematically an example of an elevator service unit 119 according to the invention. The elevator service unit 119 may comprise at least one processor 802, at least one memory 804, a communication interface 806, and one or more user interfaces 808. The at least one processor 802 may be any suitable for processing information and control the operation of the elevator service unit 119, among other tasks. The at least one processor 802 of the service unit 119 is at least configured to implement at least some method steps as described above. The at least one processor 802 of the elevator service unit 119 is thus arranged to access the at least one memory 804 and retrieve and store any information therefrom and thereto. The operations may also be implemented with a microcontroller solution with embedded software. The at least one memory 804 may be volatile or non-volatile. Moreover, the at least one memory 804 may be configured to store portions of computer program code 805a-805n and any data values. The at least one memory 804 is not lim-

ited to a certain type of memory only, but any memory type suitable for storing the described pieces of information may be applied in the context of the present invention. The communication interface 806 provides interface for communication with any external unit, such as with the elevator control unit 114, the elevator safety control unit 118 and/or any external systems. The communication interface 806 may be based on one or more known communication technologies, either wired or wireless, in order to exchange pieces of information as described earlier. The user interface 808 may be configured to input control commands, receive information, and/or instructions, and to display information. The user interface 808 may comprise at least one of the following: at least one function key, touchscreen, keyboard, mouse, pen, display, printer, speaker. The mentioned elements of the elevator service 119 may be communicatively coupled to each other with e.g. an internal bus.

The present invention as hereby described provides great advantages over the prior art solutions. For example, the present invention improves at least partly the safety of the elevators. Furthermore, the present invention enables a method for a condition-based maintenance. The present invention enables further an automated method for defining the elongation of the elevator car suspension means. Moreover, the present invention may enable further an automated method for defining a need and/or a suitable moment for adjusting, i.e. shortening, the length of the elevator car suspension means. This also allows that the monitoring of a condition of the elevator car suspension means may be performed remotely. Furthermore, the present invention may allow that the need and/or suitable moment for maintenance, i.e. for adjusting the length of the elevator car suspension means, may be provided in advance before the operation of the elevator car is stopped. Thus, the availability of the elevators may be at least partly improved, because less maintenance breaks for performing condition inspections for the elevator car suspension means are needed.

Moreover, the present invention may enable the implementation of defining elongation the elevator car suspension means and/or a need and/or a suitable moment for adjusting the length of the elevator car suspension means a by using already existing components of the elevator system. Thus, additional expensive components are not needed. The use of already existing components of the elevator system 200 that meet good Safety Integrity Level (SIL) accuracy requirements enables that defining elongation the elevator car suspension

means and/or a need and/or a suitable moment for adjusting the length of the elevator car suspension means may be defined so that good SIL accuracy requirements are met. SIL may be used to indicate a tolerable failure rate of a particular safety function, for example a safety component. SIL is defined as a

5 relative level of risk-reduction provided by the safety function, or to specify a target level of risk reduction. SIL has a number scheme from 1 to 4 to represent its levels. The higher the SIL level is, the greater the impact of a failure is and the lower the failure rate that is acceptable is.

10 The term "normal operation" of an elevator is used in this patent application to mean the operation of the elevator, wherein the elevator car is configured to drive in the elevator shaft between floors in order to serve passengers and/or to carry loads. The normal operation of the elevator covers also the time periods, when the elevator car is configured to wait at a floor an instruction to move to another floor.

15 The term "door zone" is used in this patent application to mean a zone extending from a lower limit below floor level to an upper limit above the floor level in which a landing door and an elevator car door are in mesh and operable. The door zone may be determined to be from -400mm to +400mm for example. Preferably, the door zone may be from -150 mm to +150mm. When arriving to

20 the door zone the elevator car is allowed to begin to open the doors even before the elevator car is stopped.

The verb "meet" in context of a limit is used in this patent application to mean that a predefined condition is fulfilled. For example, the predefined condition may be that the limit for overtravel distance is reached and/or exceeded.

