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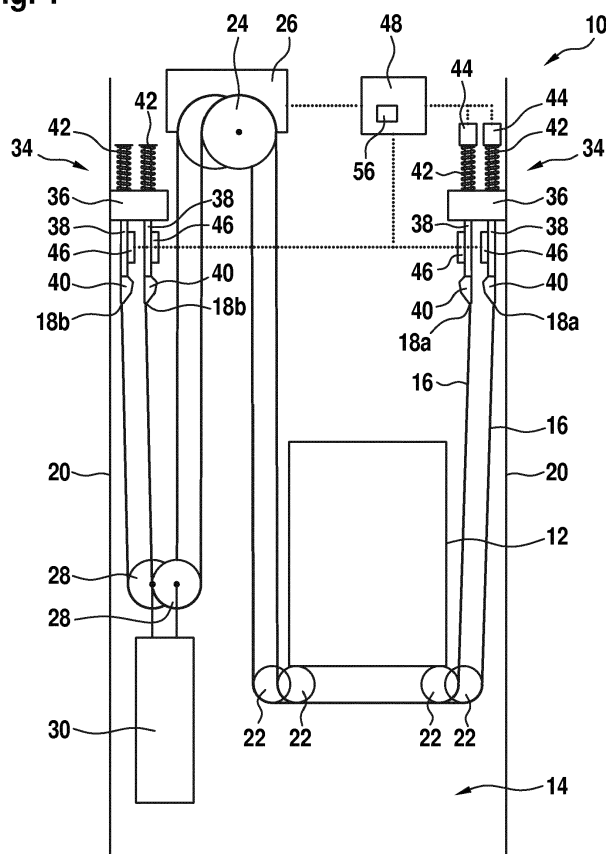
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(54) **ELEVATOR CONNECTION ASSEMBLY WITH STRAIN GAUGE**

(57) A connection assembly (34) for connecting an end (18a, 18b) of a traction medium (16) of an elevator system (10) to an elevator shaft (14) comprises a support member (36) attachable to the elevator shaft (14); a rod (38) attached to the support member (36); a mount (40)

at an end of the rod (38) for mounting the end (18a, 18b) of the traction medium (16) to the connection assembly (34); and a strain gauge (46) attached to the rod (38) and adapted for measuring a change of length of the rod (38) caused by a tension of the traction medium (16).

Fig. 1



Description

[0001] The present invention relates to a connection assembly for connecting an end of a traction medium of an elevator to an elevator shaft, a method and a controller for evaluating measurement signals from a strain gauge of a connection assembly, as well as to an elevator system.

[0002] For a correct and efficient operation, the tension of traction media of an elevator (such as cables or belts) has to be adjusted to specific values and has to be regularly monitored. For example, for checking the equalization of the tensions of two traction media, a service technician may compare the compression of two springs, which are used for cushioning the tension of two traction media. However, this method may be not accurate and depends on the feeling of the service technician, who is doing the commissioning.

[0003] US 6 123 176 shows a rope tension monitoring assembly with load cells for sensing a tension of a rope. Also, in WO 03/074406 an elevator load weighing device with load cells is shown.

[0004] There may be a need for more efficiently and/or more exactly monitor and/or adjust and/or equalize a tension in one or more elevator traction media. There also may be a need for a more efficient and safer elevator.

[0005] Such needs may be met with the subject-matter of the independent claims. Advantageous embodiments are defined in the dependent claims.

[0006] Ideas underlying embodiments of the present invention may be interpreted as being based, inter alia, on the following observations and recognitions.

[0007] An aspect of the invention relates to a connection assembly for connecting an end of a traction medium of an elevator to an elevator shaft. The connection assembly may be adapted for being connected to a sidewall of the elevator shaft, for example in the region of the uppermost floor. For example, the connection assembly may be screwed to the wall.

[0008] The traction medium may be a flexible elongated medium adapted for transferring a force from an elevator drive along its longitudinal extension. For example, the traction medium may comprise a cable and/or a belt.

[0009] The traction media may be connected with one end to a first connection assembly, may run over pulleys and/or rolls, which are connected to an elevator cabin, a counter weight and/or an elevator drive and may be connected with a second end to a second connection assembly.

