(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 309 105 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.04.2018 Bulletin 2018/16

(51) Int Cl.:
B66B 7/12 *(2006.01)*

(21) Application number: **16193877.4**

(22) Date of filing: **14.10.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

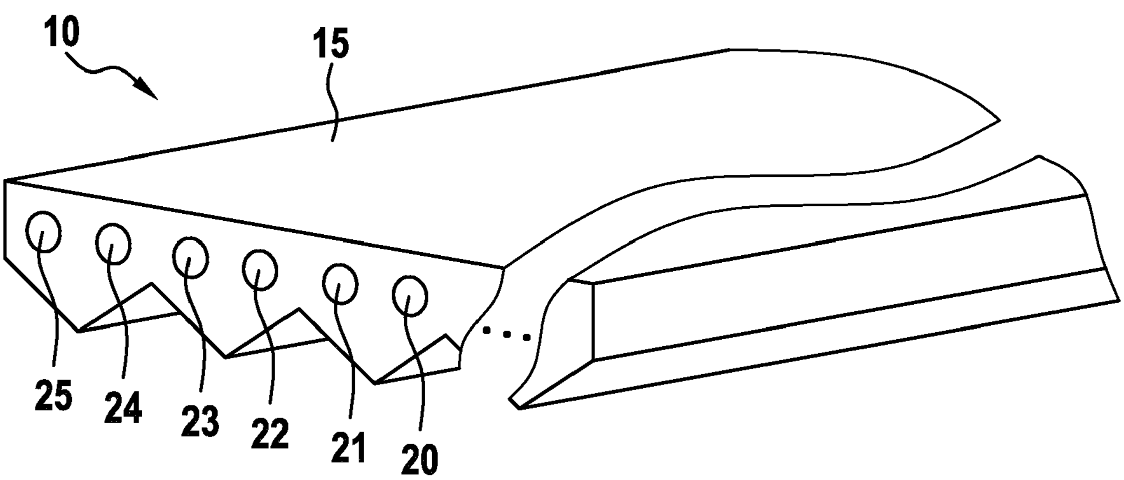
(71) Applicant: **Inventio AG**
6052 Hergiswil (CH)

(72) Inventor: **WEINBERGER, Karl**
6405 Immensee (CH)

(54) METHOD AND CONTROL DEVICE SYSTEM FOR MONITORING THE SUSPENSION TRACTION MEANS OF AN ELEVATOR AND ELEVATOR SYSTEM COMPRISING AN ELEVATOR AND A CONTROL DEVICE SYSTEM

(57) A method for monitoring the suspension traction means (10) of an elevator is disclosed, wherein the suspension traction means (10) comprises several cords (20-25), wherein the method comprises the following steps: measuring a thickness of at least one cord (20-25) of the suspension traction means (10) at at least one point of the cord (20-25); comparing the measured thickness of the cord (20-25) with a first value and/or with a second value, wherein the second value is lower than the first value; and generating and sending a warning signal when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the first value and/or generating and sending an operation terminating signal for terminating the operation of the elevator when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the second value.

Fig. 1



EP 3 309 105 A1

Description

Description

[0001] The present invention pertains to a method for monitoring the suspension traction means of an elevator, to a control device system for monitoring the suspension traction means of an elevator and to an elevator system comprising an elevator and a control device system.

[0002] Usually, elevator cabins are held and moved by suspension traction means. Generally, the suspension traction means have to be monitored because the safety of the elevator/elevator system depends on the suspension traction means. In particular, the suspension traction means or parts thereof can break which influences the safety of the operation of the elevator/elevator system. Normally, suspension traction means are encapsulated, so no optical inspection of the suspension traction means or its parts is possible.

[0003] There may be a need for a method for monitoring the suspension traction means of an elevator which enhances the safety of the operation of the elevator. There may be also a need for a control device system for monitoring the suspension traction means of an elevator which enhances the safety of the elevator. There may be also a need for an elevator system with a high safety level.

[0004] Such needs may be met with the subject-matters of the independent claims. Advantageous embodiments are defined in the dependent claims and in the following specification.

[0005] According to a first aspect of the present invention, a method for monitoring the suspension traction means of an elevator is proposed, wherein the suspension traction means comprises several cords, wherein the method comprises the following steps: measuring a thickness of at least one cord of the suspension traction means at at least one point of the cord; comparing the measured thickness of the cord with a first value and/or with a second value, wherein the second value is lower than the first value; and generating and sending a warning signal when the measured thickness of the cord at at least one point of the cord is lower than the first value and generating and sending an operation terminating signal for terminating the operation of the elevator when the measured thickness of the cord at at least one point of the cord is lower than the second value.

[0006] One advantage hereof is that deteriorations of the cord of the suspension traction means can be detected very early and that corresponding actions can be taken at a very early stage of deterioration, normally. By having two values, a higher first value and a lower second value, usually, first actions can be taken if the thickness of the cord is lower than a first value and more severe actions can be taken, e.g., stopping the operation of the elevator, if the thickness of the cord is lower than a second value. Therefore, only necessary actions depending on the degree of deterioration of the cord/suspension traction means can be taken. Usually, this saves time and money. Furthermore, generally, the operation of the elevator/elevator system is only interrupted if the safety of the operation can no longer be guaranteed.