25 The specific examples provided in the description given above should not be construed as limiting the applicability and/or the interpretation of the appended claims. Lists and groups of examples provided in the description given above are not exhaustive unless otherwise explicitly stated.

CLAIMS

1. A method for defining elongation of an elevator car suspension means, wherein the method comprising:
 - obtaining periodically a value representing an overtravel distance of the elevator car, and
 - defining the elongation of the elevator car suspension means on a basis of the periodically obtained values representing the overtravel distance of the elevator car.
2. The method according to claim 1, wherein the method further comprising:
 - defining a longtime trend of the overtravel distance on a basis of the periodically obtained values representing the overtravel distance, and
 - defining a suitable moment for adjusting the length of the elevator car suspension means on a basis of the defined longtime trend.
3. The method according to claim 2, wherein the method further comprising defining the longtime trend on a basis of at least one elevator type specific parameter of said elevator together with the periodically obtained values representing the overtravel distance, wherein the at least one elevator type specific parameter is at least one of the following: operating distance of a final limit switch, travel height, suspension ratio, load, number of ropes, type of ropes.
4. The method according to claim 1, wherein the method further comprising generating a first signal indicating a need for adjusting the length of the elevator car suspension means for an elevator service unit, in response to a detection that the periodically obtained value representing the overtravel distance meets a predefined first limit for the overtravel distance.
5. The method according to claim 4, wherein the method further comprising generating a second signal comprising an instruction to take the elevator car out of service for an elevator control unit, in response to a detection of that the periodically obtained value representing the overtravel distance meets a predefined second limit for the overtravel distance.

6. The method according to any of preceding claims, wherein the value representing the overtravel distance is obtained by:

- overcoupling a final limit switch arranged to the elevator shaft above the top floor,

5 - driving the elevator car upwards from a top floor until a counterweight comes into a contact with a buffer, and

10 - obtaining a distance travelled by the elevator car from the top floor up to a detection of a change in a torque of a hoisting motor indicating that the counterweight comes into a contact with the buffer, wherein said distance corresponds to the value representing the overtravel distance of the elevator car.

7. The method according to any of the preceding claims, wherein the method further comprising obtaining an operating distance of a final limit switch in order to verify actual operating position of the final limit switch.

15 8. An elevator system for defining elongation of an elevator car suspension means, the elevator system comprising:

- an elevator car,

- an elevator suspension means for carrying the elevator car,

- an elevator service unit, and

- an elevator safety control unit,

20 wherein the elevator safety control unit is configured to obtain periodically a value representing an overtravel distance of the elevator car, and

25 wherein the elevator safety control unit or the elevator service unit is configured to define the elongation of the elevator car suspension means on a basis of the periodically obtained values representing the overtravel distance of the elevator car.

9. The elevator system according to claim 8, wherein the elevator safety control unit or the elevator service unit is further configured to:

- define a longtime trend of the overtravel distance on a basis of the periodical-ly obtained value representing the overtravel distance, and
- define a suitable moment for adjusting the length of the elevator car suspen-sion means on a basis of the defined longtime trend.

5 10. The elevator system according to claim 9, wherein the elevator safety control unit or the elevator service unit is further configured to define the long-time trend on a basis of at least one elevator type specific parameter of said elevator together with the periodically obtained values representing the over-travel distance, wherein the at least one elevator type specific parameter is at
10 least one of the following: operating distance of a final limit switch, travel height, suspension ratio, load, number of ropes, type of ropes.

11. The elevator system according to claim 8, wherein the elevator safety control unit is configured to generate a first signal comprising an instruction to take the elevator car out of service for an elevator control unit, in response to a
15 detection that the obtained value representing the overtravel distance meets a predefined second limit for the overtravel distance.

12. The elevator system according to claim 11, wherein the elevator safety control unit is further configured to generate a second signal comprising an in-struction to take the elevator car out of service for an elevator control unit, in
20 response to a detection that the obtained value representing the overtravel distance meets a predefined second limit for the overtravel distance.