[0010] According to an embodiment of the invention, the connection assembly comprises a support member attachable to the elevator shaft; a rod attached to the support member; a mount at an end of the rod for mounting the end of the traction medium to the connection assembly; and a strain gauge attached to the rod and adapted for measuring a change of length of the rod caused by a tension of the traction medium.

[0011] The support member may be adapted for being

fixed to a sidewall of the elevator shaft, for example with one or more screws.

[0012] The rod may extend in a vertical direction in the elevator shaft. It may be used for supporting a spring, which is adapted for exerting tension onto a traction medium attached to the rod. The rod furthermore may be a threaded rod, for example to thread the mount to the rod and/or to attach the rod to the support member.

[0013] The mount, usually provided at a lower end of the rod, may be any member adapted for attaching an end of the traction medium to the rod. For example, the mount may be a bracket and/or may comprise an eye, in which the end of the traction media may be mounted.

[0014] The support member, the rod and the mount may be made of metal, such as steel. They may be separate members, which are assembled together or the connection assembly (or at least the support member and the rod or the rod and the mount) may be one piece.

[0015] On the rod, one or more strain gauges may be mounted that are adapted for measuring a change of length of the rod (or at least of part of the rod) due to a tension force, which is exerted on the rod by the traction medium. For example, four strain gauges interconnected as a full-bridge circuit, based on Wheatstone bridge, may be used. The rod may be seen as a (very stiff) spring, which is stretched and/or compressed due to a tension (a force) exerted by the traction medium.

[0016] There may be one or more strain gauges attached to one rod and/or to different rods, which may be used for supporting the same or different traction mediums. The measurement signals of the one or more strain gauges may be evaluated in a controller of the elevator. As described above, the measurement signals may be based on changes in an electrical conductivity.

[0017] For example, the measurement signals may be used for determining a tension (force) on one and/or all traction media, for example for determining the load in the elevator cabin and/or for comparing tensions in different traction media. Such information may be used for adjusting and/or equalizing of tensions of traction media. Furthermore, such information may be provided to a load measurement system and/or a slack detector.

[0018] The connection assembly and/or the corresponding controller may be used in many types of elevator systems, such as systems with and without machine room, with cabin top sling or cabin under sling, etc. The structure of the remaining parts of the elevator system needs not be adapted to the connection assembly. On the other hand, the controller may have information of loads and/or tensions of many or even all components of the elevator under suspension.

[0019] According to an embodiment of the invention, the rod has an outer threading and the strain gauge is attached to the outer threading. The outer threading may be used for attaching the mount to the rod and/or the rod to the support member. The strain gauge (for example its foil) may be glued or otherwise attached to an outer surface of the rod providing the threading.

[0020] According to an embodiment of the invention, the strain gauge is based on a foil changing an electrical resistance, in particular of a conductor on the foil, when stretched. A strain gauge may comprise a flexible foil with an electrical conductor, which is stretched and/or compressed, when the foil is stretched and/or compressed. When the flexible foil is stretched and/or compressed, the electrical conductor will change its electrical conductivity in dependence of the current length of the foil in the direction it is stretched and/or compressed.

[0021] The foil may extend in a direction substantially parallel to the extension of the rod (its middle axis). For example, the foil may be attached (such as glued) to an outer surface of the rod or to a further member, which is stretched and/or compressed by the rod and/or which is attached to at least two points on an outer surface of the rod.

[0022] According to an embodiment of the invention, the connection assembly comprises at least two rods attached to the support member. For example, the rods may be used for supporting the ends of at least two traction media. A strain gauge may be attached to each rod, such that a change of length of each rod is measurable independently. In such a way, information on different tensions and/or loads in the traction media may be gathered.

[0023] A further aspect of the invention relates to a method for evaluating measurement signals from a strain gauge of a connection assembly as described in the above and in the following. For example, the one or more strain gauges are communicatively connected (for example via cables) with a controller of the elevator system, which evaluates their measurement signals and performs the method.