[0007] Normally, the thickness of the cord can be equal to the diameter of the cord. Typically, the suspension traction means is adapted for holding/suspending and moving/driving the elevator cabin of the elevator system. Generally, the suspension traction means can be a belt in which the cords are embedded or a rope comprising the cords. Typically, the cord can comprise or can consist of several (single) wires. Normally, the thickness or diameter of the cord can be measured perpendicular to the length of the cord (which is the direction of the greatest/largest dimension of the cord).

[0008] According to a second aspect of the present invention, a control device system for monitoring the suspension traction means of an elevator is proposed, wherein the suspension traction means comprises several cords, wherein the control device system comprises: a measuring means for measuring a thickness of at least one cord of the suspension traction means at at least one point of the cord; a comparison means for comparing the measured thickness of the cord with a first value and/or with a second value, wherein the second value is lower than the first value; and an evaluation means - for generating and sending a warning signal when the measured thickness of the cord at at least one point of the cord is lower than the first value and/or - for generating and sending an operation terminating signal when the measured thickness of the cord at at least one point of the cord is lower than the second value.

[0009] One advantage thereof is that deteriorations of the cord of the suspension traction means can be detected very early and that corresponding actions can be taken at a very early stage of deterioration, normally. By this, usually, first actions can be taken if the thickness of the cord is lower than a first value and more severe actions can be taken, e.g., stopping the operation of the elevator immediately, if the thickness of the cord is lower than a second value. Therefore, only necessary actions depending on the degree of deterioration of the cord/suspension traction means can be taken. Usually, this saves time and money. Furthermore, generally, the operation of the elevator/elevator system is only interrupted if the safety of the operation is no longer given.

[0010] According to a third aspect of the present invention, an elevator system comprising an elevator and a control device system as described above is proposed.

[0011] Ideas underlying embodiments of the present invention may be interpreted as being based, inter alia, on the following observations and recognitions.

[0012] A cord of a suspension traction means of an elevator is a safety relevant part, so the state of the cord should be determined regularly and/or monitored, in particular during operation of the elevator system without interrupting the operation of the elevator system, so that changes and/or deteriorations of the cord can be detected at an early stage.

[0013] Generally, the thickness of the cord is proportional to the remaining breaking force or load bearing capacity, i.e., which force is necessary for breaking/tearing the cord. Thus, normally, the thickness of the cord is a very good indicator how much weight can be held and carried safely by the cord and, thus, by the suspension traction means comprising the cord.

[0014] According to an embodiment, the first value and the second value are dependent on the thickness of the cord before a first operation of the elevator. Generally, one advantage hereof is that the degree of deterioration of the cord is a percentage value, e.g., 99%, 95%, 90% of the "original" thickness of the cord, i.e., the thickness of the cord before a first operation of the elevator. Thus, normally, no absolute values are considered, but relative values are considered which are most relevant for the safety of the operation of the elevator. Generally, the thickness of the cord can change over time, in particular decrease over time, for example by wear and tear and/or mechanical impacts.

[0015] According to an embodiment, the warning signal and/or operation terminating signal is sent to a control device which controls the elevator. Normally, one advantage hereof is that a control device can take necessary steps due to the degree of deterioration of the cord. For example, the control device can terminate the operation of the elevator (immediately) based on the operation terminating signal, i.e., move the elevator cabin to the next possible floor, open the elevator doors and request the passengers to exit the elevator cabin and then terminate operation of the elevator. Also, generally, the control device can call for maintenance, in particular if a warning signal and/or an operation terminating signal is sent to the control device.

[0016] According to an embodiment, based on the warning signal and/or the operation terminating signal an optical and/or acoustic warning indication is given to persons inside an elevator cabin of the elevator, wherein the elevator cabin is held by the suspension traction means. Generally, one advantage hereof is that the persons using the elevator/inside the elevator cabin are informed about the deterioration of the cord. Thus, the persons can leave the elevator cabin of the elevator as soon as a deterioration of a cord of the suspension traction means is detected. This enhances the safety of the operation of the elevator system.

[0017] According to an embodiment, the thickness of the cord is measured at several different points of the cord. Generally, this enhances the safety of the operation of the elevator even further, because damages of the cord are more likely to be detected.

[0018] According to an embodiment, the thickness of the cord is measured via electromagnetic waves. Generally, this allows for monitoring the thickness of a cord even if the cord is encapsulated in the suspension traction means and no optical inspection is possible. Thus, cords of suspension traction means which encapsulate the cord or cords can be monitored technically easily. Typically, the electromagnetic waves can comprise or be a voltage signal and/or a current signal.

[0019] According to an embodiment, the thickness of the cord is measured via radar, waves in the Terahertz range, X-rays, ultrasonic waves, by measuring an inductance of the cord and/or by measuring a change in inductance of the cord. Generally, one advantage hereof is that the thickness of the cord can be measured non-destructively and technically easily.