13. The elevator system according to any of claims 8-12, wherein the value representing the overtravel distance is obtained by:

25 - overcoupling a final limit switch arranged to the elevator shaft above the top floor,

- driving the elevator car upwards from a top floor until a counterweight comes into a contact with a buffer, and

30 - obtaining a distance travelled by the elevator car from the top floor up to a detection of a change in a torque of a hoisting motor indicating that the coun-terweight comes into a contact with the buffer, wherein said distance corre-sponds to the value representing the overtravel distance of the elevator car.

14. The elevator system according to any of claims 8-13, wherein the elevator safety control unit is further configured to obtain an operating distance of a final limit switch in order to verify actual operating position of the final limit switch.

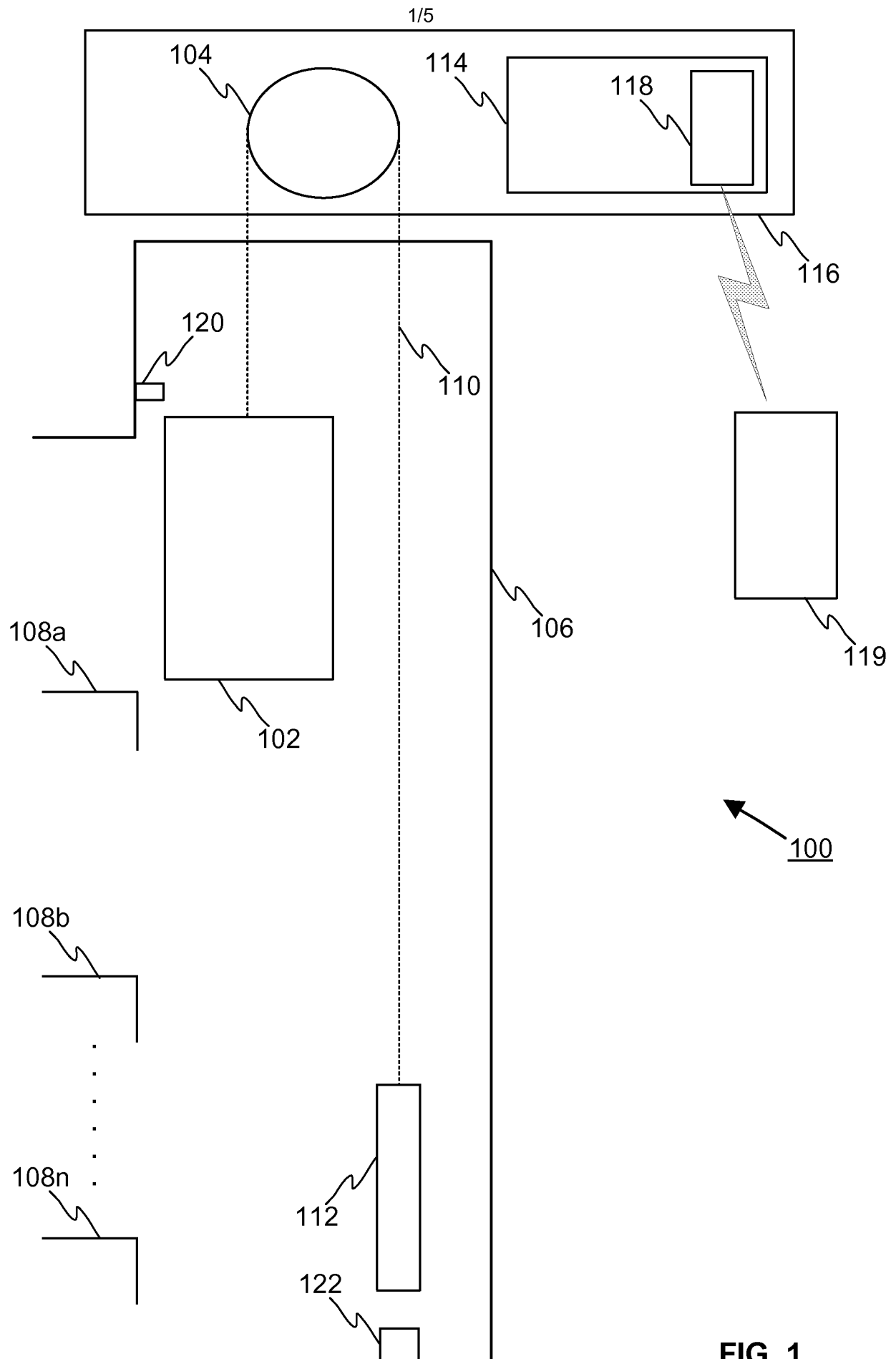
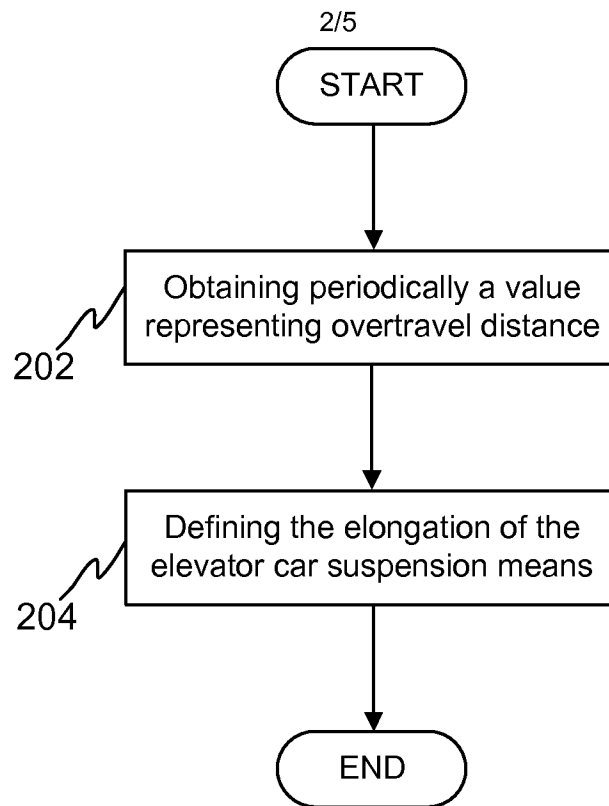
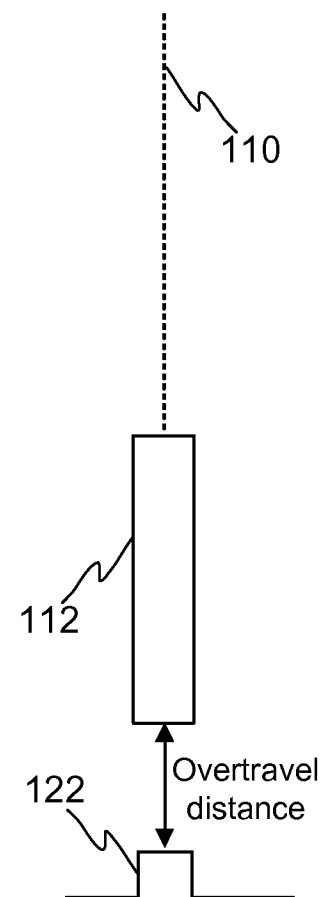
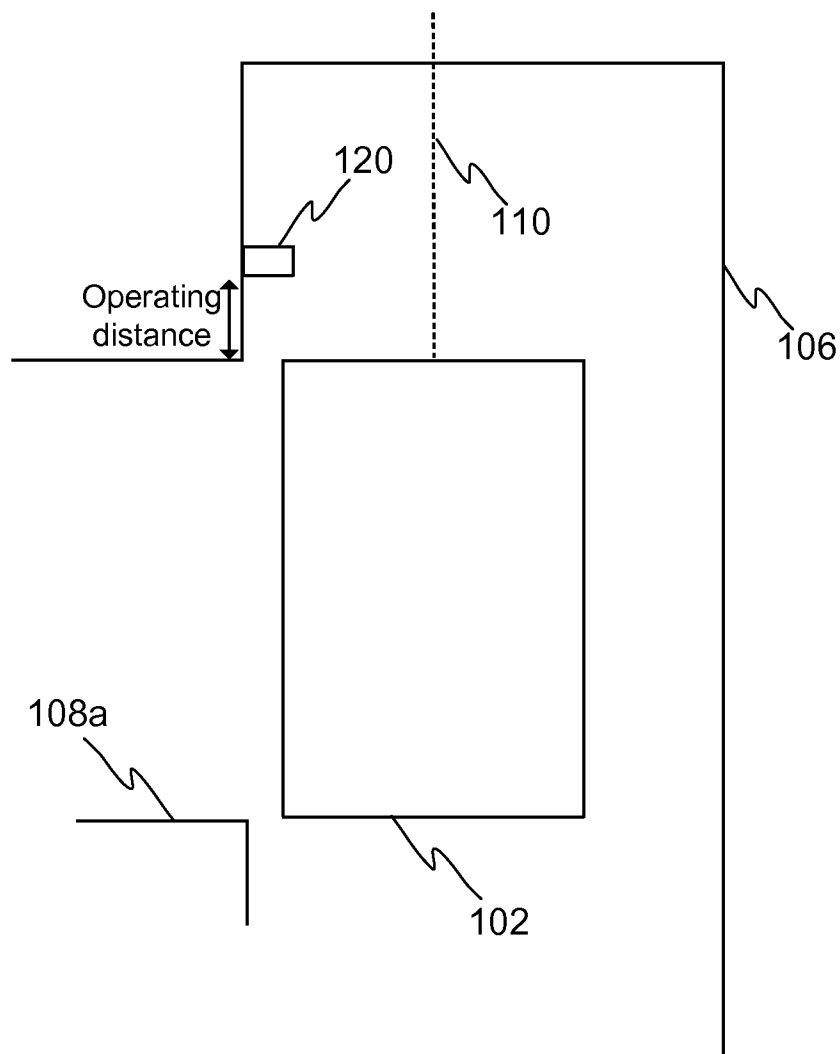
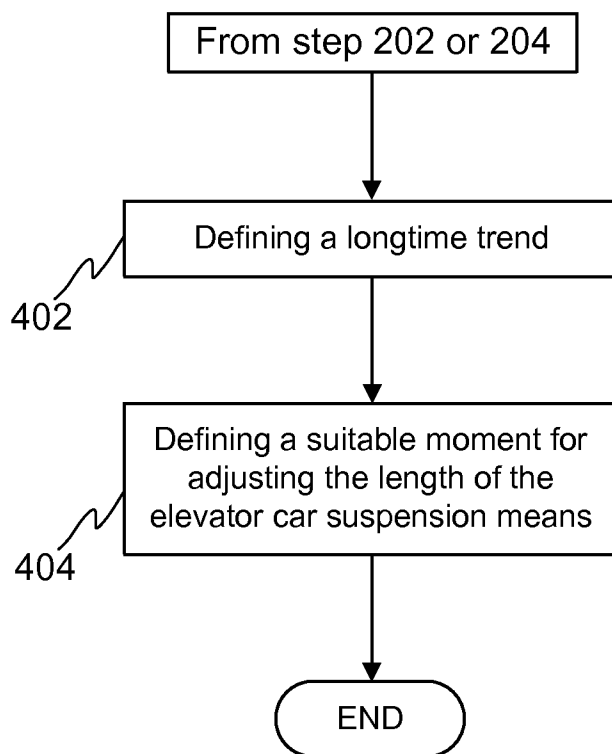
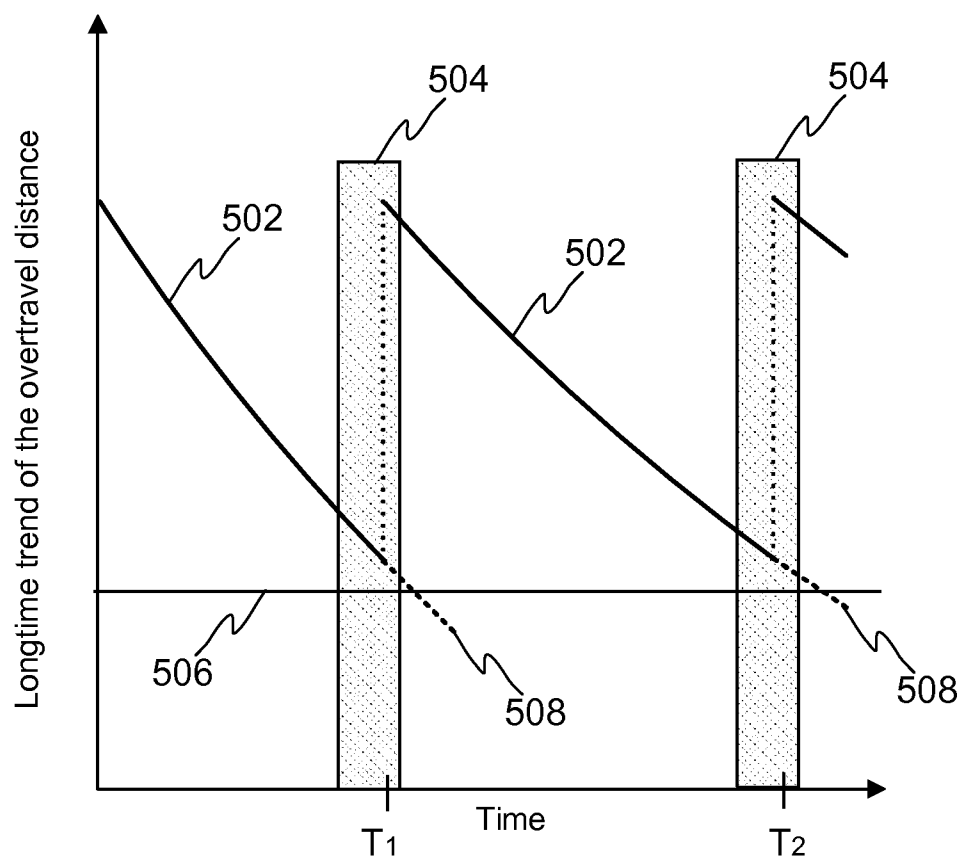


