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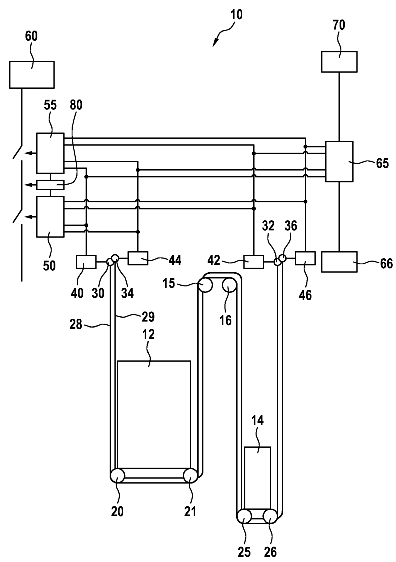
(54) **ELEVATOR MONITORING SYSTEM FOR MONITORING SUSPENSION TRACTION MEANS AND METHOD FOR MONITORING SUSPENSION TRACTION MEANS**

(57) An elevator monitoring system (10) for monitoring suspension traction means is proposed, wherein the elevator monitoring system (10) comprises: - a first suspension traction means (28) which holds an elevator cabin (12) and a counter weight (14), wherein a first end of the first suspension traction means (28) is attached fixedly at a first cabin side fix point (30), and wherein a second end of the first suspension traction means (28), which is opposed to the first end of the first suspension traction means (28), is attached fixedly at a second counter weight side fix point (32), - a second suspension traction means (29) which holds the elevator cabin (12) and the counter weight (14) movably, wherein a first end of the second suspension traction means (29) is attached fixedly at a third cabin side fix point (34), and wherein a second end of the second suspension traction means (29), which is opposed to the first end of the second suspension traction means (29), is attached fixedly at a fourth counter weight side fix point (36), - a first force sensor (40) disposed at the first cabin side fix point (30) and/or a second force sensor (42) disposed at the second counter weight side fix point (32), as well as a third force sensor (44) disposed at the third cabin side fix point (34) and/or a fourth force sensor (46) disposed at the fourth counter weight side fix point (36), wherein the force sensors (40, 42, 44, 46) are adapted for measuring a force exerted on the respective suspension traction means at the respective fix point and for generating measurement values corresponding to the measured force, respectively, - at least one comparison unit, wherein the comparison unit is adapted for receiving the measurement values from the first force sensor (40), from the second force sensor (42), from the third force sensor (44) and/or from the fourth force sensor (46), and for comparing the measurement value of at least one of the first force sensor (40) and the second force sensor (42) with the measurement value of at least one of the third force sensor (44) and fourth force sensor (46), and - a warning signal generating unit (80) for generating a warning signal and/or stopping the operation of the elevator cabin (12) if the comparison unit determines that a difference and/or a ratio of the measurement value of at least one of the first force sensor (40) and the second force sensor (42) and the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) is larger than a first preset value.

Fig. 1



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Description

Specification

[0001] The present invention pertains to an elevator monitoring system for monitoring suspension traction means and a method for monitoring suspension traction means.

[0002] Usually, elevator cabins and their respective counter weight of elevator systems 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. Typically, the elevator monitoring system comprises a slack cable switch which stops operation of the elevator when a slack cable/rope and/or belt (i.e., a suspension traction means) is detected. The cable/rope and/or belt should always be under tension. The mechanical slack cable switch presses perpendicularly to the length of the cable/rope or belt against the cable/rope/belt. If the cable/rope or belt gives way, this means that the cable/rope or belt is no longer under tension. This indicates a serious problem of this cable/rope or belt. Therefore, the operation of the elevator is normally stopped when such a status is detected.

[0003] One disadvantage of elevator monitoring known from the state of the art is that the slack cable switch is expensive. Furthermore, under very unfavorable circumstances, due to dynamic effects in the elevator system a slack is detected even though there is no unsafe situation. This would lead to an unnecessary call back.

[0004] There may be a need for an elevator monitoring system for monitoring suspension traction means which is constructed technically easily and which has low production costs. There may be also a need for a method for monitoring suspension traction means which is technically easily and which can be executed with an elevator monitoring system which has low production costs.

[0005] 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.