[0020] According to an embodiment, the thickness of the cord at at least one point of the cord is measured in a first direction and the thickness of the cord is measured at the at least one point in a second direction, wherein the second direction is essentially perpendicular to the first direction. Generally, one advantage hereof is that constrictions can be detected even if the constriction is along the first direction. By looking at the cord/measuring the thickness of the cord in two directions which have an angle of about 90° to each other, constrictions/damages of the cord in any direction can be detected technically easily.

[0021] According to an embodiment, the suspension traction means comprises several cords embedded in a belt. Generally, one advantage hereof is that the method can be also used for suspension traction means comprising several cords which are embedded in a belt. Typically, cords embedded in a belt cannot be inspected optically.

[0022] According to an embodiment, the suspension traction means comprises a rope comprising the several cords. Generally, by this, the method can be also used for systems comprising a rope wherein the rope comprises the several cords.

[0023] According to an embodiment, the measuring means comprises - a first sender for sending electromagnetic waves and/or ultrasonic waves through the at least one cord, - a first receiver for receiving transmitted and/or reflected electromagnetic waves and/or transmitted and/or reflected ultrasonic waves from the first sender; and - a determination device for determining the thickness of the at least one cord at the at least one point of the cord based on the received transmitted and/or reflected electromagnetic and/or ultrasonic waves. Generally, by this, the thickness of the cord or the cords can be measured technically easily. Furthermore, the control device system is low-priced.

[0024] According to an embodiment, the electromagnetic waves are waves in the Terahertz range, X-rays and/or electromagnetic waves through the length of the cord. Generally, one advantage hereof is that the thickness of the cord can be measured non-destructively and technically easily.

[0025] According to an embodiment, the control device system further comprises a second sender for sending electromagnetic waves and/or ultrasonic waves through the at least one cord and a second receiver for receiving transmitted and/or reflected electromagnetic waves and/or transmitted and/or reflected ultrasonic waves from the second sender, wherein the first sender sends the electromagnetic waves and/or ultrasonic waves through the at least one cord in a first direction and the second sender sends the electromagnetic waves and/or ultrasonic waves through the at least one cord in a second direction, wherein the second direction is essentially perpendicular to the first direction. Generally, one advantage hereof is that constrictions can be detected even if the constriction is along the first direction. By looking at the cord/by measuring the thickness of the cord in two directions which have an angle of about 90° to each other, constrictions/damages of the cord in any direction can be detected technically easily.

[0026] In the following, advantageous embodiments of the invention will be described with reference to the enclosed drawing. However, neither the drawing nor the description shall be interpreted as limiting the invention.

Fig. 1 shows a perspective view of a belt comprising embedded cords;

Fig. 2 shows a detailed perspective view of one of the cords of the belt of Fig. 1; and

Fig. 3 shows a schematic view of an embodiment of a control device system according to the present invention.

[0027] The figures are only schematic and not to scale. Same reference signs refer to same or similar features.

[0028] Fig. 1 shows a perspective view of the belt comprising embedded cords 20-25. Fig. 2 shows a detailed view of one of the cords 20-25 of the belt of Fig. 1. Fig. 3 shows a schematic view of an embodiment of a control device system 50 according to the present invention.

[0029] In Fig. 1, the suspension traction means 10 is a belt. The suspension traction means 10 is adapted for holding/suspending and moving an elevator cabin of an elevator/elevator system. The belt comprises a material/cover 15 in which the cords 20-25 are embedded. The material can comprise or be polyurethane or another synthetic or natural material. The belt comprises a plurality of cords 20-25 which are spaced apart from each other equidistantly. The cords 20-25 can be of a similar or equal built. The material in which the cords 20-25 are embedded is normally not translucent, so the cords 20-25 cannot be inspected optically from the outside. In Fig. 1, there are six cords 20-25 in the belt. The number of cords 20-25 in the belt/suspension traction means 10 can be higher, e.g., seven, eight, nine, or more than ten.

[0030] Each cord 20-25 comprises several strands 30-36. In particular, the cord 20-25 can consist of several strands 30-36, as shown in Fig. 2. The cord 20-25 consists of seven strands 30-36, wherein one strand 36 is in the middle and the six other strands 30-35 are evenly distributed in a circle around the center strand 36.

[0031] The six strands 30-35 around the center strand 36 are wrapped/wound, i.e., the position of the six strands 30-35 in relation to the center strand 36 change along the length of the cord 20-25. The length of the cords 20-25 runs in Fig. 2 essentially from left to right.

[0032] At one point of the cord 20-25, the cord 20-25 has a narrowing 40/constriction. Here, the thickness or diameter of the cord 20-25 (measured perpendicularly to the length of the cord 20-25 which is running from left to right essentially in Fig. 2) is smaller than the "normal" diameter/thickness of the cord 20-25 which is present at every other point of the cord 20-25. The thickness of the cord 20-25 along the length of the cord 20-25 stays the same except for the constriction/narrowing 40.

[0033] Here, at the narrowing 40, the cord 20-25 has been damaged. This means that at least one of the strands 30-36 has been damaged and, thus, the thickness of the cord 20-25 is smaller than the original thickness, i.e., the thickness of the cord 20-25 before a first operation of the elevator, and "normal" thickness/diameter of the cord 20-25.