[0024] According to an embodiment of the invention, the method comprises: receiving measurement signals from at least one strain gauge; and determining at least one tension of at least one traction medium based on the measurement signals. The measurement signals may be based on a changing electrical resistance in the strain gauge caused by a changing length of an electrical conductor. From such measurement signals, i.e. a force onto the rod and therefrom a tension in the traction media attached to the rod may be derived.

[0025] According to an embodiment of the invention, the method further comprises: receiving measurement signals from at least two strain gauges, which are attached to at least two rods, wherein the at least two rods carry the ends of at least two traction media; and determining at least two tensions in the at least two traction media. With more than one strain gauge, the tensions in more than one traction media may be derived. For example, the elevator cabin may be lifted by two traction media and the tension in both traction media may be determined independently from each other.

[0026] When the individual tensions of some or all of the traction media are known, also so called slack belt detection may be performed. A slack traction medium

may be a traction medium which tension is substantially smaller (such as more than 20% smaller or more than 50% smaller) as the one of other traction media. In this case, the slack traction medium may be damaged, since it may not run around its pulleys in a regular way anymore and may touch parts of the pulleys not intended for guiding the traction medium. When a slack traction medium is detected, a corresponding warning message may be generated.

[0027] According to an embodiment of the invention, the method further comprises: determining a load inside a cabin of the elevator based on the at least one determined tension. From the force(s) exerted by the one or more traction media to the rods, an overall load onto the rods and therefrom a load inside the elevator cabin (for example by subtracting the empty weight of the cabin) may be determined.

[0028] According to an embodiment of the invention, the method further comprises: providing the at least one tension to a service technician via a human machine interface, such that the service technician is able to equalize the tensions manually by adjusting the connection assembly. The determined tensions and/or forces may be displayed to a technician (for example as normalized values), which may then adjust manually the tensions to desired values. Also, the technician may equalize the tension of different traction media. This may lower maintenance costs and/or may increase the quality of maintenance and quality of the final system.

[0029] According to an embodiment of the invention, the method further comprises: adjusting the tension in one or more connection assemblies based on the at least one determined tensions by actuating a motor, which moves the rod with respect to the support member. It also may be possible that the connection assembly comprises means for automatically adjusting the tension in a traction media. For example, a motor may be actuated by the controller, which then adjusts the tension by moving the rod with respect to the support member.

[0030] According to an embodiment of the invention, the method further comprises: determining at least two tensions for at least two traction media; blocking a movement of a cabin, when a difference between the at least two tensions becomes bigger than a threshold value. The measurement signals also may be used for safety reasons. When the tensions in two traction media deviate strongly from each other, it may be that one of the traction media is damaged and the operation of the elevator may be stopped.

[0031] According to an embodiment of the invention, the method further comprises: determining a cabin position dependent tension based on measurement signals, which are evaluated at least two different positions of a cabin moved by the at least one traction medium. It also may be possible that tension values are generated at different heights of the elevator cabin in the shaft. For example, tension values may be determined for every floor. These position (height) dependent tension values

may be used for further automatically monitoring the operation of the elevator.

[0032] According to an embodiment of the invention, the method further comprises: determining a possible elevator defect by comparing cabin position dependent tensions at different cabin positions with each other. For example, when the tension in one traction medium is different at a specific position of the elevator cabin, this may indicate that the traction medium may be damaged at a specific position (which is then in contact with a roll and generates a higher or lower friction). Furthermore, misaligned rolls also may result in a specific position dependent tension of a traction media.

[0033] According to an embodiment of the invention, the method further comprises: determining a possible elevator defect by comparing cabin position dependent tensions at different cabin positions with reference tensions for these cabin positions. For example, before the normal operation of the elevator, position dependent tensions (tension values) may be recorded. The reference values may be used during the normal operation of the elevator to detect changes in the behaviour of the elevator. For example, when the tension of one end of a traction media differs substantially (for example differs more than a predefined value) from the reference value, this may indicate that a roll has become defect (and causes a higher friction).

[0034] A further aspect of the invention relates to a controller of an elevator system adapted for performing the method as described in the above and in the following. For example, the controller may comprise a processor, which is adapted for executing a computer program, which performs the method as described in the above and in the following.