FIG. 1

**FIG. 2**

3/5

**FIG. 4****FIG. 5**

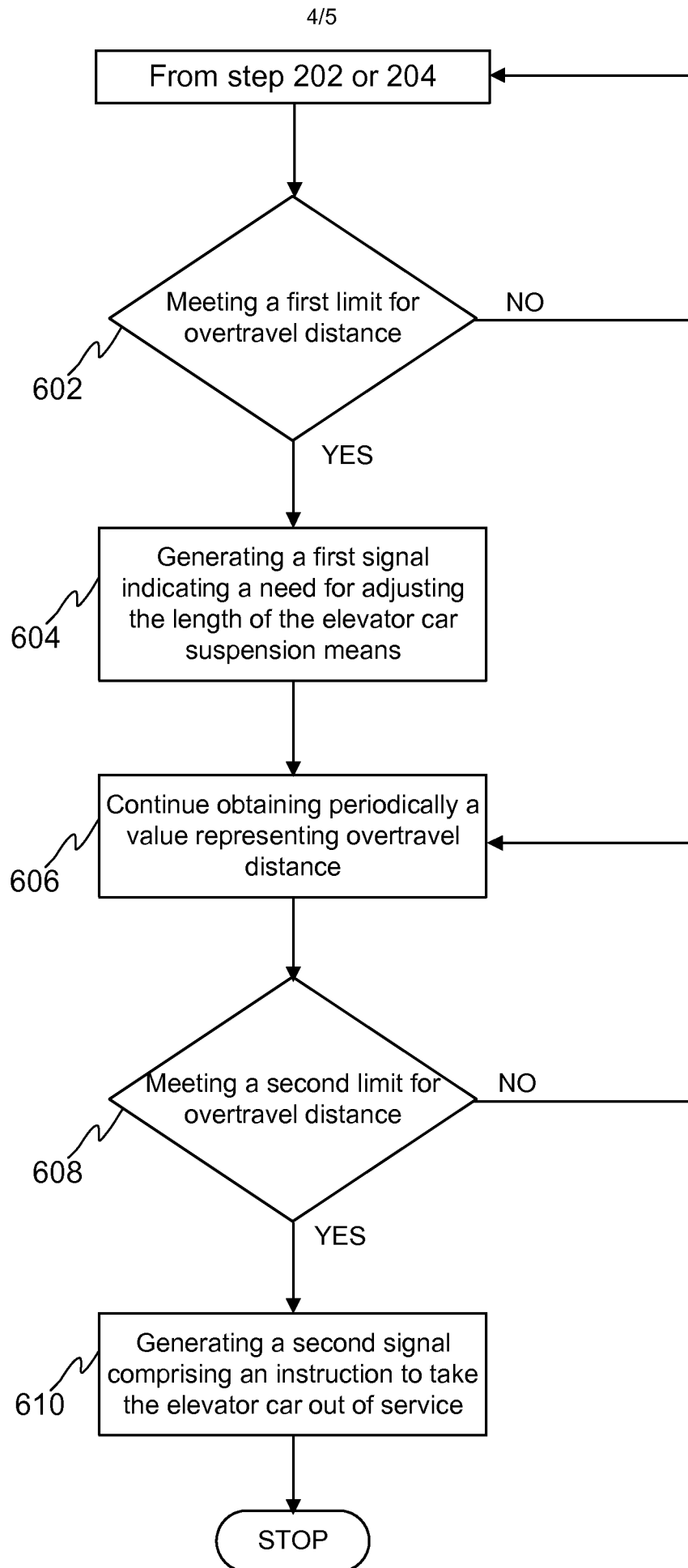


FIG. 6

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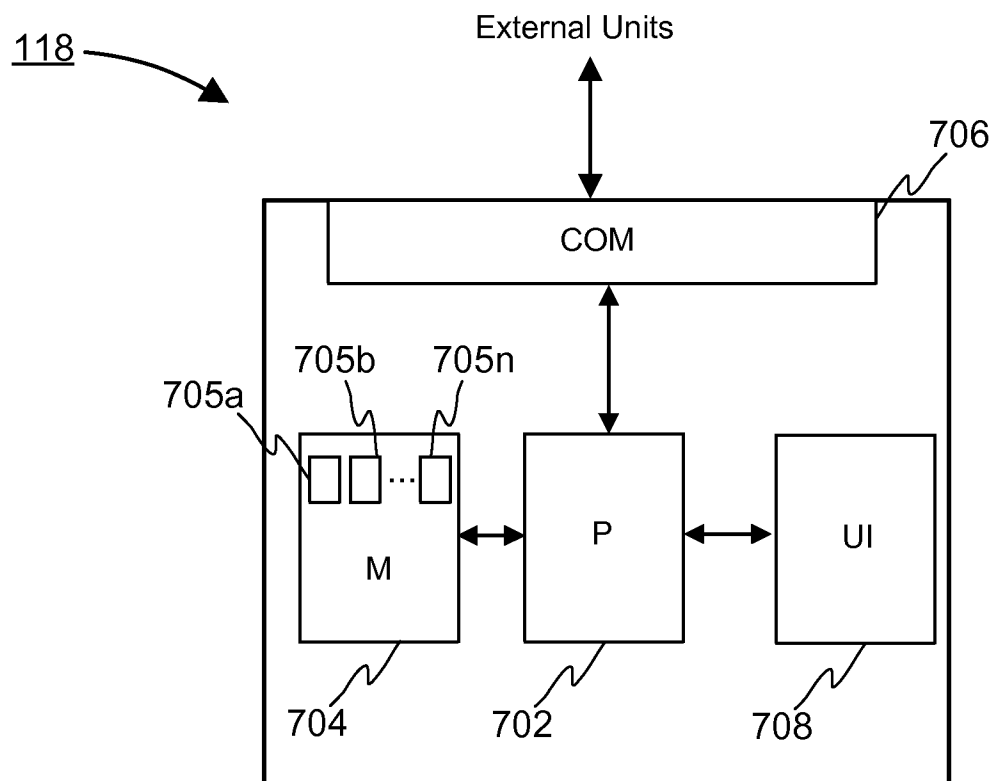