[0034] It is also possible that the cord 20-25 has a larger thickness/diameter at this point instead of a constriction/narrowing 40. Relevant is that the diameter of the cord 20-25 is different from the normal/original diameter of the cord 20-25.

[0035] The damage could have been done mechanically, e.g., by a collision/encounter of a mechanical/metallic element and the cord 20-25. Also, it is possible that one or more of the strands 30-36 have been torn/ripped and, thus, no longer run along the whole length of the cord 20-25.

[0036] The thickness or diameter of the cord 20-25 is measured by a measuring means 75. The measuring means 75 can comprise a first sender 60, a first receiver 65 and a determination device 70 for determining the thickness of the cord 20-25.

[0037] The thickness of the cord 20-25 can be measured at at least one point of the cord 20-25. The at least one point of the cord 20-25 is a small area along the length of the cord 20-25. Also, it is possible that the thickness of the cord 20-25 is measured at more than one point, e.g., two points, three points, etc.

[0038] The first sender 60 can send electromagnetic waves through the cord 20-25. A first receiver 65 receives the transmitted and/or reflected electromagnetic waves. Therefore, if the first receiver 65 shall receive the transmitted electromagnetic waves, the first receiver 65 has to be on the other side of the first sender 60 in relation to the cord 20-25. If the reflected electromagnetic waves shall be received by the first receiver 65, the first receiver 65 has to be on the same side of the cord 20-25 as the first sender 60. The determination device 70 can be a computer with software. The determination device 70 receives the received data and calculates the thickness of the cord 20-25.

[0039] The electromagnetic waves can comprise or be X-rays (also called Roentgen waves/radiation), waves in the terahertz range, radar waves, ultrasonic waves, etc.

The Terahertz range can be between ca. $1 * 10^{12}$ Hz and ca. $1 * 10^{15}$ Hz.

[0040] Also it is possible that an inductance of the cord 20-25 or a change of the inductance of the cord 20-25 is measured. For this, a first sender 60 of the electromagnetic waves is at a first end of the length of the cord 20-25, while the first receiver 65 is at the same first end of the cord 20-25 or at the opposite end (second end) of the cord 20-25. The electromagnetic waves can be a voltage and/or a current. By sending an electromagnetic wave or a current through the length of the cord 20-25, the inductance of the cord 20-25 can be measured. The transmitted signal of the electromagnetic wave through the length of the cord 20-25 and/or the reflected signal of the electromagnetic wave through the length of the cord 20-25 can be detected.

[0041] If the original conductance, i.e., the conductance of the cord 20-25 before a first operation of the elevator, is known or has been measured, a change of the inductance, or a change of inductance over time, can be determined. From this, the thickness of the cord 20-25 can be determined.

[0042] Also, it is possible that the inductance of a part of the cord 20-25 is measured. Thus, different sections of the cord 20-25 can be measured one after the other. This way, changes of the inductance of the cord 20-25 can be localized technically easily.

[0043] It is possible that the first sender 60 and/or the first receiver 65 are movable along the length of the cord 20-25 or along the length of the belt. By this, the thickness of the cord 20-25 at different points of the cord 20-25/at every point of the cord 20-25 can be determined. The first sender 60 and the first receiver 65 move along the length of the cord 20-25 while measuring the thickness of the cord 20-25 at several points.

[0044] Also, it is possible that the first sender 60 and/or the first receiver 65 and/or the second sender and/or second receiver are moved around the cord 20-25. They can be moved around the core in a full circle or only part of a circle, e.g., 180° or 90°. The movement can be around the length of the cord 20-25 which runs essentially from the lower left to the upper right in Fig. 2. The relative positions between the sender and receiver, respectively, can stay the same or can be changed during the movement around the cord 20-25.

[0045] If the strands 30-36 in the cord 20-25 are wound, in particular several strands 30-36 are wound around a center strand 30-36, the sender(s) and/or receiver(s) can "follow" one strand 30-36, i.e., they are moved around the cord 20-25 the same way the orientation/direction of the strand 30-36 changes. This way, more details of the cord 20-25 can be inspected and examined. The thickness of the cord 20-25 can be measured while the strand 30-36 is always in the same orientation relative to the sender(s) and/or receiver(s).

[0046] During the moving of the sender(s) and/or receiver(s) measurements can be taken in set time intervals. E.g., every second a measurement is made while the sender(s) and/or receiver(s) move continuously along the length of the cord 20-25. Also, it is possible that the sender(s) and/or receiver(s) stop after moving a set distance, a measurement is taken, then the sender(s) and/or receiver(s) move the set distance again, a new measurement is taken, then the sender(s) and/or receiver(s) move the set distance again, a new measurement is taken and so on.

[0047] Moving the sender(s) and/or receiver(s) along the length of the cord 20-25 and around the cord 20-25 can be combined.