[0006] According to a first aspect of the present invention, an elevator monitoring system for monitoring suspension traction means is proposed, wherein the elevator monitoring system comprises:- a first suspension traction means which holds an elevator cabin and a counter weight, wherein a first end of the first suspension traction means is attached fixedly at a first cabin side fix point, and wherein a second end of the first suspension traction means, which is opposed to the first end of the first suspension traction means, is attached fixedly at a second counter weight side fix point, - a second suspension traction means which holds the elevator cabin and the counter weight movably, wherein a first end of the second suspension traction means is attached fixedly at a third cabin side fix point, and wherein a second end of the second suspension traction means, which is opposed to the first end of the second suspension traction means, is attached fixedly at a fourth counter weight side fix point, - a first force sensor disposed at the first cabin side fix point and/or a second force sensor disposed at the second counter weight side fix point, as well as a third force sensor disposed at the third cabin side fix point and/or a fourth force sensor disposed at the fourth counter weight side fix point, wherein the force sensors are adapted for measuring a force exerted on the respective suspension traction means at the respective fix point and for generating measurement values corresponding to the measured force, respectively, - at least one comparison unit, wherein the comparison unit is adapted for receiving the measurement values from the first force sensor, from the second force sensor, from the third force sensor and/or from the fourth force sensor, and for comparing the measurement value of at least one of the first force sensor and the second force sensor with the measurement value of at least one of the third force sensor and the fourth force sensor, and - a warning signal generating unit for generating a warning signal and/or stopping the operation of the elevator cabin if either of the comparison units determines that -- a difference and/or a ratio of the measurement value of at least one of the first force sensor and the second force sensor and the measurement value of at least one of the third force sensor and the fourth force sensor is larger than a first preset value.

[0007] One advantage hereof is that the elevator monitoring system typically does not need a mechanical slack rope/belt switch for detecting the slack of a suspension traction means. The slack of one or more of the suspension traction means is detected via force sensors instead, in general. Normally, this decreases the production costs of the elevator monitoring system. Also, the elevator monitoring system detects malfunction/problems of the elevator, in particular of the suspension traction means, very reliably due to its redundancy, typically. Even if one of the force sensor and/or one of the comparison units does not work properly, normally, the suspension traction means can be monitored reliably and problems/malfunctions can be detected reliably via the other force sensors and the other comparison unit. Therefore, in general, a very high security level of the operation of the elevator system which is monitored by the elevator monitoring system can be achieved. Furthermore, in general, no calibration of the force sensors is necessary. In addition, typically, the elevator monitoring system does not have to rely on the mapping which is typically needed for a car/cabin load measurement. This increases the safety of the operation of the elevator/elevator car/elevator cabin. Furthermore, if the measurement value corresponding to a zero force exerted on the respective suspension traction means is known, the force sensors can also be used for adjusting the pre-torque of the elevator machine. The first preset value and/or the second preset value can be changed or adapted dynamically.

[0008] According to a second aspect of the present invention, a method for monitoring suspension traction means which hold an elevator cabin and a counter weight of an elevator system is proposed, wherein the suspension traction means comprise - a first suspension traction means which holds the elevator cabin and the counter weight, wherein a first end of the first suspension traction means is attached fixedly at a first cabin side fix point, and wherein a second end of the first suspension traction means, which is opposed to the first end of the first suspension traction means, is attached fixedly at a second counter weight side fix point, - a second suspension traction means which holds the elevator cabin and the counter weight, wherein a first end of the second suspension traction means is attached fixedly at a third cabin side fix point, and wherein a second end of the second suspension traction means, which is opposed to the first end of the second suspension traction means, is attached fixedly at a fourth counter weight side fix point, wherein the method comprises the following steps: -- measuring a force exerted on the first suspension traction means at the first cabin side fix point via a first force sensor and/or a force exerted on the first suspension traction means at the second counter weight side fix point via a second force sensor, as well as a force exerted on the second suspension traction means at the third cabin side fix point via a third force sensor and/or a force exerted on the second suspension traction means at the fourth counter weight side fix point via a fourth force sensor; -- generating measurement values which correspond to the measured forces, respectively; -- comparing the measurement value of at least one of the first force sensor and the second force sensor with the measurement value of at leaste one of the third force sensor and the fourth force sensor in at least one comparison unit; and -- generating a warning signal and/or stopping the operation of the elevator cabin if - -- a difference and/or a ratio of the measurement value of at least one of the first force sensor and the second force sensor and the measurement value of at least one of the third force sensor and the fourth force sensor is larger than a first preset-value.

[0009] One advantage hereof is that the suspension traction means can be monitored without the need for a mechanical slack rope/belt switch for detecting the slack of a suspension traction means. The slack of one or more of the suspension traction means is detected via force sensors instead, in general. Thus, the method can be carried out with an elevator monitoring system with low costs. Also, malfunction/problems of the elevator system, in particular of the suspension traction means, can be detected very reliably due to its redundancy, typically. Even if one of the force sensor and/or one of the comparison units does not work properly, normally, the suspension traction means can be monitored reliably and problems/malfunctions can be detected reliably via the other force sensors and the other comparison unit. Therefore, in general, a very high security level of the operation of the elevator system which is monitored with this method can be achieved. Furthermore, in general, no calibration of the force sensors is necessary. This increases the safety of the operation of the elevator/elevator car/elevator cabin.