[0035] A further aspect of the invention relates to an elevator system, which comprises a traction medium adapted for moving an elevator cabin in an elevator shaft, at least one connection assembly as described in the above and in the following and/or a controller as described in the above and in the following. In such an elevator system, many usually used sensors may be become needless, since many information about the elevator system may be determined with the aid of one or more strain gauges.

[0036] It has to be noted that features of the connection assembly and/or the elevator system may be features of the method and/or controller and vice versa.

[0037] In the following, advantageous embodiments of the invention will be described with reference to the enclosed drawings. However, neither the drawings nor the description shall be interpreted as limiting the invention.

Fig. 1 schematically shows an elevator system according to an embodiment of the invention.

Fig. 2 schematically shows a part of a connection assembly according to an embodiment of the invention.

Fig. 3 shows a flow diagram for a method for evaluating measurement according to an embodiment of the invention.

[0038] The figures are only schematic and not to scale. Same reference signs refer to same or similar features.

[0039] Fig. 1 shows an elevator system 10, which is adapted for moving an elevator cabin 12 vertically in an elevator shaft 14. Two traction media 16 (such as cables or belts) are attached with first ends 18a to a sidewall 20 of the shaft 14, run down the shaft 14 to the elevator cabin 12, are guided around one or more pulleys (rolls) 22 attached to the cabin 12 and run up to a pulley 24, which is driven by an electrical motor 26. After that, the traction media 16 run down to a pulley 28 of a counter weight 30 and run up to be connected with their second ends 18b to a further sidewall 20.

[0040] The elevator system 10 comprises two connection assemblies 34 for supporting the ends 18a, 18b of the traction media 16 and connecting them to the respective sidewall 20. Each connection assembly 34 comprises a support member 36, which may be screwed to the respective sidewall 20 and, for each end 18a, 18b of a traction member 16, a rod 38, which is vertically aligned in the shaft 14 and attached to the support member 36. A mount 40 is attached to the lower end of each rod 38, which is adapted for mounting an end 18a, 18b of a traction member 16.

[0041] Each connection assembly 34 comprises two rods 38 and two mounts 40, which are attached to the same support member 36.

[0042] A connection assembly 34 furthermore may comprise a spring 42, which is adapted to carry a rod 38, which may be guided in the support member 36. With the spring 42, a tension of the connected traction medium 16 may be adjusted, for example by changing the length of the spring 42 by adjusting screws. However, it also may be possible that a rod 38 is fixedly connected with the support member 36.

[0043] Additionally, a connection assembly may comprise a motor 44, which may be used for automatically adjusting a tension of a traction medium 16, for example by moving a rod 38 in the support member 36.

[0044] On one, more than one or each rod 38 of a connection assembly 34 (or of all connection assemblies 34), a strain gauge 46 may be provided, which is adapted for measuring a change in length of the respective rod 38 to which it is attached.

[0045] Measurement signals of the one or more strain gauges 46 may be sent to a controller 48 of the elevator system 10, which may evaluate the measurement signals and may control one or more motors 44 for adjusting a tension in a traction medium 16 and/or the motor 26 for moving the cabin 12.

[0046] Fig. 2 shows a schematic cross-section of a part of a connection assembly 34. The rod 38 may have a threading 50, which, for example, may be used for attaching the mount 40 to the rod 38 and/or the rod 38 to

the support member 36.

[0047] The strain gauge 46 may comprise a flexible foil 52, which may be attached to an outer surface of the rod 38, for example the threading 50. For example, the foil 52 may be glued to the outer surface. It also may be possible that the rod 38 has a machined surface (at least inside a sleeve 54) and that the flexible foil 52 is attached to the machined surface, for example via gluing.

[0048] An electrical conductor is provided on the foil 52, which is stretched and/or compressed in the extension direction of the rod, when the length of the rod 36 (at least the length of the part of the rod 36, the strain gauge 46 is attached to) changes. In such a way, the electrical resistance of the electrical conductor changes, and a voltage across the electrical conductor changes and may be used as measurement signal.

[0049] The strain gauge may be protected with a sleeve 54.

[0050] Fig. 3 shows a flow diagram for a method that may be performed by the controller 48.