[0048] After the thickness of the cord 20-25 at at least one point is determined, a comparison means 80, for example a CPU/a computer, compares the measured thickness of the cord 20-25 with the preset first value and/or with the preset second value. The second value is lower than the first value. The first and/or second value can be absolute values, i.e. given in centimeters or millimeters. Alternatively, the first and second value can depend on the original thickness of the cord 20-25, i.e., the thickness of the cord before a first operation of the elevator. Thus, the first and/or second value can be given as percentages, for example as percentages of the original thickness of the cord 20-25. E.g., 90% of 10 mm, i.e., 9 mm. Alternatively, the percentage value can be given in relation to the measured/determined thickness of the cord 20-25 at other points of the cord 20-25 than the currently measured point of the cord 20-25.

[0049] If the thickness of the cord 20-25 at at least one point of the cord 20-25 or at least one area of the cord 20-25 is lower than the first value, a warning signal is generated and sent.

[0050] The first value can be a thickness (of a cord 20-25) at which the safety of holding and transporting the elevator cabin is not endangered. Nevertheless, if the thickness of the cord 20-25 (at one point or at several points of the cord 20-25) is lower than the first value, the suspension traction means 10 should be checked by maintenance/service personnel. The checking could be done in great detail to determine the kind of damage of the cord 20-25 and degree of damage to the cord 20-25.

[0051] The second value can be thickness (of a cord) at which the thickness (of a cord) is below a threshold given by national and/or international and/or regional regulations and/or laws. Further damages to the suspension traction means 10 are impending. Thus, the suspension traction means 10 should no longer be used for holding and transporting the elevator cabin. In this case, the suspension traction means 10 should be checked and/or exchanged by maintenance/service personnel. The checking could be done in great detail to determine the kind of damage of the cord 20-25 and degree of damage to the cord 20-25.

[0052] The second value can be half or quarter of the first value. In particular, only the operation terminating signal can be generated and sent when the measured thickness of the cord 20-25 is lower than the second value.

[0053] Based on the warning signal the maximum permitted total weight or maximum payload of the elevator cabin be reduced. Thus, if the thickness of the cord 20-25 (at one point or at several points of the cord 20-25) is lower than the first value, the maximum weight to be carried by the elevator cabin can be reduced. If higher weights than the maximum payload are detected inside the elevator cabin, a warning tone and/or audio signal can be played and/or a visual warning signal can be displayed. No movement of the elevator cabin is allowed if the weight of the persons/goods in the elevator cabin is higher than the reduced payload. The payload can be reduced corresponding to the degree of deterioration of the cord 20-25 and/or changes of the thickness (in relation to the original thickness of the cord 20-25, i.e., the thickness of the cord before a first operation of the elevator). E.g., if the thickness of one of the cords 20-25 has changed from originally 5 cm to 4.8 cm, i.e., by 4%, the payload can be reduced by 4%.

[0054] The warning signal can be transmitted to a control unit/control device system 50/control device which controls the elevator cabin/elevator system. The warning signal can be also transmitted to an external maintenance or service point/unit. The transmittance or sending can be done via wire or wireless, e.g., via mobile radio telephone service, via the Internet among others. The warning signal can comprise the thickness of the cord 20-25 at the measured point and/or the original thickness of the cord 20-25 (thickness of the cord 20-25 before a first operation of the elevator) and/or the thickness of the cord 20-25 measured at several points.

[0055] The warning signal can be used to call the maintenance or service to check the cord 20-25 or cords 20-25 in question. The cord 20-25 can be changed and/or the suspension transaction means (belt) can be exchanged if a safety risk for the elevator exists due to the constriction/narrowing 40 of the cord 20-25 at at least one point.

[0056] Furthermore, the average thickness of the cord 20-25 can be determined by measuring the thickness of the cord 20-25 at several points. If the average thickness of the cord 20-25 has decreased, this means that a constriction/narrowing 40 at at least one point is present.

[0057] If the measured thickness is lower than the second value, an operation terminating signal is generated and sent. The operation terminating signal can be adapted for terminating the operation of the elevator. Based on the operation terminating signal, the control device/control device system 50 can move the elevator/elevator cabin to the next possible floor, open the elevator doors and request the passengers to exit the elevator cabin, e.g., via a played audio message, and then terminate the operation of the elevator.

[0058] By this, the danger that the elevator/elevator cabin cannot be held and/or moved anymore by the suspension traction means 10 and the corresponding consequences are minimized. The operation terminating signal can also be sent to a remote and/or in-house service and maintenance unit/device. Also, the measured thickness of the cord at one or several points/section of the cord(s) can be sent together with the warning signal and/or operation terminating signal.

[0059] Also, the operation terminating signal can be adapted for terminating the operation of the elevator immediately, for example, if no passengers are inside the elevator cabin. The movement of the elevator cabin is stopped as soon as the operation terminating signal is generated and sent or received at the control device of the elevator and no further movement of the elevator cabin is allowed until service/maintenance has released the operation terminating signal.

[0060] The elevator cabin can comprise an indication display. The indication display can comprise three differently colored signals with three corresponding texts, respectively. The indication display can be inside the elevator cabin, wherein the signal is shown to the persons in the elevator when a warning signal and/or operation terminating signal has been generated and sent. Additionally or alternatively, the indication display can be at a maintenance panel/display for persons maintaining the elevator/elevator system.

[0061] This way, persons maintaining the elevator can be informed about the status of the cords 20-25 of the suspension traction means 10. The local display can be in a service room of the elevator or can be at a (hidden) point of the elevator cabin.