[0010] The first end of the first suspension traction means which is attached fixedly at the first cabin side fix point has a smaller distance (along the first suspension traction means) to the elevator cabin than to the counter weight. The second end of the first suspension traction means, which is opposed to the first end of the first suspension traction means, has a smaller distance (along the first suspension traction means) to the counter weight than to the elevator cabin. The first end of the second suspension traction has a smaller distance (along the second suspension traction means) to the elevator cabin than to the counter weight. The second end of the second suspension traction means, which is opposed to the first end of the second suspension traction means, has a smaller distance (along the second suspension traction means) to the counter weight than to the elevator cabin.

[0011] In particular, if at least one of the force sensors does measure a force which is essentially zero (i.e., the suspension traction means is slack or even broken), a warning signal can be generated and/or the operation of the elevator can be stopped.

[0012] Ideas underlying embodiments of the present invention may be interpreted as being based, inter alia, on the following observations and recognitions.

[0013] According to an embodiment, the measurement values are frequency signals, respectively, in particular frequency signals with a square-wave form, respectively. One advantage hereof is that, typically, the measurement values can be transported over long distances without (significant) loss of information, since frequency signals can be transported over long distances without (significant) loss of information. Thus, in general, even when the distances over which the measurement values are to be transported are large, the measurement values can be transported reliably. Generally, this increases the safety of the operation of the elevator system.

[0014] According to an embodiment, the warning signal generating unit is adapted for generating a warning signal and/or stopping the operation of the elevator cabin only if either of the comparison unit determines that -- a difference and/or a ratio of the measurement value of at least one of the first force sensor and the second force sensor and the measurement value of at least one of the third force sensor and the fourth force sensor is larger than a first preset value for a time period which is longer than a preset time period. One advantage hereof is that, typically, even if the measurement values of the force sensors are very different for a short amount of time (lower than the preset time period), e.g., when an emergency stop of the elevator cabin is carried out, no warning signal is generated and the operation of the elevator system is not stopped. Thus, unneeded warnings and/or stops of the operation of the elevator system are avoided, in general. Therefore, normally, the operation of the elevator system is stopped only in real emergency situations. In

General, this increases the time of normal operation of the elevator system.

[0015] According to an embodiment, the force sensors are force sensors used for a load management of the elevator cabin. By this, generally, the costs of the elevator monitoring system can be further reduced, since means which are normally already present in an elevator system can be used for determining the measurement values. Also, typically, the signals of the force sensors can be mapped to a car load measurement which can be based on an additional calibration.

[0016] According to an embodiment, the elevator monitoring system further comprises an ambient temperature sensor for measuring the ambient temperature of the suspension traction means, wherein the first preset value is modified based on the measured ambient temperature of the suspension traction means. One advantage hereof is that the elevator monitoring system is even more reliably, in general. Ambient temperature changes which can influence the forces exerted on the suspension traction means differently do not influence the generation of a warning signal and/or stopping of the elevator system, since such changes are taken into account when determining if a malfunction occurred, typically.

[0017] According to an embodiment, the elevator monitoring system is adapted for adjusting the first preset value dynamically. By this, unnecessary warning signals and/or stoppings of the elevator system are minimized, since the first preset value is adjusted dynamically to values which are the limits of the normal operation of the elevator system. The limits of the normal operation can change or depend on the ambient temperature, the people in the elevator car, amongst others.

[0018] According to an embodiment of the method, the measurement values are frequency signals, respectively, in particular frequency signals with a square-wave form, respectively. One advantage hereof is that the measurement signals can transported over long distances without attenuation, in general. Typically, this improves the reliability. The measurement values can comprise or be analogue or digital signals.

[0019] According to an embodiment of the method, a warning signal is only generated and/or the operation of the elevator cabin is only stopped if --- a difference and/or a ratio of the measurement value of at least one of the first force sensor and the second force sensor and the measurement value of at least one of the third force sensor and the fourth force sensor is larger than a first preset-value for a time period which is longer than a preset time period. By this, in general, the number of false warning signals and/or unnecessary stoppings of the operation of the elevator cabin (i.e., if there are no malfunction is present, but a malfunction is determined) is reduced. This increases the reliability even further, generally.

[0020] According to an embodiment of the method, the measurement values of the force sensors are also used for a load management of the elevator cabin. In general, by this, an elevator monitoring system with low production costs can be used to carry out the method. Also, typically, the method can be carried out technologically easily.