[0051] In step S10, measurement signals from the strain gauges 46 are received in the controller 48. The controller 48 then determines tensions of the traction media 16 based on the measurement signals. For example, the controller 48 may evaluate measured resistances, voltages and/or currents and may transform them into analog and/or digital measurement signals.

[0052] The measurement signals may indicate a change in length of the respective rod 38 and this change of length may be transformed into a force applied to the rod 38, i.e. a tension.

[0053] The corresponding rod 38 may be seen as a spring, which is compressed and/or extended by the force.

[0054] It has to be understood that the controller 48 needs not be one device situated at the site of the elevator, but may comprise different parts, which are communicatively interconnected. For example, it may comprise devices for transforming the output of the strain gauge 46 into a measurement signal, which may be situated directly at the strain gauge 46. It furthermore may comprise parts remote from the elevator system 10, which may be connected via internet with the parts at the site of the elevator system 10.

[0055] A tension may be provided in the form of a tension value, which, for example, may be a number.

[0056] In particular, tension values for each strain gauge 46, i.e. each rod 38 with a strain gauge 46 and/or each end 18a, 18b of a traction medium 16 attached to a rod 38 with a strain gauge 46 may be determined. These tension values may be determined continuously during the operation of the elevator system 10.

[0057] Furthermore, the tensions (and/or tension values) may be determined dependent on the cabin position. For example, the tension values may be supplemented with information, where the cabin 12 was positioned, when the respective tension value has been determined.

[0058] In the end, the controller may comprise a list of

actual tensions, which may be dependent on the end 18a, 18b of a traction media 16, on a traction media 16 itself and/or a cabin position.

[0059] From the following steps, the controller 48 may perform one, some or all.

[0060] In step S12, the controller 48 determines a load inside the cabin 12 of the elevator system 10 based on the determined tension(s). For example, this load may be used for controlling the movement of the cabin 12. A higher load may result in a higher power that is provided by the motor 46.

[0061] For determining the load, the controller 48 may determine an actual overall weight of the cabin 12 from the actual tension values and may subtract an empty load of the cabin 12. Reference values for tension values, when the cabin 12 is empty and/or with normed loads may be determined during a commissioning phase before the normal operation of the elevator system 10.

[0062] For example, during the commissioning phase, the controller 48 may learn tension values for "empty cabin" and "reference load" on different levels and/positions of the shaft 14 (such as in the bottommost, middle and topmost floors). When a service technician starts a corresponding software in the controller 48, while the cabin is empty, the controller 48 may acquire the tensions on different points of the shaft 14 by moving the cabin to these points. After that, the service technician may put loads inside the cabin and may start a further software for acquiring the tensions for a reference load. The software then may acquire the (usually different) tensions on different points of the shaft 14.

[0063] In step S14, the controller 48 provides the determined tensions to a service technician via a human machine interface 56 (see Fig. 1), such that the service technician is able to equalize the tensions manually by adjusting the corresponding connection assembly 34, for example by adjusting screws screwed onto the corresponding rod 38. For example, the human machine interface 56 may be connected to the controller 48 or may be provided by a further device (such as a laptop) carried by the service technician.

[0064] However, the controller 48 alternatively or additionally may control further equipment of the elevator system 10 itself and/or may generate warning messages based on the determined tensions. For example, after the commissioning, the controller 48 may constantly check if some adjustments are needed.

[0065] In step S16, the controller 48 adjusts the tensions in one or more connection assemblies 34 based on the determined tensions by actuating one or more of the adjustment motors 44.

[0066] In step S18, the controller 48 compares actual tension values of two different traction media 16 and blocks a movement of the cabin 12, when a difference between the tension values becomes bigger than a threshold value. For example, when one of the traction media becomes damaged, the tensions in the traction media 16 may become significantly different, what may

be detected by the controller 48. In this case, the controller 48 may stop and/or block an operation of the elevator system 10 due to safety reasons.

[0067] During normal operation of the elevator system 10, the controller 48 may constantly check an equalization of the tensions of the traction media 16. If there is a small deviation, the controller 48 may generate a warning message, which, for example, may be written to an internal error log. The warning message also may be sent to an external service provider and/or to a remote monitoring system.