[0062] For example, the indication signal display can comprise a first signal with the text "OK" wherein the color is green. The second signal can be a text with "WARNING" with the color orange or yellow. Furthermore, a third signal with the text "elevator stopped DANGER" with the color red can be shown when an operation terminating signal is generated and sent.

[0063] The thickness of the cord 20-25 can be measured at at least one point of the cord 20-25 in a first direction and also in a second direction, wherein the second direction has a degree of essentially 90° to the first direction. The two directions can be perpendicular to the length of the cord 20-25. This way, constrictions along the first direction can be also detected and measured. When measuring in only one direction (first direction), constrictions in this direction can be hardly detected or cannot be detected.

[0064] The suspension traction means 10 can also be a rope which comprises the several cords 20-25. In particular, the rope can consist of the several cords 20-25, for example six cords 20-25 wound around a central cord 20-25.

[0065] The thickness of several cords 20-25 can be measured. This can be done simultaneously or consecutively in time.

[0066] Furthermore, the average and/or median thickness of the cord 20-25 can be measured/determined. This information can be sent to the maintenance/service unit/device.

[0067] It is also possible that a warning signal and/or operation terminating signal is generated and sent only if two or more cords 20-25 of the suspension traction means 10 have a thickness lower than the first value or second value at at least one point of the respective cord. Also, it is possible that a warning signal and/or operation terminating signal is generated and sent only if two or more cords have a reduced thickness (compared to the original thickness/thickness of the cord 20-25 before a first operation of the elevator), e.g., lower than the first value or lower than the second value, at the same point or at points which are close to each other (e.g., within ca. 10 cm or within ca. 50 cm). If two or more cords have a thickness lower than the first value or lower than the second value at two points, respectively, which are very far apart from each other, e.g., more than ca. 50 cm or more than ca. 100 cm, no warning signal or no operation terminating signal is generated and sent.

[0068] Typically, if the measured thickness of the cord 20-25 (at at least one point of the cord 20-25) is lower than the second value, only the operation terminating signal is generated and sent.

[0069] Finally, it should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

List of reference numerals:

[0070]

10	suspension traction means (belt)
15	cover
20-25	cord
30-36	strand
40	narrowing
50	control device system
60	first sender
65	first receiver
70	determination device
75	measuring means
80	comparison means

Claims

1. Method for monitoring the suspension traction means (10) of an elevator, wherein the suspension traction means (10) comprises several cords (20-25), wherein the method comprises the following steps:

   measuring a thickness of at least one cord (20-25) of the suspension traction means (10) at at least one point of the cord (20-25);
   comparing the measured thickness of the cord (20-25) with a first value and with a second value, wherein the second value is lower than the first value; and
   generating and sending a warning signal when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the first value
   and
   generating and sending an operation terminating signal for terminating the operation of the elevator when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the second value.

2. Method according to claim 1, wherein the first value and the second value are dependent on a thickness of the cord (20-25) before a first operation of the elevator.

3. Method according to claim 1 or 2, wherein the warning signal and/or operation terminating signal is sent to a control device which controls the elevator.

4. Method according to one of the preceding claims, wherein based on the warning signal and/or the operation terminating signal an optical and/or acoustic warning indication is given to persons inside an elevator cabin of the elevator, wherein the elevator cabin is held by the suspension traction means (10).

5. Method according to one of the preceding claims, wherein the thickness of the cord (20-25) is measured at several different points of the cord (20-25).

6. Method according to one of the preceding claims, wherein the thickness of the cord (20-25) is measured via electromagnetic waves.

7. Method according to one of the preceding claims, wherein the thickness of the cord (20-25) is measured via radar, waves in the Terahertz range, X-rays, ultrasonic waves, by measuring an inductance of the cord (20-25) and/or by measuring a change in inductance of the cord (20-25).

8. Method according to one of the preceding claims, wherein the thickness of the cord (20-25) at at least one point of the cord (20-25) is measured in a first direction and the thickness of the cord (20-25) is measured at the at least one point in a second direction, wherein the second direction is essentially perpendicular to the first direction.

9. Method according to one of the preceding claims, wherein
the suspension traction means (10) comprises several cords (20-25) embedded in a belt.

10. Method according to one of the preceding claims, wherein
the suspension traction means (10) comprises a rope comprising the several cords (20-25).

11. Control device system (50) for monitoring the suspension traction means (10) of an elevator, wherein the suspension traction means (10) comprises several cords (20-25),
wherein the control device system (50) comprises:

a measuring means (75) for measuring a thickness of at least one cord (20-25) of the suspension traction means (10) at at least one point of the cord (20-25);
a comparison means (80) for comparing the measured thickness of the cord (20-25) with a first value and with a second value, wherein the second value is lower than the first value; and
an evaluation means

- for generating and sending a warning signal when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the first value and
- for generating and sending an operation terminating signal when the measured thickness of the cord (20-25) at at least one point of the cord (20-25) is lower than the second value.