[0021] According to an embodiment of the method, the first preset value is modified based on a measured ambient temperature of the suspension traction means. Typically, one advantage hereof is that the method is even more reliably. Ambient temperature changes which can influence the forces exerted on the suspension traction means differently do not influence the generation of a warning signal and/or stopping of the elevator system when carrying out the method, since such changes are taken into account when determining if a malfunction occurred, in general.

[0022] Each suspension traction means can comprise a rope and/or a belt, respectively.

[0023] 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 schematic view of an embodiment of an elevator monitoring system according to the present invention.

[0024] The figure is only schematic and not to scale. Same reference signs refer to same or similar features.

[0025] Fig. 1 shows a schematic view of an embodiment of an elevator monitoring system 10 according to the present invention.

[0026] The elevator monitoring system 10 comprises a first suspension traction means 28 which holds an elevator cabin 12 and a counter weight 14 and a second traction means which holds the elevator cabin 12 and the counter weight 14, too. The elevator monitoring system 10 can comprise more than two suspension traction means (e.g., three, four, five or more than five) holding the elevator cabin 12 and the counter weight 14.

[0027] The first suspension traction means 28 is fixed at its two opposite ends. A first end (the left end in Fig. 1) of the first suspension traction means 28, wherein the first end is closer to the elevator cabin 12 than the counter weight 14, is fixed at a first cabin side fix point 30. Also, the first suspension traction means 28 is fixed at its second end which is opposite to its first end. The second end has a smaller distance to the counter weight 14 than to the elevator cabin 12. The second end is fixed at a second counter weight side fix point 32. The distances of the first force sensor 40 and the second force sensor 42 are measured along the first suspension traction means 28.

[0028] The first cabin side fix point 30 can be fixed at the cabin itself. The second counter weight side fix point 32 can be fixed at the counter weight 14 itself.

[0029] The first suspension traction means 28 runs from the first cabin side fix point 30 over a first elevator cabin pulley 20, 21 and a second elevator cabin pulley 20, 21 for holding the elevator cabin 12. The first elevator cabin pulley 20, 21 and the second elevator cabin pulley 20, 21 are fixed at an underside of the elevator cabin 12. Then the first suspension traction means 28 runs over a two fixed pulleys 15, 16. The positions of the two fixed pulleys 15, 16 do not change during a movement of the elevator cabin 12 and the counter weight 14. Finally, the first suspension traction means 28 runs over two counter weight pulleys 25, 26 before reaching the second counter weight side fix point 32. The two counter weight pulleys 25, 26 are fixed at an underside of the counter weight 14.

[0030] The end of the second suspension traction means 29 is fixed at a third cabin side fix point 34. The third cabin side fix point 34 has a smaller distance to the elevator cabin 12 than to the counter weight 14. The first suspension traction means 28 runs from the third cabin side fix point 34 over two elevator cabin pulleys 20, 21. The elevator cabin pulleys 20, 21 for the second suspension traction means 29 can be the same as for the first suspension traction means 28. Then, the second suspension traction means 29 runs over two fixed pulleys 15, 16. The fixed pulleys 15, 16 of the second suspension traction means 29 can be the same as for the first suspension traction means 28. Then, the second suspension traction means 29 runs over two counter weight pulleys 25, 26 before reaching the fourth counter weight side fix point 36. At the fourth counter weight side fix point 36, the second suspension traction means 29 is fixed. The two counter weight pulleys 25, 26 of the second suspension traction means 29 can be the same as the counter weight pulleys 25, 26 of the first suspension traction means 28.

[0031] At each of the fix points, a force sensor 40, 42, 44, 46 is installed. The force sensor 40, 42, 44, 46 measure the force exerted on the suspension traction means, respectively. I.e., the first force sensor 40 measures the force exerted on the first suspension traction means 28 at the first fix cabin side point. The second force sensor 42 measures the force exerted on the first suspension traction means 28 at the second counter weight side fix point 32. The third force sensor 44 measures the force exerted on the second suspension traction means 29 at the third cabin side fix point 34. The fourth force sensor 46 measure the force exerted on the second suspension traction means 29 at the fourth counter weight side fix point 36.

[0032] The force sensor 40, 42, 44, 46 can convert the measured force into a frequency. This conversion can be done in two steps: First, the measured force is converted into a voltage. Then, the voltage is converted into a frequency. The wavelength of the frequency generated by the respective force sensor 40, 42, 44, 46 is proportional to the force measured by the respective force sensor 40, 42, 44, 46.

[0033] The frequency signal generated by each force sensor 40, 42, 44, 46 is sent/forwarded to a first comparison unit 50 and a second comparison unit 55. The first comparison unit 50 and the second comparison unit 55 receives the measurement values of the four force sensors 40, 42, 44, 46, respectively. Thus, there are eight input signals when there are four force sensors 40, 42, 44, 46.