[0068] For example in the case of a slack of a traction medium 16, which may be detected in such a way, the elevator system 10 may be blocked until an inspection by a service technician.

[0069] In step S20, the controller 48 determines possible elevator defects by comparing actual tension values either with each other or with previously acquired reference values. A warning message with a detected possible defect may be transmitted to an external service provider, for example via Internet.

[0070] As a first example, the controller may compare cabin position dependent tensions at different cabin positions with each other. In such a way, it may be detected that the traction medium has a section with low quality, which may result in a higher friction, when this section is pulled around one of the pulleys 22, 24, 28.

[0071] As a second example, cabin position dependent tensions at different cabin positions may be compared with reference tensions for these cabin positions. The reference tensions may have been acquired during a commissioning phase as explained above. When actual tensions are compared with tensions acquired during a phase, in which the elevator system 10 was surely operating correctly, differences in the tension values may indicate wear of components.

[0072] 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 signs

[0073]

10	elevator system
12	elevator cabin
14	elevator shaft
16	traction medium
18a	first end
18b	second end
20	sidewall
22	pulley
24	pulley
26	motor

28	pulley
30	counter weight
34	connection assembly
36	support member
5 38	rod
40	mount
42	spring
44	motor
46	strain gauge
10 48	controller
50	threading
52	foil
54	sleeve
56	human machine interface

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Claims

1. A connection assembly (34) for connecting an end (18a, 18b) of a traction medium (16) of an elevator system (10) to an elevator shaft (14), the connection assembly (34) comprising:
 - a support member (36) attachable to the elevator shaft (14);
 - a rod (38) attached to the support member (36);
 - a mount (40) at an end of the rod (38) for mounting the end (18a, 18b) of the traction medium (16) to the connection assembly (34);
 - a strain gauge (46) attached to the rod (38) and adapted for measuring a change of length of the rod (38) caused by a tension of the traction medium (16).
2. The connection assembly (34) of claim 1, wherein the strain gauge (46) is attached to an outer surface of the rod (38); and/or wherein the rod (38) has an outer threading (50) and the strain gauge (46) is attached to the outer threading (52).
3. The connection assembly (34) of claim 1 or 2, wherein the strain gauge (46) is based on a foil (52) changing an electrical resistance, when stretched.
4. The connection assembly (34) of one of the preceding claims, wherein the connection assembly (34) comprises at least two rods (38) attached to the support member (36); wherein a strain gauge (46) is attached to each rod (38), such that a change of length of each rod (38) is measurable independently.
5. A method for evaluating measurement signals from a strain gauge (46) of a connection assembly (34) of one of the preceding claims, the method comprising:

- receiving measurement signals from at least one strain gauge (46);
determining at least one tension of at least one traction medium (16) based on the measurement signals.
- 5
6. The method of claim 5, further comprising:
- receiving measurement signals from at least two strain gauges (46), which are attached to at least two rods (38), wherein the at least two rods (38) carry the ends (18a, 18b) of at least two traction media (16);
determining at least two tensions in the at least two traction media (16).
- 10
7. The method of claim 5 or 6, further comprising:
- determining a load inside a cabin (12) of the elevator system (10) based on the at least one determined tension.
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8. The method of one of claims 5 to 7, further comprising:
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- providing the at least one tension to a service technician via a human machine interface (56), such that the service technician is able to equalize the tensions manually by adjusting the connection assembly.
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9. The method of one of claims 5 to 8, further comprising:
- adjusting the tension in one or more connection assemblies (34) based on the at least one determined tensions by actuating a motor (44), which moves the rod (38) with respect to the support member (36).
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10. The method of one of the claims 5 to 9, further comprising:
- determining at least two tensions for at least two traction media (16);
blocking a movement of a cabin (12), when a difference between the at least two tensions becomes bigger than a threshold value.
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- 50
11. The method of one of claims 5 to 10, further comprising:
- determining a cabin position dependent tension based on measurement signals, which are evaluated at at least two different positions of a cabin (12) moved by the at least one traction medium (16).
- 55
12. The method of claim 11,
determining a possible elevator defect by comparing cabin position dependent tensions at different cabin positions with each other.
13. The method of claim 11 or 12, further comprising:
- determining a possible elevator defect by comparing cabin position dependent tensions at different cabin positions with reference tensions for these cabin positions.
14. A controller (48) of an elevator system (10) adapted for performing the method of one of the claims 5 to 13.
15. An elevator system (10), comprising:
- a traction medium (16) adapted for moving an elevator cabin (12) in an elevator shaft (14);
at least one connection assembly (34) according to one of the claims 1 to 4; and/or
a controller (48) according to claim 14.