12. Control device system (50) according to claim 11, wherein
the measuring means (75) comprises

- a first sender (60) for sending electromagnetic waves and/or ultrasonic waves through the at least one cord (20-25),
- a first receiver (65) for receiving transmitted and/or reflected electromagnetic waves and/or transmitted and/or reflected ultrasonic waves from the first sender (60); and
- a determination device (70) for determining the thickness of the at least one cord (20-25) at the at least one point of the cord (20-25) based on the received transmitted and/or reflected electromagnetic and/or ultrasonic waves.

13. Control device system (50) according to claim 11 or 12, in particular according to claim 12, wherein
the electromagnetic waves are waves in the Terahertz range, X-rays and/or electromagnetic waves through the length of the cord (20-25).

14. Control device system (50) according to one of the claims 11-13, in particular according to 12-13, further comprising
a second sender for sending electromagnetic waves and/or ultrasonic waves through the at least one cord (20-25) and a second receiver for receiving transmitted and/or reflected electromagnetic waves and/or transmitted and/or reflected ultrasonic waves from the second sender,
wherein the first sender (60) sends the electromagnetic waves and/or ultrasonic waves through the at least one cord (20-25) in a first direction and the second sender sends the electromagnetic waves and/or ultrasonic waves through the at least one cord (20-25) in a second direction, wherein the second direction is essentially perpendicular to the first direction.