FIG. 7

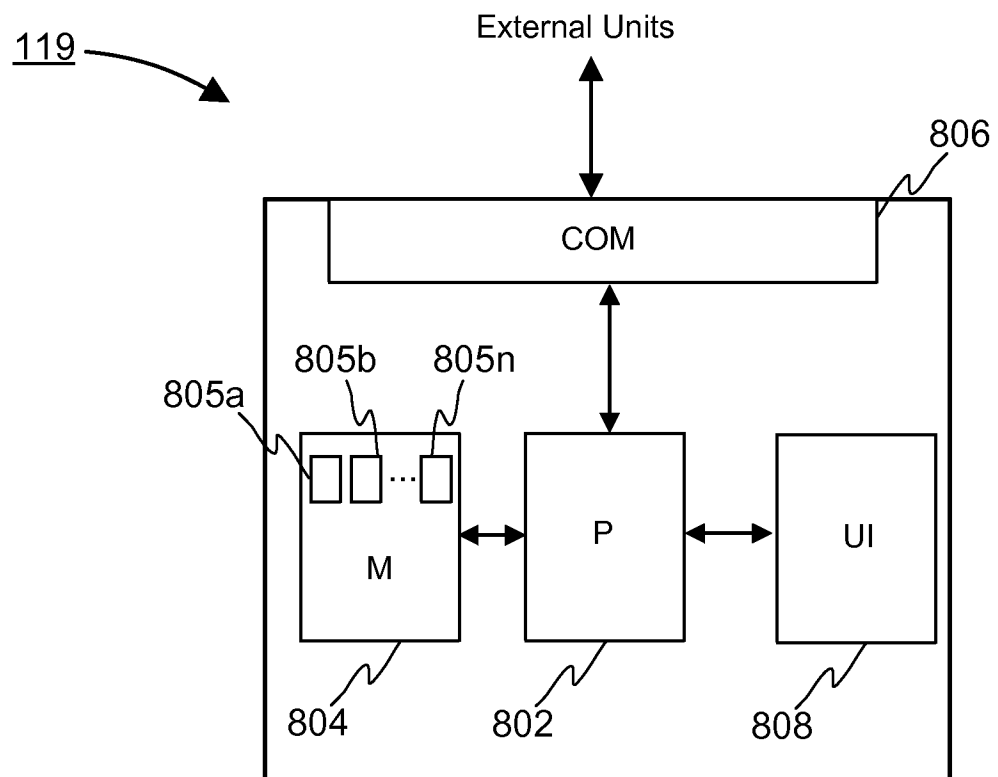


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2017/050685

A. CLASSIFICATION OF SUBJECT MATTER

B66B 5/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPODOC, WPIAP, EPO-Internal full-text databases, COMPDX, INSPEC, XPESP, XPIEE & XPI3E

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	paragraphs [0007]–[0021]; figures 1 & 2	2–5, 9–12
Y	US 2017022028 A1 (CORTONA ELENA [CH] et al.) 26 January 2017 (26.01.2017) paragraphs [0011], [0024], [0028], [0031] & [0032]; figures 1–3	2–5, 9–12
A	GB 2226428 A (HITACHI LTD [JP]) 27 June 1990 (27.06.1990) page 1 lines 1–9, page 8 line 27 – page 10 line 16 & page 15 lines 21–23; figure 3	1, 8
A	JP 2007039240 A (MITSUBISHI ELEC BUILDING TECHN) 15 February 2007 (15.02.2007) paragraphs [0006], [0008], [0015], [0025], [0031] & [0032]	6, 7, 13, 14

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 11 January 2018 (11.01.2018)	Date of mailing of the international search report 17 January 2018 (17.01.2018)
Name and mailing address of the ISA/FI Finnish Patent and Registration Office FI-00091 PRH, FINLAND Facsimile No. +358 29 509 5328	Authorized officer Petri Ojames Telephone No. +358 29 509 5000

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2017/050685

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