Fig. 1

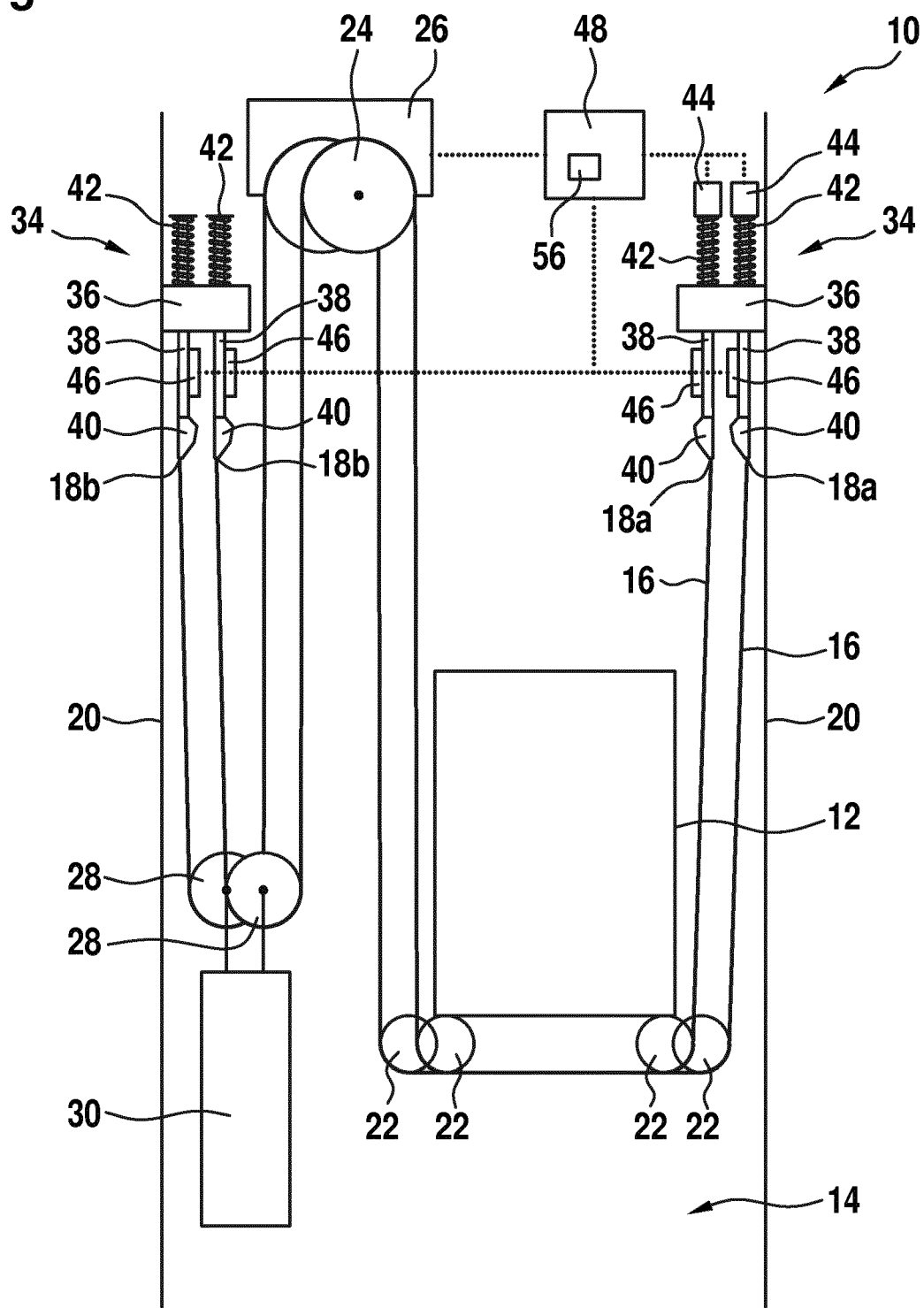


Fig. 2

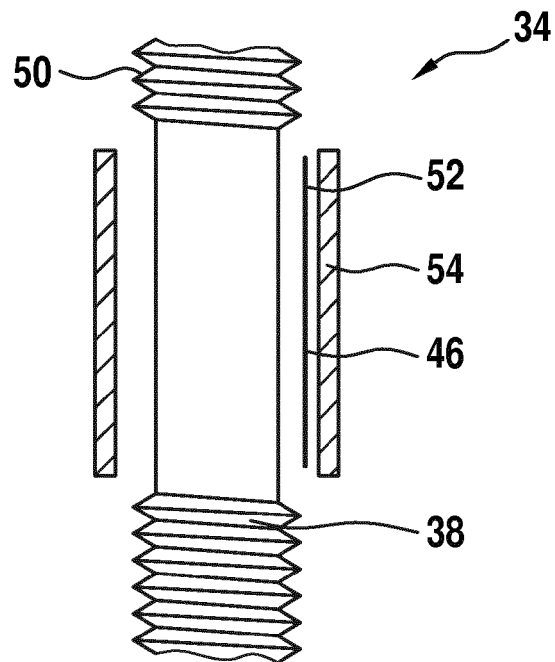
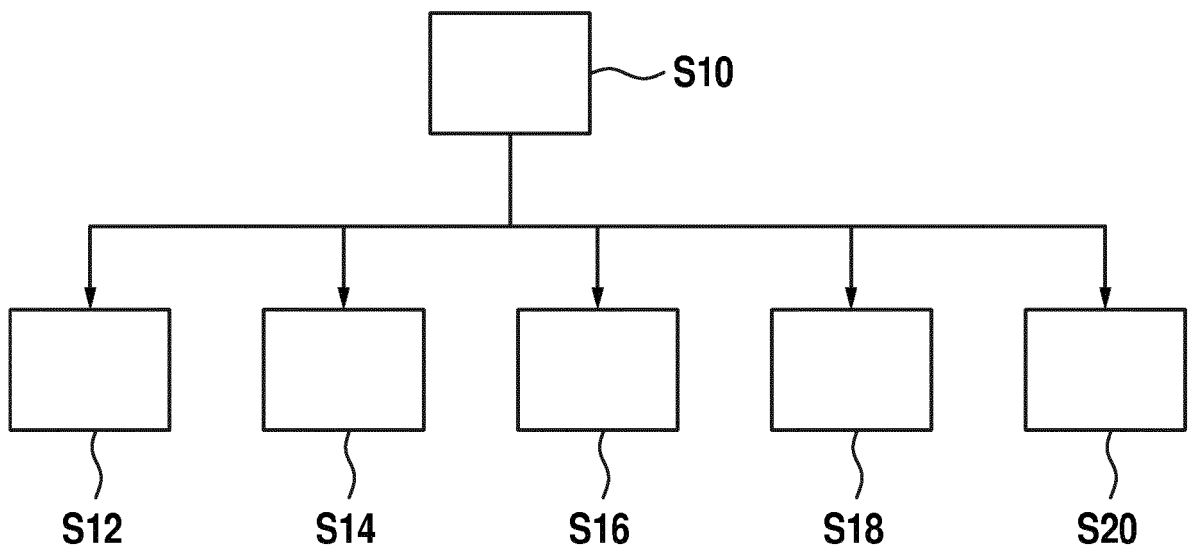


Fig. 3





EUROPEAN SEARCH REPORT

Application Number
EP 16 15 6941

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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	KR 100 923 174 B1 (OTIS ELEVATOR CO) 22 October 2009 (2009-10-22) * abstract; figures 3, 4 * * paragraphs [0040] - [0066] * -----	1-15	INV. B66B7/10 B66B1/34
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 July 2016	Examiner Bleys, Philip
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 03.02 (P04C01)

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EP 16 15 6941

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27-07-2016

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EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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