[0034] Each comparison unit 50, 55 compares the received measurement values of different force sensors 40, 42, 44, 46 which are disposed at the same kind of end of one of the suspension traction means (i.e., cabin side or counter weight side). The same ends of the suspension traction means are closer to the elevator cabin 12 than to the counter weight 14 along the suspension traction means (and, thus, farther away from the counter weight 14; so-called cabin side) or are closer to the counter weight 14 than to the elevator cabin 12 (counter weight side). In Fig. 1, the same or same kind of ends of the first suspension traction means 28 and the second suspension traction means 29 are on the left side and are on the right side, respectively. The first comparison unit 50 works independently from the second comparison unit 55.

[0035] The first suspension traction means 28 normally runs parallel to the second suspension traction means 29. Thus, the force measured at the first cabin side fix point 30 and the force measured at the third cabin side fix point 34 should be equal or similar to each other. Also, the forces measured at the second counter weight side fix point 32 and at the fourth counter weight side fix point 36 should be equal or similar.

[0036] Each of the two comparison units 50, 55 compares the measurement signal of the first force sensor 40 with the measurement signal of the third sensor. The two measurement values should have an essentially constant difference or ratio (within tolerance ranges) be equal or similar. The comparing in the comparison units 50, 55 can be done via subtracting one measurement value from the other or by calculating a ratio between the first force sensor 40 and the third force sensor 44, the third force sensor 44 and the first force sensor 40 or the second force sensor 42 and the fourth force sensor 46 or the fourth force sensor 46 and the second force sensor 42.

[0037] If the comparison unit 50, 55 finds that the difference or the ratio is larger than a preset value, a warning signal generating unit 80 generates a warning signal and/or stops the elevator cabin 12. The preset value is chosen such that differences in the forces measured at uneven fix points (first fix cabin side point, third counter weight side fix point etc.) and at even fix points (second cabin side fix point, fourth counter weight side fix point 36 etc.) during normal operation of the elevator cabin 12 are below the preset values. Thus, a warning signal is only generated and/or the elevator cabin 12 is only stopped when the difference is larger than the preset value. This indicates that there is slack in at least one suspension traction means and/or one of the force sensors 40, 42, 44, 46 does not function normally anymore. Hence, at least one malfunction/failure has occurred and the operation of the elevator cabin 12 is stopped for safety reasons. Also, the force sensors 40, 42, 44, 46 responsible for stopping the elevator system can be identified in a display for maintenance personal and/or can be stored in an error memory and/or can be sent via a wire or wireless connection to a maintenance/service center.

[0038] Since only relative values, i.e., differences or ratios between measurement values, are considered, no calibration of the force sensors 40, 42, 44, 46 is necessary.

[0039] By having two comparison units 50, 55 and by inputting all measurement values in all of the comparison units 50, 55, the elevator monitoring system 10 is redundant. Even if one of the comparison unit 50, 55 fails or does not work properly anymore, the other comparison unit 50, 55 can generate/trigger the warning signal and/or stop the operation of the elevator cabin 12, if it finds that the difference/ratio between the measured values of the respective force sensors 40, 42, 44, 46 is not within a normal range.

[0040] A malfunction/failure can be a slack in one of the suspension traction means, i.e., the tension of the suspension traction means is not as intended/originally adjusted/set. Another possibility of a malfunction/failure could be that one of the force sensors 40, 42, 44, 46 is damaged.

[0041] The ratio between the measurement values of two respective force sensors 40, 42, 44, 46 (e.g., the first cabin side force sensor 40 and the third cabin side force sensor 44) can be calculated as follows:

$$(f_{\text{third force sensor}} - f_{\text{first force sensor}}) / (f_{\text{third force sensor}} + f_{\text{first force sensor}})$$

[0042] This ratio which corresponds to a percentage value is compared with a first preset value. If the ratio is larger than the first preset value, a warning signal is generated and/or the operation of the elevator system is stopped.

[0043] Alternatively or additionally, the following ratio can be calculated:

$$(f_{\text{first force sensor}} - f_{\text{third force sensor}}) / (f_{\text{third force sensor}} + f_{\text{first force sensor}})$$

[0044] If this ratio (or at least one of the two ratios) is larger than the first preset value, a warning signal is generated and/or the operation of the elevator system is stopped.

[0045] Also, it is possible that two ratios per pair of force sensors 40, 42, 44, 46 are calculated (or three ratios per triple of force sensors etc.). I.e., the ratio $f_{\text{third force sensor}} / f_{\text{first force}}$ sensor and the ratio $f_{\text{first force sensor}} / f_{\text{third force sensor}}$ are calculated. If either of the ratios is larger than the first preset value, a warning signal is generated and/or the operation of the elevator system is stopped.