15. Elevator system comprising an elevator and a control device system (50) according to one of the claims 11-14.

Fig. 1

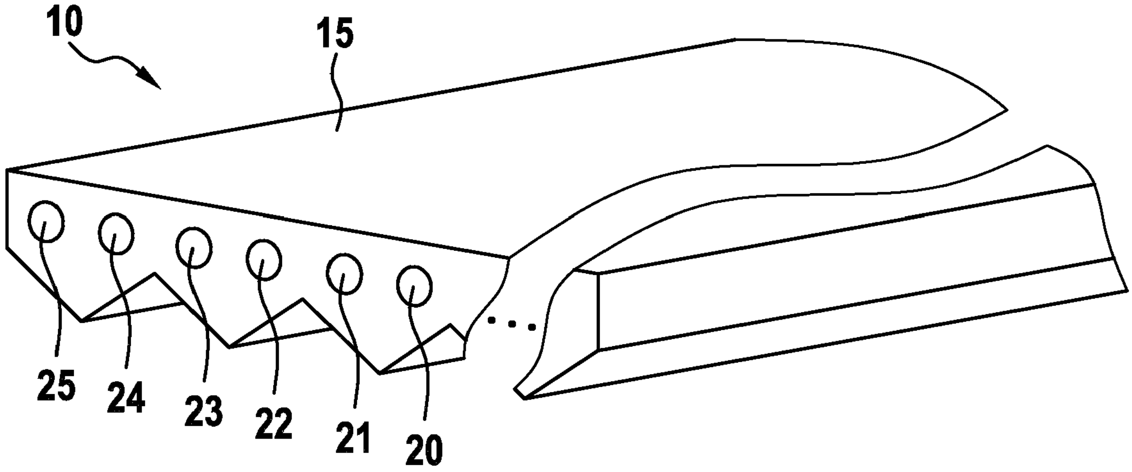


Fig. 2

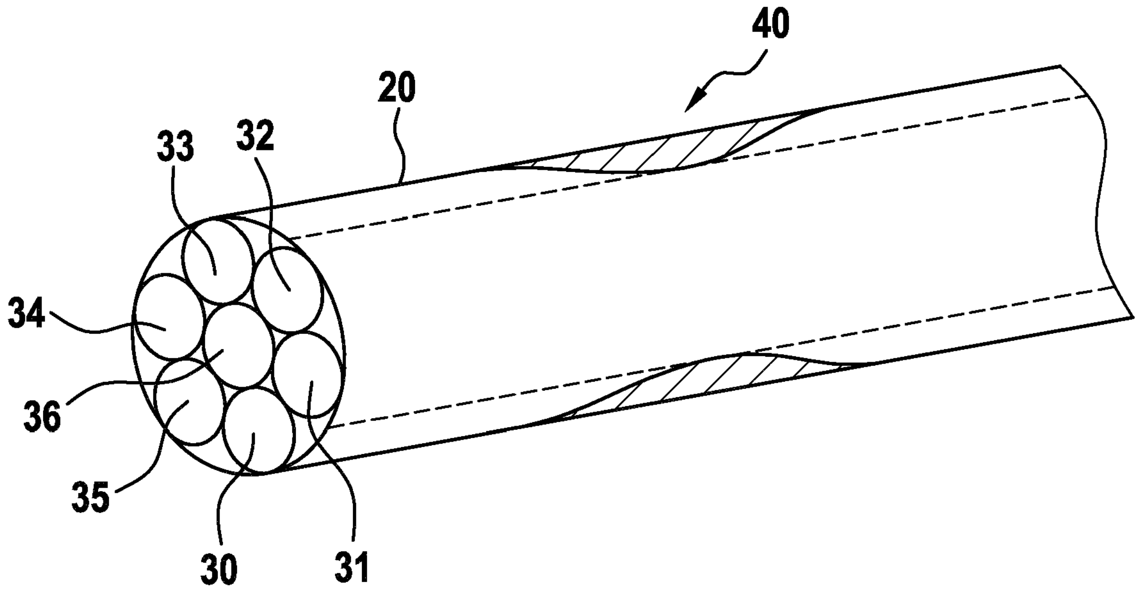
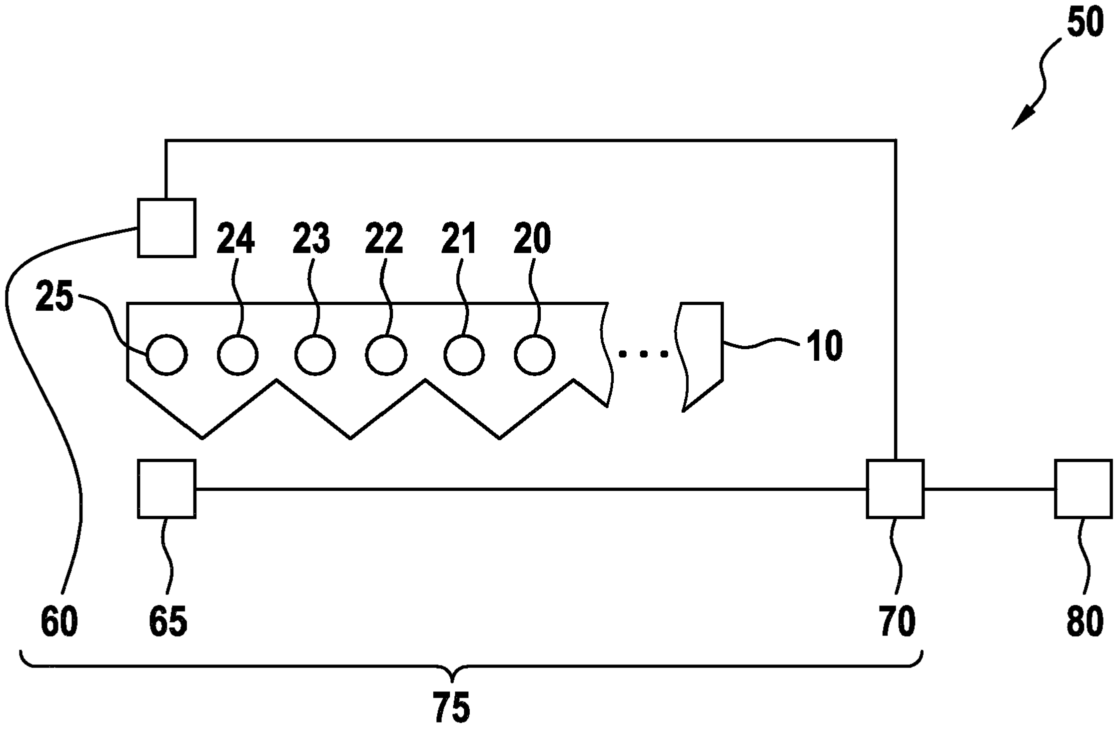


Fig. 3



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 16 19 3877

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2011/220438 A1 (ANNEN MIRCO [CH] ET AL) 15 September 2011 (2011-09-15)	1-7, 9-11,15	INV. B66B7/12
Y	* paragraph [0090] - paragraph [0095]; figure 13 *	8,12-14	
Y	WO 2015/110791 A1 (PARKBURN PREC HANDLING SYSTEMS LTD [GB]) 30 July 2015 (2015-07-30)	8,14	
A	* page 6, line 1 - line 8 *	1-7, 9-13,15	
Y	US 2011/192683 A1 (WEINBERGER KARL [CH] ET AL) 11 August 2011 (2011-08-11)	12,13	
A	* paragraph [0012] * * paragraph [0069] *	1-11,14, 15	
A	EP 2 020 394 A1 (MITSUBISHI ELECTRIC CORP [JP]) 4 February 2009 (2009-02-04) * paragraph [0021] - paragraph [0022] *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B66B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	16 March 2017	Szován, Levente

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 3877

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-03-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011220438 A1	15-09-2011	AU 2009317388 A1	27-05-2010
		BR PI0922055 A2	22-12-2015
		CN 102216193 A	12-10-2011
		EP 2346768 A1	27-07-2011
		ES 2402542 T3	06-05-2013
		HK 1157718 A1	07-06-2013
		KR 20110084422 A	22-07-2011
		MY 154186 A	15-05-2015
		RU 2011124920 A	27-12-2012
		US 2011220438 A1	15-09-2011
		WO 2010057797 A1	27-05-2010
WO 2015110791 A1	30-07-2015	GB 2536597 A	21-09-2016
		WO 2015110791 A1	30-07-2015
US 2011192683 A1	11-08-2011	CN 101778791 A	14-07-2010
		EP 2185455 A1	19-05-2010
		US 2011192683 A1	11-08-2011
		WO 2009024452 A1	26-02-2009
EP 2020394 A1	04-02-2009	CN 101233066 A	30-07-2008
		EP 2020394 A1	04-02-2009
		JP 5436776 B2	05-03-2014
		KR 20080026617 A	25-03-2008
		WO 2007138643 A1	06-12-2007

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82