[0046] A division by zero results in the value infinite or a very high value, e.g. 1 000 000.

[0047] Furthermore, it is possible that a difference and a ratio (or ratios) of pairs of force sensors 40, 42, 44, 46 (or triples, if there are three suspension traction means, etc.) are calculated and if either the difference and/or the ratio or one of the ratios is above the first preset value, a warning signal is generated and/or the operation of the elevator system is stopped.

[0048] The first preset value and the second preset value can have the same value. Alternatively, the first preset value and the second preset value are different to each other.

[0049] The measurement values can be encoded in any possible way before sending them to the comparison units 50, 55. The comparison unit 50, 55 decodes the signals to obtain the measurement values. For example, the measurement values can be not proportional to the forces measured at the respective force sensor 40, 42, 44, 46, but the signals sent via the signal lines to the comparison unit 50, 55 correspond to values of a look-up table, which gives the measurement values depending on the received signal.

[0050] The comparison units 50, 55 can either work with the frequencies, respectively, which are received from the force sensors 40, 42, 44, 46 or can convert the frequencies back to the forces measured by the force sensors 40, 42, 44, 46, respectively. For this, the sensitivity of the force sensors 40, 42, 44, 46 (Newton/Hertz) has to be known.

[0051] The comparison unit 50, 55 can compare more than two measurement values. E.g., if there are three measurement values of same ends of three suspension traction means (first cabin side force sensor 40, third cabin side force sensor 44 and fifth cabin side force sensor), the differences or ratios between all of them (i.e., two difference values or four ratio values all together) can be calculated. If one of the difference values or one of the ratio values is large than a preset value, a warning signal can be generated and/or the operation of the elevator cabin 12 can be stopped.

[0052] The measurement values of all (four) force sensors 40, 42, 44, 46 can also be input into a load management device 65. The load management device 65 is connected with a load management compensation device 66 and a calibration device 70. By this, the load of the elevator cabin 12 can be managed. The load management device 65 as well as the load management compensation device 66 and the calibration device 70 can be integrated in one of the comparison units 50, 55.

[0053] Each of the comparison units 50, 55 can close a safety chain of the elevator monitoring system 10 independently of the other comparison unit(s) 50, 55. This redundancy increases the safety of the operation of the elevator system. Additionally, each comparison unit 50, 55 can alarm an electronic safety device 60 which also shuts down the operation of the elevator cabin 12.

[0054] Furthermore, it is possible that a warning signal is only then generated and/or the operation of the elevator system is only then stopped when a difference and/or a ratio of the measurement values of the even sensors and/or the uneven sensors, respectively, are above/larger than a preset value for a time period that is longer than a given time period. This is particularly important for emergency stops of the elevator cabin 12. During an emergency stop of the elevator cabin 12, the forces exerted on the even force sensors 42, 46 and/or the uneven 40, 44 force sensors, respectively, can be very different to each other. This unevenness between forces measured by the force sensors 40, 42, 44, 46 does not last for a longer time period, e.g., in the range of one second. Thus, if large differences in the forces exerted on the force sensors 40, 42, 44, 46 which last for a time period which is equal to or less than the preset time period are "ignored", warning signals will be generated and/or the elevator system will be stopped, only if there is at least one malfunction of the suspension traction means and/or the force sensors 40, 42, 44, 46 are present. Hence, false warning signal are not or with a lesser frequency generated and/or stopping the elevator system even if there are no malfunctions of the suspension traction means and/or the force sensors 40, 42, 44, 46 are present does not happen or happens only with a lesser frequency.

[0055] The first preset value is chosen depending on the difference between the uneven force sensors 40, 44 during normal operation of the elevator system. The second preset value is chosen depending on the difference between the even force sensors 42, 46 during normal operation of the elevator system.

[0056] The car load measurement system can be part of the first comparison unit 50 or the second comparison unit 55. The elevator monitoring system 10 can be combined with an electronic safety system monitoring other safety relevant aspects and managing the electronic equivalent of the safety chain.

[0057] 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.

Reference list

[0058]

10	elevator monitoring system
12	elevator cabin
14	counter weight
15, 16	fixed pulleys
20,21	elevator cabin pulleys
25, 26	counter weight pulleys
28	first suspension traction means
29	second suspension traction means
30	first cabin side fix point
32	second counter weight side fix point
34	third cabin side fix point
36	fourth counter weight side fix point
40	first force sensor
42	second force sensor
44	third force sensor
46	fourth force sensor
50	first comparison unit
55	second comparison unit
60	electronic safety device
65	load management device
66	load management compensation device
70	calibration device
80	warning signal generating unit

Claims

1. Elevator monitoring system (10) for monitoring suspension traction means, wherein the elevator monitoring system (10) comprises:

- a first suspension traction means (28) which holds an elevator cabin (12) and a counter weight (14) movably,

wherein a first end of the first suspension traction means (28) is attached fixedly at a first cabin side fix point (30), and wherein a second end of the first suspension traction means (28), which is opposed to the first end of the first suspension traction means (28), is attached fixedly at a second counter weight side fix point (32),

- a second suspension traction means (29) which holds the elevator cabin (12) and the counter weight (14) movably,

wherein a first end of the second suspension traction means (29) is attached fixedly at a third cabin side fix point (34), and wherein a second end of the second suspension traction means (29), which is opposed to the first end of the second suspension traction means (29), is attached fixedly at a fourth counter weight side fix point (36),

- a first force sensor (40) disposed at the first cabin side fix point (30) and/or a second force sensor (42) disposed at the second counter weight side fix point (32), as well as a third force sensor (44) disposed at the third cabin side fix point (34) and/or a fourth force sensor (46) disposed at the fourth counter weight side fix point (36),

wherein the force sensors (40, 42, 44, 46) are adapted for measuring a force exerted on the respective suspension traction means at the respective fix point and for generating measurement values corresponding to the measured force, respectively,

- at least one comparison unit (50, 55), wherein the comparison unit is adapted for receiving the measurement values from the first force sensor (40), from the second force sensor (42), from the third force sensor (44) and/or from the fourth force sensor (46), and for comparing the measurement value of at least one of the first force sensor (40) and the second force sensor (42) with the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46), and
- a warning signal generating unit (80) for generating a warning signal and/or stopping the operation of the elevator cabin (12) if the comparison unit determines that a difference and/or a ratio of the measurement value of at least one of the first force sensor (40) and the second force sensor (42) and the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) is larger than a first preset value.

2. Elevator monitoring system (10) according to claim 1, wherein
the measurement values are frequency signals, respectively, in particular frequency signals with a square-wave form, respectively.

3. Elevator monitoring system (10) according to claim 1 or 2, wherein
the warning signal generating unit (80) is adapted for generating a warning signal and/or stopping the operation of the elevator cabin (12) only if either of the comparison unit determines that

-- a difference and/or a ratio of the measurement value of at least one of the first force sensor (40) and the second force sensors (42) and the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) is larger than a first preset value for a time period which is longer than a preset time period.

4. Elevator monitoring system (10) according to one of the preceding claims,
wherein
the force sensors (40, 42, 44, 46) are force sensors used for a load management of the elevator cabin (12).

5. Elevator monitoring system (10) according to one of the preceding claims, further comprising an ambient temperature sensor for measuring the ambient temperature of the suspension traction means, wherein the first preset value is modified based on the measured ambient temperature of the suspension traction means.

6. Elevator monitoring system (10) according to one of the preceding claims,
wherein the elevator monitoring system is adapted for adjusting the first preset value dynamically.

7. Method for monitoring suspension traction means which hold an elevator cabin (12) and a counter weight (14) of an elevator system,
wherein the suspension traction means comprise

- a first suspension traction means (28) which holds the elevator cabin (12) and the counter weight (14), wherein a first end of the first suspension traction means (28) is attached fixedly at a first cabin side fix point (30), and wherein a second end of the first suspension traction means (28), which is opposed to the first end of the first suspension traction means (28), is attached fixedly at a second counter weight side fix point (32),
- a second suspension traction means (29) which holds the elevator cabin (12) and the counterweight (14),

wherein a first end of the second suspension traction means (29) is attached fixedly at a third cabin side fix point (34), and wherein a second end of the second suspension traction means (29), which is opposed to the first end of the second suspension traction means (29), is attached fixedly at a fourth counter weight side fix point (36), wherein the method comprises the following steps:

-- measuring a force exerted on the first suspension traction means (28) at the first cabin side fix point (30) via a first force sensor (40) and/or a force exerted on the first suspension traction means (28) at the second counter weight side fix point (32) via a second force sensor (42), as well as a force exerted on the second suspension traction means (29) at the third cabin side fix point (34) via a third force sensor (44) and/or a force exerted on the second suspension traction means (29) at the fourth counter weight side fix point (36) via a fourth force sensor (46);
-- generating measurement values which correspond to the measured forces, respectively;
-- comparing the measurement value of at least one of the first force sensor (40) and the second force sensor (42) with the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) in at least one comparison unit (50) ; and
-- generating a warning signal and/or stopping the operation of the elevator cabin (12) if
--- a difference and/or a ratio of the measurement value of at least one of the first force sensor (40) and the second force sensor (42) and the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) is larger than a first preset-value.

8. Method according to claim 7, wherein
the measurement values are frequency signals, respectively, in particular frequency signals with a square-wave form, respectively.

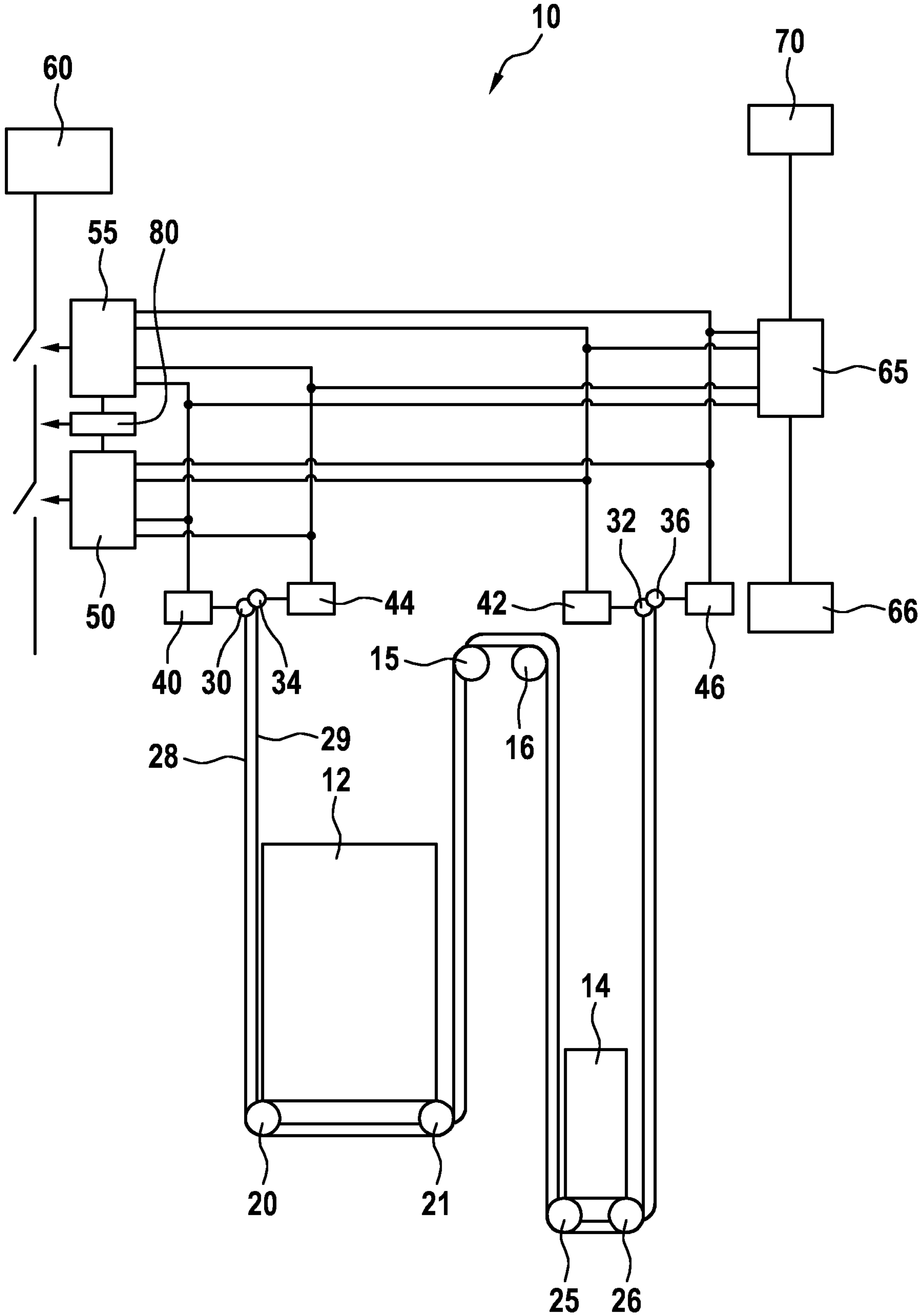
9. Method according to claim 7 or 8, wherein
a warning signal is only generated and/or the operation of the elevator cabin (12) is only stopped if

--- a difference and/or a ratio of the measurement value of at least one of the first force sensor (40) and the second force sensor (42) and the measurement value of at least one of the third force sensor (44) and the fourth force sensor (46) is larger than a first preset-value for a time period which is longer than a preset time period.

10. Method according to one of the claims 7-9, wherein
the measurement values of the force sensors (40, 42, 44, 46) are also used for a load management of the elevator cabin (12).

11. Method according to one of the claims 7-10, wherein
the first preset value is modified based on a measured ambient temperature of the suspension traction means.

Fig. 1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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 1508

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TECHNICAL FIELDS SEARCHED (IPC)

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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